Energy Economics 134 (2024) 107546

Contents lists available at ScienceDirect

Energy Economics

journal homepage: www.elsevier.com/locate/eneeco

Nudges versus prices: Lessons and challenges from a water-savings program

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ARTICLE INFO

JEL:
C93
D03
D49
D91
L95
O12

Keywords:
Peer effects
Social norms
Randomized evaluation
Water tariffs
Water utilities

ABSTRACT

This study evaluates the effects of two exogenous interventions targeting residential consumers using both pecuniary and nonpecuniary incentives, with the potential of increasing the moral and monetary costs of water use. The first intervention provided households with personalized reports including normative information regarding household water use compared with neighbors. The second intervention consisted of an exogenous change in water tariffs. The timing of the interventions provides a unique opportunity to separately assess both the individual and combined effects of each policy instrument. The empirical analysis was conducted on the same sample households assessed in the field experiment by Jaime and Carlsson (2018), whose behavior was followed one year after implementation. The results reveal that both nonpecuniary and pecuniary incentives significantly reduce water use when each instrument is applied separately, with the change in tariffs generating larger reductions in water use, compared with information provision, at 11% vs. 7%, respectively. However, the effectiveness of the combined policy depends on the setting of implementation. While the differentiated effects of the social information campaign associated with the change in tariffs suggest this policy remains effective, the evidence also suggests potential crowding-out effects arising upon the introduction of the new tariff regime. The largest reductions in water use are achieved when the instruments are jointly implemented. Findings shed light on the importance of accurately defining the timing and order of the interventions to maximize their impact on resource conservation.

1. Introduction

Estimation of residential water demand is an ongoing and increasingly relevant topic due to its nature and importance in the field of consumption as well as the potential effects of water's availability due to climate change, and the pressure imposed by human behavior as societies evolve. The problems of water scarcity and water stress faced by many societies have been aggravated by population growth and climate change (Wang et al., 2016; Goette et al., 2019). Therefore, the combination of water supply and water demand management strategies to adapt to increasing water scarcity and various environmental uncertainties are particularly relevant, as water access directly affects individuals' health and wellbeing, the environmental quality of urban areas, and economic development (Vairavamoorthy et al., 2008; He et al., 2021).

Given the growing demand for water and the uncertainty of future water supply, it is essential that users internalize the notion that water is a scarce resource (He et al., 2021). The use of interventions and combinations of instruments represent an important tool to address environmental problems by changing the behavior of individuals (Maris et al., 2024). Because of their distinct nature, pecuniary and nonpecuniary incentives appear to be suitable instruments for sustainable water management. A growing body of literature focuses on the effects of exogenous changes on pecuniary incentives (e.g., price changes) (Olmstead and Stavins, 2009; Marzano et al., 2018; Li and Jeuland, 2023) or nonpecuniary incentives (e.g., provision of social information, social comparisons, nudging, etc.) (Nauges and Whittington, 2019) on water demand.

The use of pricing policies to induce conservation behavior along with the need to stabilize utility-level revenue, are important mechanisms for regulating water demand, where increased prices lead to reductions in residential water use (Baerenklau et al., 2014; Ghimire et al., 2016; Ebbs et al., 2018; López Rivas, 2019; Goette et al., 2019; Rajapaksa et al., 2019; Garrone et al., 2020; Browne et al., 2021; Li and

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https://doi.org/10.1016/j.eneco.2024.107546
Received 2 May 2023; Received in revised form 3 April 2024; Accepted 12 April 2024
Available online 18 April 2024

Jeuland, 2023). Browne et al. (2021) show that increased water prices explain between 40% and 44% of the changes in residential water use among households in Fresno, California. Garrone et al. (2020) highlight the importance of pricing as a mechanism to induce consumers' water conservation behavior, compared to alternative mechanisms. Besides, Li and Jeuland (2023) analyze the effects on residential water demand in response to a non-linear price structure originated by a water pricing reform in a major city in China. Findings evidence a small effect on low-consumption households, but large savings among high-consumption households.

Nonpecuniary conservation programs, such as the use of social information or appealing to norm-based behavior, and peer-consumption comparisons are also found to be of relevant influence on individuals' consumption decisions, with a significant impact on behavior and the environment (Carlsson et al., 2021a). A series of randomized experiments designed to promote water and energy conservation suggest that it is possible to affect individuals' behavior by delivering messages that appeal to prosocial/environmental behavior, achieving significant reductions in water, gas, and electricity use (Ferraro et al., 2011; Allcott, 2011; Ferraro and Price, 2013; Costa and Kahn, 2013). Similarly, there is evidence regarding the positive effect of normative messages (e.g., descriptive and/or injunctive norms), which are shown to be an effective way to promote conservation efforts in residential households in both developed countries (Ferraro et al., 2011; Ferraro and Price, 2013; Costa and Kahn, 2013; Bernedo et al., 2014; Ito et al., 2018) and developing countries (Jaime and Carlsson, 2018; Sengupta, 2020; Carlsson et al., 2021b; Kažukauskas et al., 2021; Lurbé et al., 2023). Ferraro and Price (2013) evidence that while prosocial messages reduce water use by almost 3%, average treatment effects are larger when households receive normative-based messages (4.8%). Jaime and Carlsson (2018) evidence the existence of both direct and indirect (spillover) effects of an information campaign appealing to norm-based behavior on residential water use. While direct effects (assuming the existence of spillovers) reveal a reduction in water use of ~13% 1 year after the intervention, households that were not targeted by the campaign also experienced a reduction of ~6% 6-months after the start of the campaign. The findings suggest that nonpecuniary incentives have the potential to modify patterns of water use in the desired direction. List and Price (2016) suggest that targeted messages that frame resource conservation as a normative behavior are also powerful tools for managing residential water use. The rationale behind their use is that nonpecuniary incentives have the potential to generate long-lasting changes in individuals' behavior through the introduction of moral costs/rewards, which are comparable to the role of monetary incentives in generating economic costs/payoffs (Lindbeck, 1997).

Although considerable evidence demonstrates that resource conservation can be achieved through a range of pecuniary and nonpecuniary instruments, the synergies and trade-offs resulting from a combination of policies that could effectively change individuals' behavior in the desired direction remain a subject of ongoing debate (Browne et al., 2021; List et al., 2023; Maris et al., 2024). This motivates our main question: Is changing prices more effective than nudging for achieving efficient water residential water use? To our knowledge, evidence regarding the effects of the interaction of such policies among the same population of individuals is rather limited. As Nayar (2017) notes, while pecuniary action and coercive regulation have a minimal effect on water conservation, the introduction of pecuniary incentives may not only affect individuals' perceptions of autonomy, but may also reduce motivation for adopting pro-environmental behavior, as individuals are unable to distinguish whether their participation is voluntary or economically motivated in the presence of such incentives (Bénabou and Tirole, 2003; Bénabou and Tirole, 2006; Frey and Stutzer, 2008; Gneezy et al., 2011). Nevertheless, there is ample evidence supporting the role of pricing in achieving efficient water management. In contrast, information provision may be preferred to price increases when prices are already prohibitively high and price elasticities are small in magnitude. These instruments are also preferred when demand is price inelastic and further price increases are necessary to generate reductions in water use. Conversely, when prices are below average costs, utilities target a sustained reduction in water use through rate reform (Nauges and Whittington, 2019).

To the extent of our knowledge, only a few studies are devoted to analyzing the combined effects of targeting individuals with both pecuniary and nonpecuniary incentives (see, e.g., Halvorsen, 2012; Mizobuchi and Takeuchi, 2013; Pellerano et al., 2017; List et al., 2023). Pellerano et al. (2017) assess the performance of intrinsic normative messages and extrinsic financial incentives on residential electricity use in Ecuador. Results evidence that financial incentives in the form of persuasion messages do not generate further reductions in electricity use, as compared with providing normative messages alone. Similarly, Halvorsen (2012) analyses households' voluntary contributions to recycling in a sample of 10 OECD countries, where an ample range of recycling schemes are in place. Findings suggest that the design of monetary incentives in place matters to increase recycling rates. Moreover, these studies evidence that monetary incentives crowd out morally motivated behavior, which is detrimental to resource conservation. List et al. (2023) conduct a meta-analysis to estimate welfare effects of both nudges and taxes stemming from a series of pecuniary and nonpecuniary interventions in the market for cigarettes, influenza vaccinations, and household energy. In these markets, behavioral biases are allegedly ubiquitous. Findings suggest that, despite nudges being effective in changing behavior in these markets, they are not necessarily the most efficient policy. While nudges are superior to taxes in potentially reducing the heterogeneity in behavioral distortion, taxes have the advantage of internalizing the marginal externality. Thus, whenever the heterogeneity in bias is large relative to the size of the externality, nudges dominate taxes. Results shed light on the importance of estimating these statistics to inform policy design. This paper differs from this literature in two main aspects. First, our analysis focuses on actual behavior by households in response to the instruments in place, as registered by the water utility. Second, monetary incentives take the form of an exogenous tariff increase affecting the cost of using water for our sample of individuals.

