Combining price and non-price interventions for water conservation

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Abstract

Marginal pricing has long been the instrument of choice to address water conservation challenges. More recently, non-price behavioral interventions have emerged as an alternative. However, there is limited data on the relative efficacies of price and non-price interventions. We report results from long-term field experiments studying unit-level water conservation responses to both price and non-price interventions in the same group of households (n = 64,186 household-days). Conservation habits, attitude-action gaps, principal-agent incongruities, and billing cycles help account for the heterogeneity in response between households, and across time. A non-price behavior modification intervention before the introduction of marginal pricing resulted in a large and significant effect on treated households (33%). The subsequent introduction of marginal volumetric pricing also reduced water use (8%, for previously untreated households). However, this average price effect masks how a large share (21%) of households increased water use, or how a mere 12% of the households accounted for all the aggregate reduction in water use. We investigated such heterogeneous responses as a systematic conservation maximization design question beyond statistical variance in individual responses. We used daily water consumption measurements across three years alongside a household survey to delineate structural and agentic barriers to conservation behavior. Our analysis reveals how combining price and non-price behavioral interventions could hold the key to achieving conservation effects that are both large and persistent.

Keywords: Persistent Conservation Behavior, Behavioral Heterogeneity, Field Experiments, Water Conservation

1. Introduction

The world is not on track to meet the Sustainable Development Goal 6 (SDG6) target – ensuring availability and sustainable management of water and sanitation for all – by 2030. According to a recent United Nations report (1), we "require a sixfold increase in current global rates of progress on drinking water, a fivefold increase for sanitation and a threefold increase for hygiene." The World Bank and eminent scientists raise similar severe concerns about the large gap between what the world needs, especially the poor in low-income countries, and the current level of access to water and sanitation (2–4).

The enormous challenge of meeting SDG6 is growing, especially in the rapidly urbanizing Global South. Despite large-scale supply projects,[1] the cities continue facing recurring water scarcity compounded by high temperatures and unequal access to services. Just this year (2024), Delhi and Bengaluru, among the largest urban centers in Asia, are facing acute water shortages, and the slums are facing the worst of the supply crisis (5, 6). In this context of recurring failures and slow progress towards SDG6 in urban areas, we examine water demand reduction in affluent communities by combining price and non-price behavioral interventions. We investigate the response to introducing a price signal, at the aggregate level, in various subsets of households, and over time. Through this research, we contribute to a richer understanding of household-level water conservation behavior drivers, such as specific individual attributes and events that can translate heterogeneity of response to a higher level of overall conservation.

Non-price behavioral interventions have attracted attention as alternatives and complements to marginal pricing, the longstanding resource conservation intervention of choice (7–10). However, even when these non-price interventions are theoretically appealing to reduce demand (11), their practical effect sizes are small and are also plagued by replication issues (12). Price as a tool for inducing conservation behavior also involves the risk that resource users might switch from social norms of cooperation or benevolence to market-driven norms leading to adverse conservation behavior (13–15). More crucially, the large body of research on price and non-price interventions seldom directly compares price and behavioral interventions (16–18**)**. However, such comparisons are especially relevant to modifying the consumption behavior of affluent or high-income individuals who account for disproportionate resource use (18–20). We report results from a unique set of long-term field experiments on water use that allowed us to juxtapose the relative efficacies of a typical price intervention and a powerful non-price behavioral intervention and to delineate potential design templates for combining diverse price and non-price interventions to maximize persistent conservation response. In our field experiments, while both non-price and price interventions succeeded in reducing water use, the effect size was four times larger for the novel non-price intervention than the typical price intervention. Further, the adverse response to price is lower in households that received both interventions.