In this study, we analyze the effects of two exogenous interventions targeting residential customers in Colombia with both pecuniary and nonpecuniary incentives, with the potential to increase the moral and monetary costs of consuming water. The first intervention provided households with personalized reports that included normative information regarding households' water use compared with neighbors. This intervention was intended to increase the moral costs of consuming water when not behaving according to the social norm of efficient water use. The second intervention consisted of an exogenous change in tariffs, raising the monetary cost of consuming water. The order and timing of these interventions provide a unique opportunity to assess not only the effects of each intervention on actual behavior separately, but also the combined effect of being targeted by this policy mix. The empirical analysis was conducted on the same sample of households in Jaime and Carlsson (2018). To our knowledge, this study is one of the first attempts to evaluate the effects of two different interventions on actual behavior among the same population of individuals at different points in time. An assessment of the interplay between pecuniary and nonpecuniary incentives has the potential to unravel the synergies and tradeoffs embedded in this policy mix (i.e., whether they can be understood as substitute or complementary policy instruments). The importance of understanding this relationship has been previously highlighted in the work of List and Price (2016) and Rajapaksa et al. (2019). Our experimental design allows estimating the effects of interest while focusing on the same sample of individuals, which offers a suitable setting for identification.

The remainder of the study is organized as follows. Section 2 presents the experimental design and data, Section 3 details the econometric approach, Section 4 examines the results, and Section 5 presents the

conclusions and policy recommendations.

2. Material and methods

2.1. Experimental design

This study is constructed using information obtained in a field experiment conducted by Jaime and Carlsson (2018), which took place in the municipality of Jericó, located in the southeastern subregion of Antioquia in Colombia. In this study, the local water utility provided information on residential customers' actual water consumption from December 2011 to December 2013. The analysis considers all residential accounts with consumption meters meeting the technical requirements that worked correctly for at least three months, to control for consumers' possible intentional manipulation. A sample of 1311 households met these requirements and were exposed to the social information campaign. Because this study sought to assess the direct and indirect effects of the information campaign, a random sample of 500 households from a nearby town with similar characteristics was also included as the control group.[1]

Building on the study by Jaime and Carlsson (2018), we continue the analysis by observing the behavior of the same group of households following the end of the information campaign in December 2023. The local utility granted access to information on households' actual water use from July to December 2014. This period was preceded by an exogenous increment in the cost of water consumption in Jericó. This change came into force in May 2014, after a series of protests by consumer associations in the town.[2] Because water consumption records during the protest period were unavailable, our period of analysis corresponds to the months under the initial tariff regime (i.e., December 2011 to December 2013), and the months following the approval of the revised regime (i.e., July to December 2014). Meanwhile, the tariff regime in the control town remained unchanged.

2.2. Pecuniary and nonpecuniary incentives

Our experimental design includes two exogenous interventions that took place at different points in time. The first policy comprises the introduction of nonmonetary incentives (i.e., a social information campaign). This campaign provided information to households on the amount of water used by neighboring households with similar characteristics in comparison to their own water use (Jaime and Carlsson, 2018). The second policy was implemented six months following the completion of the information campaign, consisting of a tariff change that modified the existing price structure, increasing the cost of water consumption.

Households participating in the social information campaign were randomly assigned to either a targeted group (receiving information reports along with their water bills) or an untargeted group (receiving their water bills as usual), with 656 and 655 households assigned to each group, respectively. The households targeted by the information campaign received personalized consumption reports, which included a message appealing to both descriptive and injunctive norms. This report was received monthly with the water bill, for one year, starting in January 2013. The information contained in the reports was based on the water consumption billed in the corresponding month, and untargeted households did not receive additional reports or messages. An additional sample of 500 households from a nearby town (Támesis) was also drawn to assess the existence of spillover effects. Households in this town are regarded as the control group.

The consumption reports had three components. The first component is the *Social Comparison Component*, which includes descriptive and injunctive norms. In the descriptive norm section, each household is compared to the mean and 25th percentile of its comparison group, while the injunctive norm section ranks households as *Excellent*, *Average*, or *Room to Improve*. The second component is the *Information Component*, in which households receive a detailed explanation of the environmental implications of being in a specific category. Finally, the third was the *Opting-out Component*, in which households could decide to stop receiving consumption information. According to Jaime and Carlsson (2018), the channels through which information treatment operates are related to the moral utility experienced by individuals when saving water, because this contributes to ameliorating the negative effects of excessive water consumption. As the provision of social information creates or reinforces the notion of an acceptable level of water use, households that receive consumption reports are more likely to experience moral benefits, compared to those that do not receive such reports. In addition, when receiving consumption reports, households realize that their actions are being observed; therefore, a reduction in the average water use of households in the targeted group, compared to households in the untargeted group (i.e., in the same city) or the control group (i.e., in a different city) was expected (Ferraro and Price, 2013; Jaime and Carlsson, 2018).

After the implementation of the information campaign, an exogenous change occurred in the tariff regime in place in the city of Jericó. Water pricing in Jericó consists of a two-block tariff structure and a cross-subsidy scheme.[3] Consequently, targeted and untargeted households in this city faced a tariff increase of about 12% for the first consumption block (1–20 m^3), and about 38% for the second consumption block (>20 m^3). In contrast, households in the control group (i.e., those in the city of Támesis) maintained the existing pricing scheme and did not experience an increase in the cost of water consumption. In policy terms, the option to increase tariffs would send a signal to households regarding the cost of providing water services; therefore, if prices were higher, residential water use would be closer to the socially optimal level. Consequently, the channel through which the price treatment operates is a price and income effect, whereby an increase in tariffs makes consumption of an additional m^3 of water more costly, and thus, an increase in prices reduces water consumption. The changes in prices in the town of Jericó and the percentage of households falling in the first and second consumption blocks are presented in Tables A1 and A2 (Appendix A), respectively. A timeline of the intervention is depicted in Fig. 1.

The timing of these interventions presents us with three subsamples of interest: (*i*) *targeted households* (affected by both the information campaign and the exogenous change in tariffs), (*ii*) *untargeted households* (affected only by the tariff change), and (*iii*) *control households*, which were not targeted by either intervention due to their location on a different city. The composition of the subsamples of interest is depicted in Fig. 2. Focusing on the behavior of these three population groups allows us to assess both individual and combined effects of pecuniary and nonpecuniary incentives.

[1] For further information regarding experimental design, see Jaime and Carlsson (2018).

[2] In February 2014, upon finalization of the social information campaign by Jaime and Carlsson (2018), there was an unexpected change in water tariffs in the town of Jericó. This change generated a series of protests by consumers, who refused to pay their water bills. Thus, the managers of the utility had to lower this increment, generating a revised set of tariffs. This second -and definitive- change took place in May 2014. Because this process implied negotiations between consumer associations and the utility, water consumption was not billed for a couple of months, until an agreement had been made, and the system was functioning again. This occurred in June 2014, and the utility gave us access to consumption data during the period July – December 2014.

[3] Housing in Colombia is classified into six income strata for policy purposes. Strata 1–3 denote the poorest and lower-middle-income households, and strata 4–6 denote upper-middle- and upper-middle-income households. All households in Jericó are beneficiaries of subsidies.

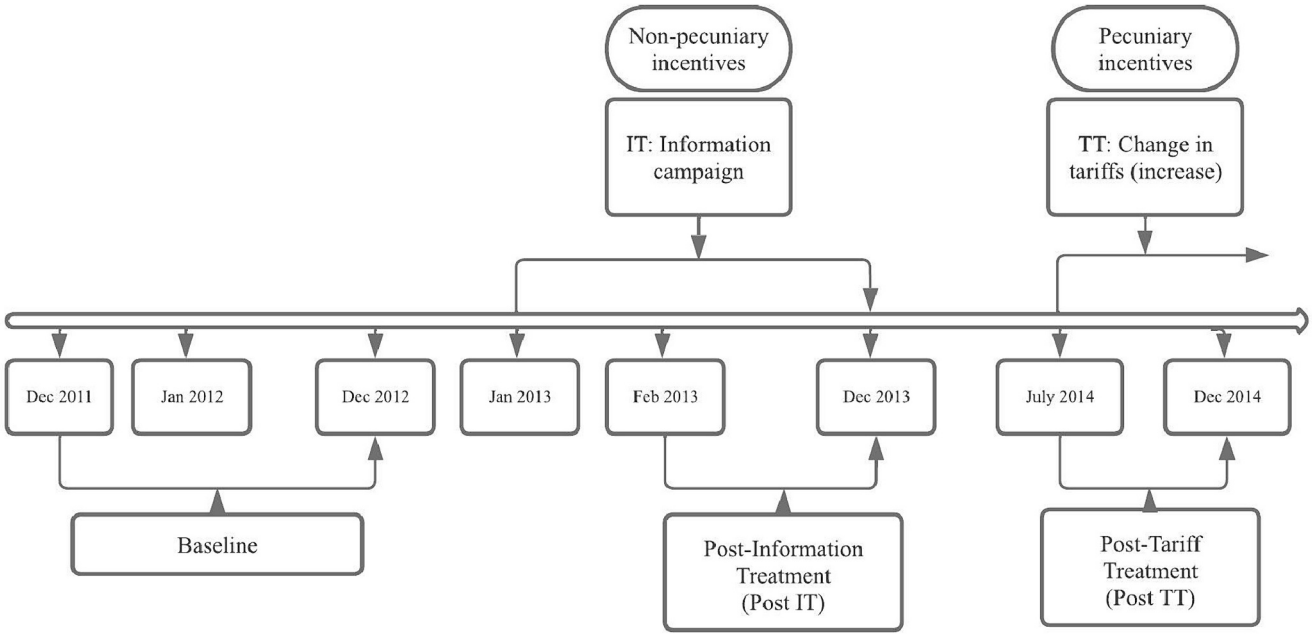

Fig. 1. Timeline of the pecuniary and nonpecuniary interventions.
Source: Own elaboration.

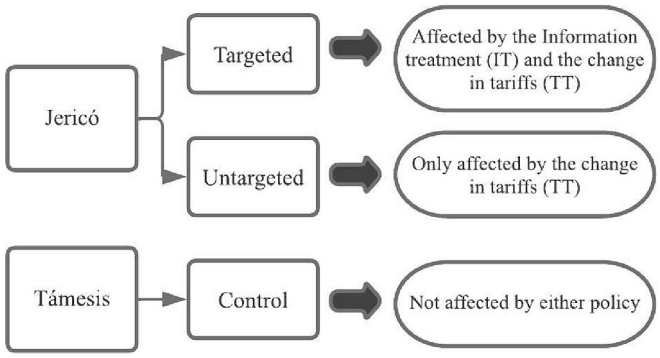

Fig. 2. Definition of subsamples of households of interest.
Source: Own elaboration.

2.3. Data and baseline characteristics

The water utility granted us access to actual monthly consumption data from December 2011 to December 2013, and from July to December 2014. As the consumption reports were sent from January 2013 to January 2014, we obtained a series of pre- and post-treatment observations. Similarly, the change in tariff structure was implemented in 2014, for which, the period of interest corresponds to the months from July to December 2014.[4] Fig. 3 illustrates the average water consumption during the period studied for targeted and untargeted households in the town of Jericó (i.e., the locality targeted by the information campaign and affected by the change in tariffs). This figure indicates higher variation in the patterns of water use in the baseline period, which becomes smoother following the two interventions.

Table 1 presents the average water use, average price of consuming water, and socioeconomic and household characteristics in the pre-treatment period (baseline) for the subsample of households under study. Monthly water consumption at the household level ranges between 12.66 and 14.34 cubic meters per month among the subgroups of interest. The average price paid per cubic meter of water consumed by households is US$1.05.[5] Regarding the socioeconomic characteristics of the households targeted by both treatments, on average, 26% of the population of the group analyzed is male, the population is 51 years of age on average, and has an average level of 8 years of schooling. The average household monthly income is US$ 260.07. In addition, households include four members, on average. In terms of housing, 57% of households own their home, and 36% rent the house in which they live. The average dwelling size is approximately 61 square meters, with an average of seven rooms. The data also reveal that 4% of the dwellings have a terrace, 22% have a garden, ~19% have multi-story houses, the average age of the houses is ~28 years, and have one bathroom, on average.

We conduct tests of difference in means to evaluate the balance of covariates in the pre-treatment period, finding no evidence of statistically significant differences between targeted and untargeted households. However, when comparing targeted and untargeted households (town of Jericó) with those in the control group (town of Támesis), statistically significant differences in some covariates emerge. Specifically, the average water consumption of targeted and untargeted households differs from that of the control group, and for a lower number of households' characteristics. This circumstance can be explained by the fact that randomization took place at the individual level rather than at the town level. These differences will be addressed in the empirical analysis, following the same procedure conducted by Jaime and Carlsson (2018).

3. Empirical strategy

Our empirical strategy is based on reduced-form specifications. We aim at evaluating direct effects on households' water use resulting from pecuniary and non-pecuniary interventions taking place at different points in time. A special focus is given to analyzing the effects of their interactions, including: (1) the effect of information provision, (2) the

[4] There is a period lacking information, for which the utility company did not deliver measurements due to social unrest because of the sudden change in the tariff structure in force in the city of Jericó.

[5] Figures are expressed in US dollars. 1US$ = 1847.91 COP (May 2, 2013).

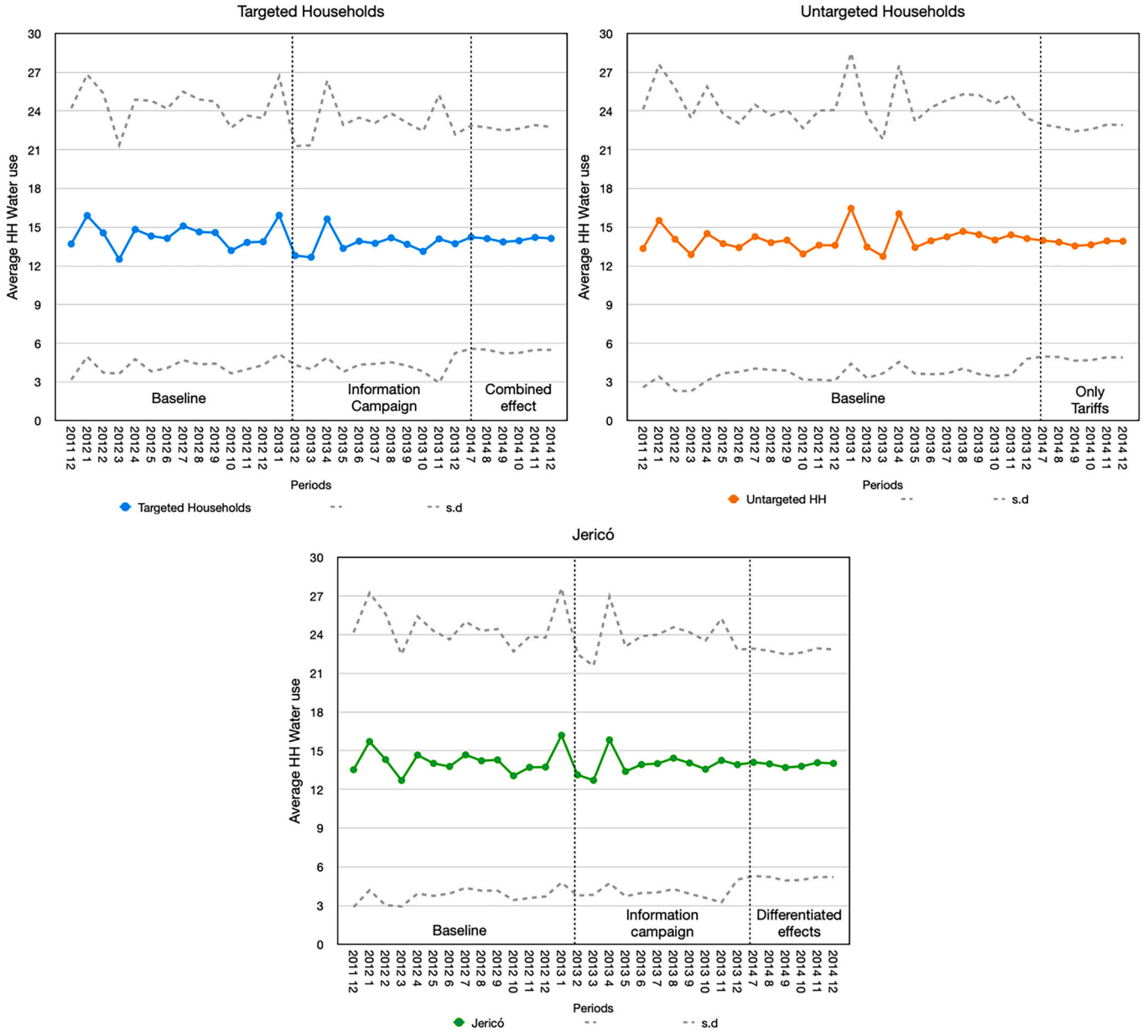

Fig. 3. Average water use (Dec. 2011 – Dec. 2014).
Source: Own elaboration.

effect of an exogenous change in the monetary cost of water consumption that occurred following the information campaign, and (3) the combined effects of both interventions.[6] We use the difference-in-differences estimator to estimate the effects of interest.