Several pathways underlying behavioral responses to a conservation-inducing price signal, including habits and attitudes, have been studied over several decades (21–24). However, the relative paucity of field experiments measuring unit-level responses has stymied a systematic understanding of heterogeneity in individual responses to conservation pricing (25). Indeed, unit-level responses to a priced-regime switchover are rarely, if ever, measured and only aggregate responses are studied and reported. From a water policy perspective, understanding heterogeneous response patterns to price signals is central to designing the most effective resource pricing interventions. For example, the introduction of volumetric pricing for water in European cities led to an overall reduction in the aggregate consumption of water (26). However, these studies do not answer whether any individual households exercised their agency to increase water consumption. Similarly, several popular models accounting for responses to non-price behavioral interventions also do not account for the considerable heterogeneity in responses (9, 27, 28). Without a disaggregated unit-level understanding of responses, we can never be sure if a price or a non-price intervention (or some combination) is the most optimal in generating the greatest possible demand reduction.

We investigate heterogeneous responses as a conservation maximization design question rather than merely a statistical variance in individual responses (25, 29, 30). Our long-duration field experiments show how combining price and non-price interventions can address water sustainability conundrums to increase resource conservation outcomes (22, 29).

[1] As a possible exception, in the recent years India has invested heavily through two nation-wide infrastructure-centric schemes, one on sanitation and another on drinking water. These two Federal government schemes – called SBM (https://swachhbharatmission.ddws.gov.in/) and JJM (https://jaljeevanmission.gov.in/) – have tried to bring large-scale improvement in service delivery, especially in rural areas of India. The United Nations is monitoring the outcomes of these long-duration schemes (https://india.un.org/en/171844-health-water-and-sanitation).

We present the materials and methods summarizing the field experiment's setting and the econometric models used for data analysis in Section 2. We then present the results of our non-price behavioral intervention and price intervention in Section 3. We summarize the results of heterogeneous responses to interventions based on household-level factors and time. We also present a summary of detailed results from time-series analysis at the household level and various levels of aggregation of households. In Section 4, we discuss the results and conclude in Section 5.

2. Materials and Methods

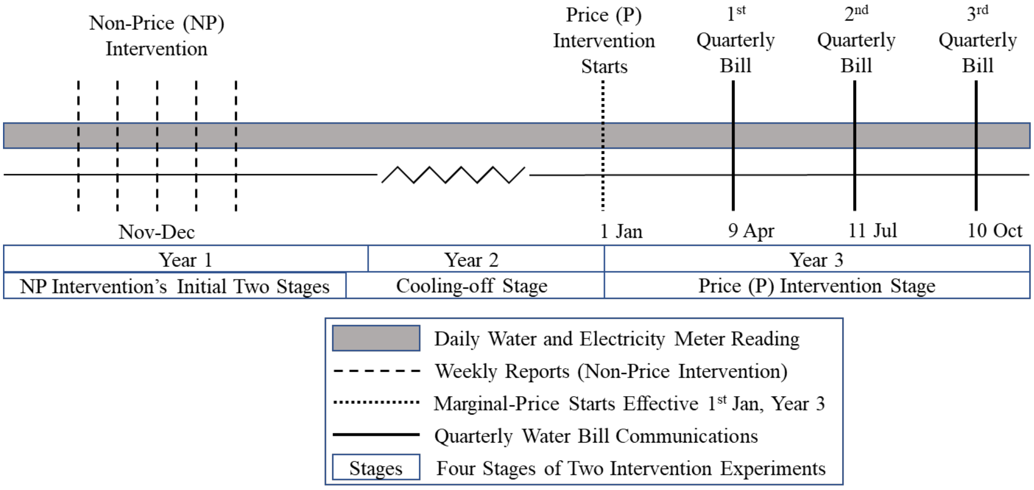
2.1 Experimental Setting

The field site for our experiments is an affluent gated condominium community in Bengaluru, arguably India's most globalized metropolis. Despite the severe shortage of public water supply in Bengaluru, residents in wealthy gated communities receive round-the-clock water supply through their private distribution networks (31, 32). The central feature of our field site that allows us to compare price and non-price interventions and to characterize heterogeneous responses to this intervention is the availability of daily household volumetric water consumption metering data before the introduction of volumetric marginal pricing and before we made any behavioral interventions. In a typical water conservation-inspired metering project, metering and marginal pricing are temporally coterminous. A multi-year gap between water consumption metering and the implementation of marginal pricing is rare, and this valuable setting allowed us to study conservation responses to both non-price (NP) and price (P) interventions targeting the same set of households.[2]