3.1. Homogeneous effects

We begin by analyzing the direct effects of the interventions on the subsamples of households of interest. First, we replicate the analysis of the effects of the information campaign on water use from Jaime and Carlsson (2018) by comparing the subsamples of targeted and untargeted households in Jericó, assuming the absence of spillover effects. Hereinafter, we refer to this analysis as the *information-only treatment*. The main specification is given by Eq. (1) as follows:

$$ln(w_{it}) = \alpha T_{IT} Post_{ITit} + \beta Post_{ITit} + \mu_t + v_i + \varepsilon_{it} \quad (1)$$

where w_{it} denotes the water use of household i in period t; T_{IT} is a dichotomous variable that indicates the state of treatment, which equals 1 if the home is treated by the information campaign and 0 otherwise; $Post_{ITit}$ is an indicator of post-treatment information that equals 1 from February 2013 to December 2013, and 0 otherwise; μ_t denotes month-by-year variables; v_i represents fixed effects; and ε_{it} is the error term. Because targeted and untargeted households in Jericó are the same in the baseline, the direct effect of the information treatment is consistently estimated through parameter α.

We continue by analyzing the effect on water use in response to the exogenous change in water tariffs (i.e., tariffs-only treatment) by

[6] Because of the existence of significant differences in terms of the timing, length, and subpopulations of households affected by either intervention -and the subsequent combination of interventions-, it is not possible to estimate the effects of the interest and test our hypotheses through the estimation of only one equation. Instead, the proposed empirical strategy exploits the variations in the timing of the interventions in the subpopulations of interest.

Table 1
Descriptive statistics of the main variables.

Variable	Targeted			Untargeted			Control			Test for diff. in means		
	N	Mean	sd	N	Mean	sd	N	Mean	sd	*p*-value (T-U)	*p*-value (T-C)	*p*-value (U-C)
	Water use											
Water use [m^3/month]	656	14.34	10.20	655	13.99	10.72	500	12.66	11.74	0.48	0.00	0.00
	Socioeconomic Characteristics											
Gender [1 = male; 0 = female]	645	0.25	0.44	639	0.26	0.43	500	0.25	0.43	0.97	0.81	0.77
Age [No. years]	645	51.20	16.18	639	51.60	15.72	500	48.54	15.75	0.62	0.01	0.00
Education [No. years]	645	7.94	4.67	639	8.26	4.84	500	7.16	4.22	0.22	0.00	0.00
Household members [No.]	645	3.34	1.73	639	3.34	1.82	500	3.25	1.83	0.96	0.43	0.00
Household income [US$/month]	645	260.07	311.34	639	253.32	270.69	500	280.81	192.54	0.68	0.19	0.00
Own dwelling [yes = 1; 0 = no]	645	0.57	0.50	639	0.57	0.50	500	0.49	0.50	0.94	0.01	0.00
Rented dwelling [yes = 1; 0 = no]	645	0.36	0.48	639	0.35	0.48	500	0.41	0.49	0.78	0.06	0.00
Family dwelling [yes = 1; 0 = no]	645	0.07	0.27	639	0.08	0.27	500	0.10	0.30	0.72	0.10	0.00
	Characteristics of the dwelling											
Dwelling size [M^2]	645	60.78	41.55	639	62.43	42.40	500	45.61	34.08	0.48	0.00	0.00
Rooms in dwelling [No.]	645	7.30	2.11	639	7.46	2.24	500	6.73	2.02	0.17	0.00	0.00
Terrace [yes = 1; 0 = no]	645	0.04	0.20	639	0.04	0.19	500	0.08	0.27	0.80	0.01	0.00
Garden [yes = 1; 0 = no]	645	0.22	0.41	639	0.19	0.39	500	0.23	0.42	0.22	0.75	0.00
Several floors [yes = 1; 0 = no]	645	0.19	0.39	639	0.17	0.38	500	0.17	0.38	0.48	0.42	0.59
Apartment building [yes = 1; 0 = no]	645	0.01	0.10	639	0.01	0.10	500	0.01	0.12	0.99	0.46	0.00
Interior apartment [yes = 1; 0 = no]	645	0.04	0.20	639	0.03	0.17	500	0.04	0.21	0.47	0.66	0.00
Age of dwelling [No. years]	645	29.09	16.69	639	28.43	15.79	500	27.89	14.94	0.47	0.20	0.03

Source: Own elaboration based on consumption records by both Empresas Públicas de Jericó (EPJ), Empresas Públicas de Támesis (EPT), and *ex-ante* data. *Note*: The notations T-U, T-C, and U-C represent the comparison between targeted and untargeted households, targeted households and the control group, and untargeted households and the control group, respectively. ***$p < 0.01$, **$p < 0.05$, and *$p < 0.1$.

comparing untargeted households in the town of Jericó with those from the control town of Támesis. Because of the existing differences between households in these towns, we use the sample weights from Jaime and Carlsson (2018) to evaluate the existence of spillover effects and generate a matched sample of individuals.[7] Our outcome of interest is estimated by means of weighted regressions, where the weights resulting in the matching are used as sample weights. The main specification is given by Eq. (2) as follows:

$$ln(w_{it}) = \gamma T_{TT} Post_{TTit} + \delta Post_{TTit} + \mu_t + v_i + \varepsilon_{it} \quad (2)$$

where w_{it} denotes the water use of household i in period t; T_{TT} is a dichotomous variable that indicates the state of treatment, which equals 1 if the home is affected by the change in tariffs and 0 otherwise[8]; $Post_{TTit}$ indicates the post-treatment tariff, which equals 1 from July 2014 to December 2014 and 0 otherwise; μ_t denotes month-by-year variables; v_i represents fixed effects; and ε_{it} is the error term. The direct effect of the change in water tariffs is consistently estimated through the parameter γ.

Finally, we focus on the combined effects of the interventions. Because the timing of the treatments affected the subsample of households of interest in various ways, we have two additional outcomes of interest: (*i*) the *differentiated effects of information provision* (i.e., how much larger is the effect of the policy mix compared with the tariff increase alone), and (*ii*) the *joint effect of being targeted by both interventions* (i.e., how large is the combined effect of pecuniary and nonpecuniary incentives compared with not being targeted with either intervention). To assess the differentiated effects of information provision, we compare the water use of targeted households in Jericó (i.e., households that were first targeted by the social information campaign, and then affected by the change in water tariffs) with that of untargeted households in the same city (i.e., those only affected by the change in the tariff regime). By comparing these subsamples of households, it is possible to assess the effects on water use resulting from introducing a tariff increase in a subpopulation that was previously targeted by a nonpecuniary intervention. The specification of interest is given by Eq. (3).

$$ln(w_{it}) = \widetilde{\alpha} T_{IT} Post_{ITit} + \widetilde{\beta} Post_{ITit} + \widetilde{\gamma} T_{TT} Post_{TTit} + \widetilde{\delta} Post_{TTit} + \mu_t + v_i + \varepsilon_{it} \quad (3)$$

where w_{it} denotes the water use of household i in period t; T_{IT} is a dichotomous variable indicating the information treatment status, which equals 1 if the household was targeted by the information campaign and 0 otherwise; $Post_{ITit}$ is an indicator of post information treatment, which equals 1 from February 2013 to December 2013 and 0 otherwise; T_{TT} is a dichotomous variable indicating the status of the tariff treatment, which equals to 1 if the household was affected by the change in tariffs and 0 otherwise; $Post_{TTit}$ is an indicator of post tariff treatment, which equals 1 from July 2014 to December 2014 and 0 otherwise; μ_t denotes month-by-year variables; v_i are fixed effects; and ε_{it} is the error term. The proposed specification splits the study period into two parts. The first part corresponds to the period when households were exclusively targeted by the social information campaign. It is expected that during this period, a norm of water savings will emerge, which is likely to influence individuals' values and beliefs regarding water use. The second part includes the period upon introduction of the change in the tariff regime. Because this change was introduced after the finalization of the social information campaign, the introduction of pecuniary incentives is expected to challenge individuals' beliefs once again. Thus, our parameter of interest (i.e., differentiated effects of information provision) is captured by the parameter $\widetilde{\gamma}$. Because the targeted and untargeted households in Jericó are statistically the same in

[7] Jaime and Carlsson (2018) generated two set of sample weights after matching to assess spillover effects. The first one balances observable characteristics of targeted households in Jericó (i.e., those receiving consumption reports as part of the social information campaign and subsequently being affected by the change in tariffs) with those in the control group in the town of Támesis (i.e., households not affected by either incentive). The second one compares untargeted households in the town in Jericó (i.e., households that were not affected by social information provision but were affected by the change in tariffs later on) with those in the control group of Támesis. The matching procedure successfully corrected unbalancing problems in either subsample, and estimated effects are robust to a number of matching procedures.

[8] The dataset supporting our empirical analysis includes households' water consumption (m3/month). Despite water consumption being billed monthly, this information was regarded as confidential. Consequently, the nature of our treatment variable is dichotomous. Notwithstanding the limitations of not being able to fully exploit the magnitude of the price change, our experimental design is suitable for identifying the effects of the change in the tariff regime as nearly 82% of households fall in the first consumption block (1–20 m^3).

the baseline in terms of observable characteristics, $\widetilde{\gamma}$ can be consistently estimated without relying on the use of sample weights. Moreover, by comparing $\widetilde{\gamma}$ and $\widetilde{\alpha}$, is also possible to assert the extent to which the introduction of subsequent interventions affects an individual's beliefs and motivations to save water, and the subsequent changes in water use. The interplay between these instruments could give rise to either reinforcement effects ($\widetilde{\alpha}+\widetilde{\gamma}<0$) or conflicting effects ($\widetilde{\alpha}+\widetilde{\gamma}>0$).

To conclude, we estimate the joint effect of the information and pricing treatments by comparing the subsample of households that were targeted by the information campaign, with the control households in the town of Támesis. Because of the existing differences between households in these towns, we use the sample weights from Jaime and Carlsson (2018) to evaluate the existence of reinforcement effects, generating a matched sample of individuals. Our outcome of interest is then estimated using weighted regressions, where the weights from the matching produced are used as sample weights. The main specification is given by Eq. (4) as follows:

$$ln(w_{it}) = \breve{\alpha} T_{CT} Post_{CTit} + \breve{\beta} Post_{CTit} + \mu_t + v_i + \varepsilon_{it} \quad (4)$$

where w_{it} denotes the water use of household i in period t; T_{CT} is a dichotomous variable that indicates the state of treatment, which equals 1 if the household was targeted by both the information campaign and the change in tariffs and 0 otherwise; $Post_{CTit}$ is an indicator of the period after the combined effect of the treatments that equals 1 from February 2013 to December 2014, and 0 otherwise; μ_t denotes month-by-year variables; v_i represents fixed effects; and ε_{it} is the error term. The outcome of interest is consistently estimated by the parameter $\breve{\alpha}$. Eqs. (1)–(4) are estimated using a standard fixed effects estimator, and standard errors are clustered at the household level. A summary of the comparisons proposed to evaluate the impact of the treatments is presented in Fig. 4.

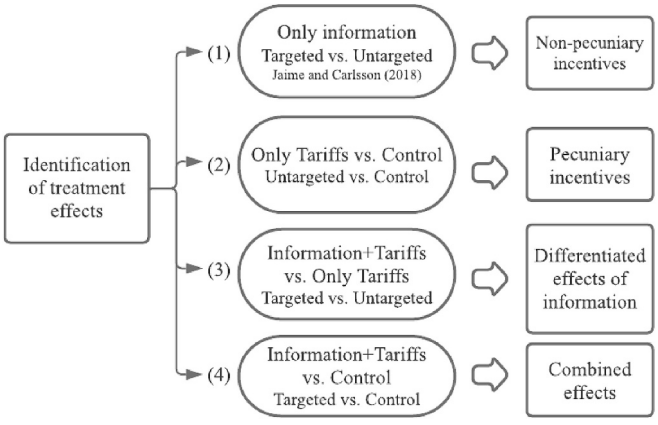

Fig. 4. Identification of treatment effects.
Source: Own elaboration. *Note*: This figure depicts the subsamples used for identifying individual and combined effects of the interventions. (*i*) The effect of the *only information treatment* is estimated by comparing the water use of targeted and untargeted households (i.e., those who did and did not receive personalized consumption reports, respectively) in the city of Jericó. (*ii*) The effect of the *only tariff treatment* is estimated by comparing water use of untargeted households in the city of Jericó with control households in the nearby city of Támesis (i.e., those who were not affected by either intervention). (*iii*) The *differentiated effects of information provision* are estimated by comparing the subsample of households that were first targeted by the social information campaign, and subsequently affected by the change in the tariff regime, with those only affected by the change in the tariff regime (i.e., the subsample of untargeted households). (*iv*) The *combined effects of the interventions* are estimated by comparing the water use of targeted households in the city of Jericó (i.e., those targeted by both the social information campaign and the change in tariffs), with that of the control group in the city of Támesis.

3.2. Heterogeneous effects

We continue by analyzing the heterogeneous effects of these interventions for the subgroups of low- and high-income households. To this end, households with incomes lower than the median are regarded as low-income, whereas those exceeding this value are regarded as high-income households. The proposed analysis aims to shed light on the effects of the interventions -and their interactions- among subgroups of households across the income distribution. This is important because households with different income levels are likely to exhibit important differences not only in the underlying motives to save water, but also in terms of affordability (i.e., the ability to accommodate water use to changes in its prices). Thus, while some households may benefit from these policies, others will face their burden. Specifications in Eqs. (1)–(4) are then estimated for the subgroups of interest.

To conclude, we analyze heterogeneous effects that may arise in response to the magnitude of the tariff change. The change in the tariff regime generated increments of 12% and 35% in the cost of using water for the groups of households in the first (1–20 m^3/month) and second blocks (>20 m^3/month), respectively. Thus, we estimate the specification in Eq. (3) on the subsamples of households in either block. To this end, households whose water use surpassed 20 m3 in the two months preceding the initial change in tariffs (i.e., November and December 2013) were assigned to the subsample of high tariff increase. Similarly, households with water use lower or equal to 20 m3 were assigned to the subsample of low tariff increase. Specifications in Eqs. (1)–(4) are also estimated for the subgroups of interest.

4. Results

As previously noted, we are interested in the effects of the interactions between *nonpecuniary* (i.e., being targeted by a social information campaign) and *pecuniary incentives* (i.e., being affected by a change in tariffs) on residential water use. Our specifications are in semi-logarithmic form, allowing us to estimate semi-elasticities; thus, estimated parameters are multiplied by 100 to elicit percentage changes in water use. Standard errors are clustered at the household level.

4.1. Homogeneous effects

Table 2 summarizes the results of the estimation of the specifications outlined in Eqs. (1)–(4). To analyze the effects of *nonpecuniary incentives* (i.e., information-only treatment), we compare the behavior of the households that were and were not targeted by the social information campaign in the city where this intervention took place, as shown in Eq. (1). The results presented in column (1) indicate that the information campaign had a positive and statistically significant effect on residential water use reduction, as found by Jaime and Carlsson (2018). The findings suggest that targeting individuals with norm-based social information generates an approximately 7% reduction in water use, compared with those who did not receive consumption reports. This figure mirrors the results of Jaime and Carlsson (2018), which demonstrate a reduction in water use of approximately 6.8% in 11 months following the implementation of the information treatment, assuming no spillover effects. This result is also in line with several randomized experiments aimed at water (Ferraro et al., 2011; Ferraro and Price, 2013; Bernedo et al., 2014; Sengupta, 2020; Kažukauskas et al., 2021; Lurbé et al., 2023) and energy conservation (Allcott, 2011; Ayres et al., 2013; Costa and Kahn, 2013; Mizobuchi and Takeuchi, 2013; Allcott and Rogers, 2014; Ito et al., 2018; Andor et al., 2020; Myers and Souza, 2020; Kažukauskas et al., 2021), evidencing that non-pecuniary policy instruments such as social information campaigns with/without appealing to norm-based behavior are suitable instruments to tackle environmental problems and promoting resource conservation (Allcott and Kessler, 2019; List et al., 2023; Maris et al., 2024).

To analyze the effect of targeting individuals with *pecuniary*

Table 2
Homogeneous effects of the interventions.