Figure 1 summarizes the timeline of our experimental study, which consists of four sequential stages - baseline, during NP-intervention, cooling-off between P and NP interventions, and the P-intervention. As summarized in the figure, our NP-intervention is a weekly water usage report based on a theoretically-grounded habit-change framework (33). Before the start of the NP-interventions, households were randomly divided into four groups – one control group (labeled C0) that did not receive reports and three test groups that received one, two, or three behavioral intervention components of the weekly reports – component A to group T1, components A and B to group T2, and all three components to group T3. These three components (SI Figure S1) combined to help individuals change habits and take actions specific to water usage in their homes and nudged them towards a conservation norm (see intervention's design details in SI of (33)).

[2] Our field site's management installed water consumption meters in each of the 120 condo units to introduce volumetric marginal pricing to encourage conservation. However, a lack of consensus among residents, software expenses for billing, additional resources needed for establishing and running the proposed billing process, and other logistical concerns delayed the actual introduction of marginal pricing. From an experimental perspective these turned out to be fortuitous and served as an almost ideal field setting.

Figure 1. Overall timeline.



Note: We study two sequential intervention experiments for water conservation. The first is a short-duration non-price (NP) intervention on randomly allocated households, followed by a long-duration price (P) intervention on all households. NP-intervention consists of five weekly reports containing three components designed using a household-level environmental conservation framework. Price intervention consists of starting a marginal (i.e., volumetric) price for water in place of a uniform embedded fee. Our study begins in year 1 with the pre-intervention baseline stage followed by the NP-intervention stage and the start of the cooling-off stage which lasts till the end of year 2. In year 3, all households receive quarterly bills based on monthly water usage effective 1st January. We collect daily usage information using three water meters per household. The timeline is not to scale. N = 64,186 household-days across 120 household units.

We then observe a price intervention on the same group of households. The price intervention, created by the condominium management office, consisted of the introduction of volumetric pricing for water with billing every quarter. The quarterly bill is based on a month-level calculation of volumetric charges using an increasing block tariff and a social comparison message (SI Figure S2). A periodic bill amount and a comparison with the median level of water use per household make this intervention an external structure like many worldwide utility bills.

A household survey was conducted after the start of water billing, with approval from an Institutional Review Board.[3] The survey measured resident's water conservation habits, attitudes towards the environment and water, homeownership, and several other structural factors. We obtained consent from each surveyed individual and property management office. We also collected periodic data on occupancy, movements, etc., from the property management office.

We collected household-level water consumption across three years (n = 64,186 household-days). Daily records provided enough statistical power to study heterogeneity in behavioral response using multiple of methods (for details of data preparation, please refer to SI section 2.3).

2.2 Econometric Models

We used fixed-effect panel data analysis to estimate the average treatment effect (ATE) of non-price (NP) and price (P) interventions. We estimate the transience and heterogeneity of response to price intervention using intervention time-series models, at the household level and various aggregations of individual households. Daily household water consumption data is used for the panel models and smoothened weekly data is used for time-series models.

For the non-price intervention, we estimate the ATE of each of the non-price treatments (T1, T2, and T3) in three stages of the experiment – during the NP-intervention, cooling-off, and price (P) intervention (33), using a fixed-effects panel data model commonly used in experimental studies (7, 17). The three

[3] This study was approved by the Institutional Ethics Committee (IEC) at the Centre for Public Policy, Indian Institute of Management Bangalore (CPP-IIMB), registered with the U.S. Department of Health and Human Services (HHS), IORG#: IORG0004307.

treatment groups (T1, T2, and T3) and the three chronological stages provide us with nine ATE estimates using interaction terms in our difference-in-differences (DiD) design (see model 1 in SI). Further, we also consolidate the households from the three treated groups into one NP-treated pool to compute three further ATE estimates using interaction terms. We do not include household-level determinants, such as the size of the dwelling-unit, habits, or attitudes, as these time-invariant variables are absorbed in fixed-effects.