	Only information		Only tariffs		Information + Tariffs vs. Only Tariffs		Information + Tariffs vs. Control	
	(1)		(2)		(3)		(4)	
$Post\text{-}treatment_I \times Treated_I$	−0.07***	−0.07***			−0.07***	−0.07***		
	(0.02)	(0.03)			(0.02)	(0.19)		
$Post\text{-}treatment_I$	0.00	0.08***			0.01	0.09***		
	(0.01)	(0.02)			(0.01)	(0.02)		
$Post\text{-}treatment_T \times Treated_T$			−0.11***	−0.11***	0.05**	0.05**		
			(0.03)	(0.03)	(0.01)	(0.16)		
$Post\text{-}treatment_T$			0.14***	0.13***	0.03*	0.01		
			(0.02)	(0.03)	(0.01)	(0.02)		
$Post\text{-}treatment_C \times Treated_C$							−0.14***	−0.09***
							(0.04)	(0.04)
$Post\text{-}treatment_C$							0.10***	0.08**
							(0.03)	(0.04)
Constant	2.57***	2.53***	2.23***	2.23***	2.57***	2.53***	2.29***	2.27
	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.13)	(0.01)	(0.01)
Month-by-year	No	Yes	No	Yes	No	Yes	No	Yes
No. Obs.	29,636	29,636	26,877	26,877	29,636	29,636	26,160	26,160
No. Households	956	956	867	867	956	956	872	872

Notes: Estimates correspond to the period between December 2011 and December 2014. The columns correspond to the difference-in-differences estimator for the sample of meters that met the technical requirements and worked correctly for three months. The dependent variable is the logarithm of monthly water consumption. Column (1) replicates the results of Jaime and Carlsson (2018). Clustered standard errors are in parentheses. ***$p < 0.01$, **$p < 0.05$, and *$p < 0.1$.

incentives (i.e., tariffs-only treatment), as outlined in Eq. (2), we compare the subsample of untargeted households in Jericó (i.e., those that did not receive social information reports in the city where this intervention took place), with the households in the control group from Támesis (i.e., households that were not targeted by either intervention). The results in column (2) indicate that the introduction of the revised tariff regime has a significant effect on water use. Specifically, the group affected only by the change in the tariff structure decreased water use by approximately 11%, regarding the control group after this change came into force. This finding is in line with some studies demonstrating that monetary incentives are effective instruments for reducing residential water use (López Rivas, 2019; Goette et al., 2019; Garrone et al., 2020; Yudhistira et al., 2020; Browne et al., 2021; Li and Jeuland, 2023). This also suggests that the effect of this policy is effective and stronger in magnitude when implemented separately in comparison to information provision. Particularly, the finding that pecuniary incentives generate larger effects compared with non-pecuniary incentives, is consistent with the notion that the potential of behavioral interventions may be diminished when Pigouvian taxes can be introduced to internalize an environmental externality (Carlsson et al., 2021a). This notion is consistent with our study setting, where an increment in water tariffs was feasible –and subsequently introduced– as a policy instrument to promote water savings. In these cases, pecuniary incentives appear more suitable policy instruments than nonpecuniary incentives.

We next focus on the effects of the interactions between pecuniary and nonpecuniary incentives. Column (3) in Table 2 presents the *differentiated effects of introducing nonpecuniary incentives* (i.e., how much larger is the effect of the policy mix compared with the tariff increase alone), as outlined in Eq. (3). To do so, we compare the behavior of households that were targeted by the information campaign and subsequently affected by the change in tariffs with households that were only affected by the increased monetary cost of consuming water. Results evidence a positive and statistically significant effect of the social information campaign on water use for this subsample of households (i.e., a reduction in water use compared with the comparison group). The magnitude of the effect remains the same, in comparison to the information-only treatment (7%). Surprisingly, results also evidence a negative and statistically significant effect of the tariff change on water use, with water use increasing by around 5% for the same subsample of households following the implementation of the change in the tariff regime. This suggests the presence of crowding-out effects. This finding is in line with the notion that individuals' intrinsic motivations to save water may have been undermined by the introduction of extrinsic motivations in the form of monetary punishments (i.e., a tariff increase), as supported by the literature (see, e.g., Frey, 1992; Frey and Pommerehne, 1993; Frey and Oberholzer-Gee, 1997; Rode et al., 2015). This result could also be related to/reinforced by the timing -and length- of the interventions. Households were targeted by the social information campaign for nearly one year, generating significant and persistent changes in behavior, as reported by Jaime and Carlsson (2018). Thus, a social norm of water conservation was likely to emerge. The sudden introduction of the change in the tariff regime could be understood as previous water-saving efforts by consumers being unimportant, causing low acceptability of the price scheme, and lowering their incentives to perform water-saving actions in the household. The fact that the tariff change had to be revised before finally coming into force, due to consumer protests in the city, is evidence that households may have perceived the introduction of the tariff change as a coercive policy, discouraging households from saving water (Bénabou and Tirole, 2003; Bénabou and Tirole, 2006; Frey and Stutzer, 2008; Gneezy et al., 2011). Similar results are found in the studies by Pellerano et al. (2017) and Halvorsen (2012) in the domains of energy and recycling, respectively. Overall, the analysis of the differentiated effects of introducing pecuniary incentives suggests that the timing, content, and stringency of interventions could play an important role in incentivizing consumers' responses in the desired direction, but most importantly, they highlight the need to reconsider the use of price incentives in areas where intrinsic motivations can empirically be shown to be important (Frey and Oberholzer-Gee, 1997).

Finally, we estimate the effect of *simultaneously targeting households with both pecuniary and nonpecuniary incentives*, as displayed in Eq. (4). To this end, we focus on the subsample of households that were targeted by both the social information campaign and the change in tariffs and the control group from the city of Támesis. The results shown in column (4) of Table 2 indicate that the joint effect of the information and tariff treatments on households' water use is positive and statistically significant. Specifically, water use in the treatment group decreases, on average, by approximately 12% in comparison to that in the control group. The fact that the largest and most significant changes in behavior are attained when both instruments are jointly implemented is aligned with some studies evaluating the combined effects of both monetary and nonmonetary incentives on water use (Goette et al., 2019; Rajapaksa et al., 2019; Garrone et al., 2020), and on related domains (Convery et al., 2007; Jakovcevic et al., 2014). Particularly, this result is

supported by a study from Carlsson et al. (2021a), suggesting that nonpecuniary incentives in the form of moral nudges -as those in our social information campaign- can successfully promote sustainable water use when implemented as complements to (optimal) price incentives. To conclude, our findings demonstrate that a combination of instruments has the potential to significantly reduce water use while increasing policy acceptability, provided their design takes account of the nature of the externality, and the feasibility of introducing tariff changes as primary mechanisms to promote changes in water use in the desired direction.

Fig. 5 shows the evolution of the average treatment effect (ATE) during the post-treatment period of both the information and tariffs treatments. The monthly ATEs are statistically significant at the 99% level in all periods.

4.2. Heterogeneous effects

The estimated parameters of our main specifications in the subsamples of low- and high-income households are presented in Table 3. The results suggest several relevant findings. First, the results in column (1) indicate that information provision has a positive and statistically significant effect on high-income households' water use, compared with low-income households. This finding is in line with a study by Sengupta (2020) evidencing that wealthier households were more responsive to social comparisons, compared with those in lower income levels. This highlights the notion that nonpecuniary incentives are progressive policy instruments to encourage sustainable water use, promoting significant changes in behavior among households that are more inelastic to pecuniary incentives. Second, the change in the tariff structure has a significant negative effect on the water use of both subsamples, with a greater impact on high-income households, as shown in column (2). This is particularly relevant because higher-income households can exert greater pressure on this resource. This is also in line with low-income households -which often exhibit low demand-, having a reduced scope to reduce water use and most likely to exhibit affordability problems. The fact that price instruments do not distort the behavior of households when implemented alone supports the notion of price incentives being the first-best solution to promote sustainable management of water, provided their implementation is politically feasible.

Third, the introduction of both instruments (i.e., targeting households with both interventions, compared with none) appears to be beneficial to consumers, conditioned on the order of the interventions. Although these interventions were effective in generating behavioral change across the entire sample of households, regardless of income, the largest reductions in consumption were achieved for the subsample of wealthier households. Thus, the joint introduction of pecuniary and nonpecuniary incentives exhibits the potential to affect water use without harming poorer households.

Finally, the estimated parameters of our main specifications in the subsamples of households facing a low and high increase in water tariffs are presented in Table 4. Results evidence that the observed reductions in water use in response to the exogenous change in water tariffs are attributed to the subsample of households in the first consumption block. The average household facing a low increase in tariffs reduced water use by 12%. This effect is statistically significant at the 1% level. This result is consistent with empirical studies of water demand in Colombia, which estimate price elasticities conditional on the consumption block of −0.24 (Medina and Morales, 2007) and − 0.495 (Vásquez-Lavín et al., 2017). In contrast, households facing a high increase in the cost of consuming water did not respond to this policy. Despite the substantial increment in the cost of consuming water, this result could be attributed to the reduced number of consumers under this tariff block.

Another interesting result relates to the differentiated effects of nonpecuniary incentives (i.e., introducing a change in water tariffs upon finalization of the social information campaign). Once again, results evidence an increase in water use of about 4%. This effect only occurred in the subsample of households in the first consumption block (i.e., those facing a low increase in water tariffs). This result reinforces our findings that introducing tariff changes after the social information campaign could have been perceived by consumers as a coercive policy, undermining consumers' intrinsic motivations to reduce water use. The fact that our results are robust to the magnitude of the tariff change can be attributed to the fact that nearly 80% of the households are faced with the first consumption block. It is worth noticing, nevertheless, that this result is likely to obey to local features of residential water demand in our study setting (a small city in a developing setting).

5. Conclusions and policy recommendations

In this study, we analyze the individual and combined effects of two exogenous interventions targeting households with both pecuniary and nonpecuniary incentives, to promote water savings among residential customers in Colombia. The first intervention provided households with personalized reports that included normative information regarding households' water use compared with their neighbors. This intervention, designed and implemented by Jaime and Carlsson (2018), was intended to increase the moral costs of using water when not conforming to the social norm of efficient water use. The second intervention consisted of a change in tariffs, raising the monetary cost of consuming water. The order and timing of these interventions, as well as the subpopulations targeted by them, provide a unique opportunity to assess not only the effects of each intervention individually, but also the combined effect of being targeted by this policy mix. The empirical analysis was conducted on the same sample of households in Jaime and Carlsson (2018), whose behavior was followed one year after implementation. To the extent of our knowledge, this study is one of the first attempts to evaluate the effects of two different interventions on actual behavior among the same population of individuals at different points in time.

The analysis of the effects of our nonpecuniary and pecuniary interventions provides some insights that are worth discussing. First, when implemented in isolation, each intervention generates significant changes in behavior, with the change in tariffs generating larger reductions in water use (11% vs. 7%, respectively). This finding is consistent with the notion that the potential of behavioral interventions may be diminished when Pigouvian taxes can be introduced to internalize an environmental externality (Carlsson et al., 2021a). This is consistent with our study setting, where an increment in water tariffs was feasible and subsequently introduced as a policy instrument to incentivize water savings. In such cases, pecuniary incentives appear more suitable than nonpecuniary incentives. Because the feasibility of introducing tariff changes is context specific, and it is often related to developmental stages and local institutions, nonpecuniary incentives appear more relevant when implementing price incentives is politically -or economically- unfeasible, or when the environmental externality is generated in a domain that cannot be priced.

Second, there is evidence of crowding-out effects arising upon the introduction of pecuniary incentives in the subsample of households previously targeted by the social information campaign. This finding is in line with the notion that individuals' intrinsic motivations to save water may be undermined by the introduction of extrinsic motivations in the form of monetary punishments in the form of a tariff increase. This could also be reinforced by both the timing and nature of the interventions. Households were targeted by the social information campaign for nearly one year, generating significant and persistent changes in behavior, as reported by Jaime and Carlsson (2018). Thus, a social norm of water conservation was likely to emerge. The sudden introduction of the change in the tariff regime could be understood as previous water-saving efforts by consumers being unimportant, causing low acceptability of the price scheme, and lowering their incentives to perform water-saving actions in the household. In such cases, as pointed

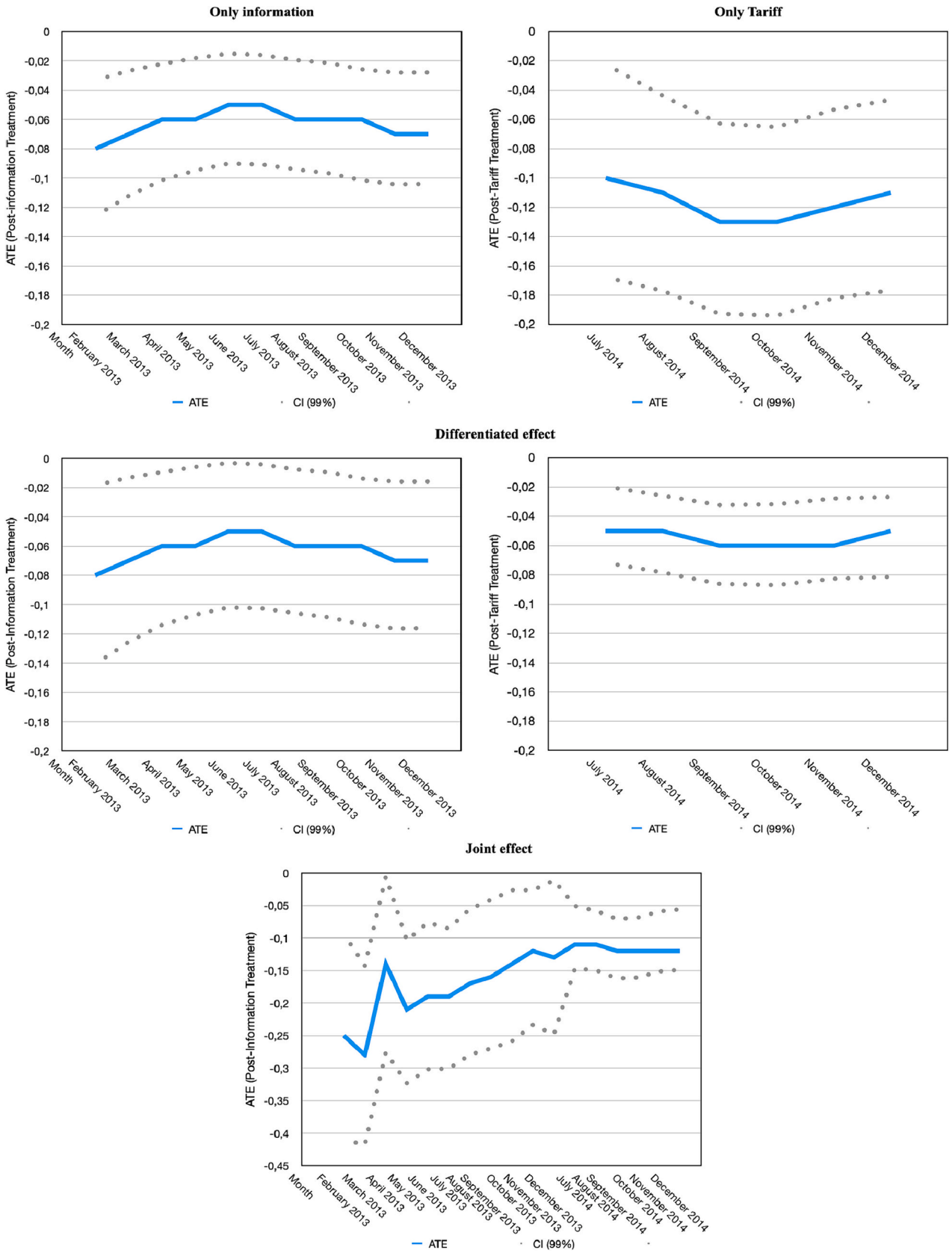

Fig. 5. Evolution of average treatment effects.
Source: Own elaboration.

Table 3
Heterogeneous effects of the interventions (Low vs. high income).