The aggregate effect of the price signal is estimated using a daily panel of household-level water usage. Apart from price, many factors contribute to household-level water usage (14, 21, 34, 35). These include household characteristics that are fixed or almost fixed in our study duration (such as type of family, size of dwelling-unit, and household income) and time-varying factors, such as weather and number of residents. The number of residents is a critical factor in water use; usage increases with increasing residents while per-capita usage reduces (34, 35). When we use a fixed-effects model at the household level, we need to control for time-varying factors to estimate the effect of price correctly. Apart from weather variables, we use the month of the year to handle seasonal changes and weekend days to separate any weekend effects. Time-invariant factors at the household level (such as the level of water conservation habits) are part of household-level fixed effects (see model 2 in SI).

The price intervention effect is estimated for various subsamples, such as NP-treated and NP-untreated. The NP-untreated pool consists of households from the control group during NP-intervention and households that moved in after completion of behavioral intervention, which we label as the post-intervention (PI) group. Other prior four groups (T1, T2, T3, and Control C0) consisted of households living in this community before we rolled out our NP-intervention and continued to live there during the price intervention stage. We collected information on movements (and changes in the number of residents) through the survey and later through the property management office.

We use time-series intervention analysis models to estimate effects at two key milestones: the first introduction of price-signal as a one-time structural change, and every subsequent quarterly bill communication. Our objective in using time-series modeling is to estimate both the initial and long-term effect of price intervention, at an aggregate level for all households, various subsets of households, and, crucially, also at the unit level. This approach provides triangulation of effects estimated from panel data models and helps distinguish between transient and persistent responses. A transient response fits into either a sharp pulse-shape or a gradual-decay pattern (SI Section 3.2). Permanent responses fit either a step change pattern or a gradual build-up pattern. These responses can correspond to an increase or decrease in usage (see model 4 in SI).

A temporary conservation response is triggered when an individual finds out about the cost of her resource use through periodic billing statements and makes a payment (36, 37). We characterize this periodic “bill-effect" heterogeneity through panel data and time-series models. In the panel-data model, we compare the usage between billing and payment with the rest of the days (see model 3 in SI). In the time-series model, we model for the introduction of price and receipt of bills (see models 5 and 6 in SI).

We use the New Ecological Paradigm (NEP) scale to measure pro-environment attitudes (38). NEP is a popular, well-established scale widely used to study conservation behavior alongside modified scales for specific environmental resources (39, 40). We construct a water-NEP scale to distinguish attitudes toward water from broader concerns about ecology or the environment. We also build a water conservation habits index based on similar indices in literature and tailor it to our field setting (40–43). We test for the association of these three indices with observed heterogeneity in pre-intervention usage and response to intervention. See the section “S3. Econometric models and statistical tests” in the SI for details of all the panel data and time-series models, the scales used, and their reliability tests.

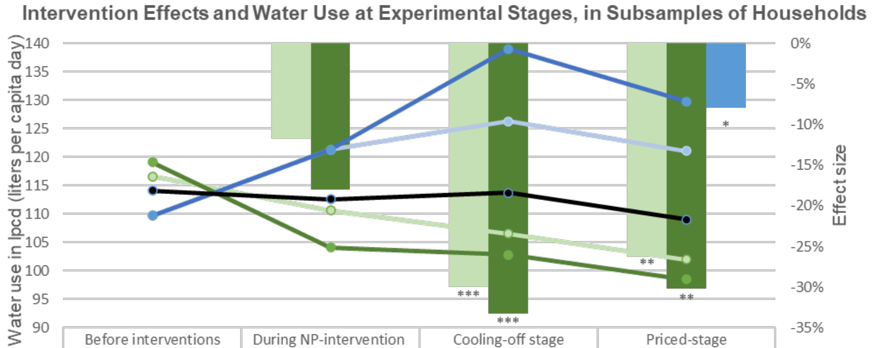
3. Results

Summary statistics (Figure 2) suggest that both NP and P interventions decreased water consumption. Water usage levels were similar in NP-treated and untreated households before the start of our experiments (SI Table S4 confirms balance). While the average water usage was reduced in treated households in each stage, it increased in untreated households in the two stages before the priced-stage.