	Only information		Only tariffs		Information + Tariffs vs. Only Tariffs		Information + Tariffs vs. Control	
	Low-inc	High-inc	Low-inc	High-inc	Low-inc	High-inc	Low-inc	High-inc
	(1)		(2)		(3)		(4)	
$Post\text{-}treatment_I \times Treated_I$	−0.03	−0.09***			−0.03	−0.11***		
	(0.02)	(0.03)			(0.03)	(0.03)		
$Post\text{-}treatment_I$	−0.01	0.00			−0.00	0.01		
	(0.02)	(0.02)			(0.02)	(0.02)		
$Post\text{-}treatment_T \times Treated_T$			−0.08***	−0.15***	−0.00	−0.04**		
			(0.02)	(0.04)	(0.01)	(0.02)		
$Post\text{-}treatment_T$			0.10***	0.19***	0.02*	0.05***		
			(0.02)	(0.04)	(0.01)	(0.01)		
$Post\text{-}treatment_C \times Treated_C$							−0.09*	−0.16***
							(0.05)	(0.05)
$Post\text{-}treatment_C$							0.07	0.11**
							(0.05)	(0.05)
Constant	2.58***	2.58***	2.19***	2.27***	2.57***	2.57***	2,29***	2.28***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.02)	(0.02)
No. Obs.	16,213	13,423	14,446	12,431	16,213	13,423	14,632	12,400
No. Households	523	433	466	401	523	433	472	400

Notes: Estimates correspond to the period between December 2011 and December 2014. The columns correspond to the difference-in-differences estimator for the sample of meters that met the technical requirements and worked correctly for three months. The dependent variable is the logarithm of monthly water consumption. Column (1) replicates the results of Jaime and Carlsson (2018). Clustered standard errors are in parentheses. ***$p < 0.01$, **$p < 0.05$, and *$p < 0.1$.

Table 4
Heterogeneous effects of the interventions (Low vs. high tariff increase).

	Only Information (Jaime and Carlsson, 2018)		Only Tariff vs. Control		Information + Tariffs vs. Only tariffs		Information + Tariffs vs. Control	
	Block 1	Block 2	Block 1	Block 2	Block 1	Block 2	Block 1	Block 2
	(1)		(2)		(3)		(4)	
$Post\text{-}treatment_I \times Treated_I$	−0.05**	−0.07**			−0.05**	−0.09**		
	(0.02)	(0.03)			(0.02)	(0.04)		
$Post\text{-}treatment_I$	0.05**	0.21***			0.05**	0.22***		
	(0.02)	(0.04)			(0.02)	(0.04)		
$Post\text{-}treatment_T \times Treated_T$			−0.12***	−0.02	0.04**	0.03		
			(0.03)	(0.02)	(0.02)	(0.04)		
$Post\text{-}treatment_T$			0.15***	0.03*	0.02	−0.07***		
			(0.03)	(0.02)	(0.02)	(0.02)		
$Post\text{-}treatment_C \times Treated_C$							−0.07*	−0.01
							(0.04)	(0.07)
$Post\text{-}treatment_C$							0.06	0.12*
							(0.05)	(0.07)
Constant	2.38***	3.12***	2.05***	3.10***	2.38***	3.12***	2.11***	3.07***
	(0.02)	(0.02)	(0.00)	(0.00)	(0.02)	(0.02)	(0.02)	(0.02)
Month-by-year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. Obs.	23,653	5983	21,824	5053	23,653	5983	22,568	4464
No. Households	763	193	704	163	763	193	728	144

Notes: Estimates correspond to the period between December 2011 and December 2014. The columns correspond to the difference-in-differences estimator for the sample of meters that met the technical requirements and worked correctly for three months. The dependent variable is the logarithm of monthly water consumption. Column (1) replicates the results of Jaime and Carlsson (2018). Clustered standard errors are in parentheses. ***$p < 0.01$, **$p < 0.05$, and *$p < 0.1$.

out by Frey and Oberholzer-Gee (1997), the use of price incentives in areas where intrinsic motivations can empirically be shown to be important is needed to be reconsidered.

Third, our findings suggest that the distance between interventions could also mediate policy acceptability and consumers' responses. For instance, there is evidence of crowding-out effects when nonpecuniary incentives are in place for quite some time before the introduction of pecuniary incentives (more than a year in our setting). In contrast, the largest and most significant changes in behavior are attained when both instruments are jointly implemented. This highlights the importance of fully understanding the nature of the environmental problem when crafting interventions. Our analysis is in line with Carlsson et al. (2021a), suggesting that nonpecuniary incentives in the form of moral nudges -as those in our social information campaign- can successfully promote sustainable water use when implemented as complements to (optimal) price incentives. When prices/tariffs cannot be set optimally, nudges could still play a role in facilitating policy acceptability, whilst their introduction is more suitable in isolation when price changes are politically unfeasible, or the externality is generated in a domain that cannot be priced.

Fourth, the analysis of the heterogeneous effects of the interventions evidence that wealthier households appear to be more responsive to policies (i.e., exhibit larger reductions in water use in response to both types of incentives) than poorer households. This finding is relevant to future policy design. An increasing block price structure not only allows subsidizing water use of the poorest households, but also charging prices that could allow utilities to cover the cost of water provision, contributing to the achievement of other objectives (e.g., cost recovery, revenue stability, social equity, cost of service equity, etc.) besides water conservation. Because nearly 80% of households fall in the first consumption block, estimated effects when accounting for the magnitude of the tariff change can be attributed to the behavior of this group.

Nevertheless, this result is attributable to local features of residential water demand in our study setting (i.e., a small city in a developing setting).

To the extent of our knowledge, our results advance the rather scarce yet growing literature on the interplay between pecuniary and non-pecuniary incentives to promote resource conservation. Particularly, the features embedded in the design of interventions and the local conditions mediating their implementation have the potential to affect individuals' behavior in various ways. Our results do not come without a caveat. Besides ordering, interventions may differ in length, stringency, and nature. Their effects may also be mediated by the salience -and importance- of the targeted domain in an individual's value system. Even if these factors are entirely accounted for when crafting an intervention -or a combination of them-, comparing their performance for policy purposes remains a challenge. Moreover, the fact that individual responses to these types of incentives are likely to be mediated by contextual factors and local institutions, similar studies in different settings and developmental stages are needed to enhance external validity. A comprehensive analysis of the ordering effects for policy implementation, an analysis of individuals' responses to price changes of different magnitude, investigating the performance of other pecuniary and nonpecuniary incentives besides normative nudges and tariffs, and evaluating the performance of similar effects in related domains arise as a venue for future research.

6. Inclusion and diversity

We worked to ensure that the study questionnaires were prepared in an inclusive way. The author list of this paper includes contributors from the location where the research was conducted who participated in the data collection, design, analysis, and/or interpretation of the work.

CRediT authorship contribution statement

Francisco Hernández: Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Marcela Jaime:** Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Writing – original draft, Writing – review & editing. **Felipe Vásquez:** Investigation, Methodology, Supervision, Writing – original draft, Writing – review & editing.

Acknowledgments

We are grateful to Empresas Públicas de Jericó and Empresas Públicas de Támesis for granting us access to water consumption data. Financial support from the Swedish International Development Cooperation Agency (SIDA) to the Environmental Economics Unit at the University of Gothenburg, and from LACEEP, the MISTRA COMMONS program, and the Center for Collectivee Action Research (CeCAR) is gratefully acknowledge. Francisco Hernández gratefully acknowledges the support provided by University of Bio-Bio, Chile, for project GI2320140. Marcela Jaime and Felipe Vásquez gratefully acknowledge financial support from CAPES through ANID PIA/BASAL FB0002. We sincerily appreciate the valuable comments by Dale Whittington, Jorge Dresdner, and participants to the 7th NENRE Annual Workshop.

Appendix A. Additional tables and figures

Table A1
Structure of water rates in Jericó (2011–2014).

Tariff	Strata	Aqueduct			
		2011	2012	2013	2014
Fixed charge	1	0.4502	0.4670	0.4670	0.3956
	2	0.7652	0.7939	0.7939	0.7906
	3	0.9005	0.9340	0,9340	1.1202
Basic consumption (1–20 m^3)	1	0.1061	0.1099	0.1099	0.1071
	2	0.1797	0.1867	0.1867	0.2143
	3	0.2116	0.2197	0.2197	0.3041
Complementary consumption (21–40 m^3) and sumptuary consumption (> 40 m^3)	1	0.2116	0.2197	0.2197	0.3577
	2	0.2116	0.2197	0.2197	0.3577
	3	0.2116	0.2197	0.2197	0.3577

Source: Empresas Públicas de Jericó (EPJ). Note: Figures are expressed in US dollars. 1US$ = 1847.91 COP (May 2, 2013).

Table A2
Distribution of households by consumption block.

Tariff	Increment	Strata	Aqueduct			
			2011	2012	2013	2014
Basic consumption (1–20 m^3)		1	1.37%	1.07%	1.30%	1.22%
	12%	2	41.42%	40.96%	40.66%	41.65%
		3	37.45%	37.91%	38.22%	38.60%
Complementary consumption (21–40 m^3) and sumptuary consumption (> 40 m^3)		1	0.38%	0.61%	0.38%	0.46%
	35%	2	9.08%	9.46%	9.76%	8.77%
		3	10.30%	9.76%	9.53%	9.08%

Source: own elaboration based on information provided by the water utility.

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.eneco.2024.107546.

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