3.1 Relative Efficacy of Non-Price and Price Interventions

Estimates of ATE (Figure 2) confirm that both P and NP interventions reduced water use, and the NP-effect is at least four times the price-effect. There is a large difference in the effect size of the two interventions, consistent with the pattern of change in lpcd usage. In the last stage, NP-treated households reached a much lower level of water use than the untreated households (102.0 and 121.1 lpcd, respectively). However, they started at a similar level (116.6 and 109.7, respectively) before interventions.[4]

Figure 2. Summary statistics comparing NP-treated and untreated households and estimated average treatment effects (ATE) of non-price (NP) and price (P) interventions.



	Before interventions	During NP-intervention	Cooling-off stage	Priced-stage
ATE of NP-treatment		-11.7%	-30.0%	-26.3%
ATE of NP-treatment in T3		-18.0%	-33.3%	-30.2%
ATE of price-intervention in C0				-8.0%
NP-treated households (1)	116.6	110.6	106.5	102.0
Untreated households (2)	109.7	121.3	126.3	121.1
NP-treated group T3 (1,T3)	119.1	104.1	102.8	98.5
Untreated control group C0 (2,C0)	109.7	121.3	139.0	129.8
All households (3 = 1 + 2)	114.1	112.6	113.7	109.0

Stages of study, effect-size and water use in subsamples of households

Note: Average water use in 101 households in lpcd (liters per capita-day) is arranged by chronological stages of study from left to right. NP-treated households (labeled 1) are a pooled group of households that were randomly allocated to one of the three non-price (NP) treatments (named T1, T2, and T3) that received one, two, or three components of a behavioral treatment for water conservation. Untreated households (labeled 2) belong to the Control group (C0) for the NP-intervention experiment, or those that moved in post-intervention (labeled PI). NP-treated group T3 received a treatment containing all three components of NP-intervention, i.e., it is the only group that received the complete treatment, and thus it is the best group to observe the full effects of NP-intervention. Untreated Control Group C0 is the best group for observing price-effects. Aggregate (labeled 3= 1+2) represents all the households. ATE is converted into percentage change from baseline lpcd**.** ATE of NP-treatment is estimated in each of the three sequential stages of the experiment - during the NP-intervention (year 1), in the cooling-off stage (year 2), and in the priced-stage (year 3) – as a difference-in-difference between NP-treated households and control households. The price-effect is depicted for control group. For details, see Tables S6 to S13 in the SI. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

The pool of all untreated households supports a marginally larger price-effect (-7.4 lpcd at borderline significance) than treated households (-5.9 lpcd). The higher statistical significance of ATE in treated households suggests a more consistent response. This pattern is also observed in the reduction in total

[4] The effect of NP-intervention is 33% in the group T3 whereas price-effect in the control group from NP-intervention (i.e., the group that received only a price intervention) is 8%.

water usage, in tests using subsets of periods in the priced-stage, and in time-series analysis (SI Tables S9 to S12; and also *cf.* Section 3.3).

3.2 Heterogenous Response to Interventions

We further examined the difference in relative effects of P and NP interventions in subsets of households based on key household attributes relevant to water conservation (SI Tables S13 to S42).[5]

We compare the price-effect in the first experiment's initial groups (Control C0, Treatments 1, 2, and 3) and a new group for post-intervention (PI) movements-in (SI Table S13). A statistically significant effect for price intervention is detected only in the untreated control group (-11.06 lpcd) and the group T1 (-10.81 lpcd). T1 group received only one component of the NP-intervention (namely simplified usage information) and it supports a relatively small NP-effect (SI Table S9). This supports the finding that price-treatment worked in only two groups. Also, the size of the NP-effect is three to five times larger than the price-effect depending on the group, and about four times larger at the aggregate level.

Water conservation habits are expected to predict water usage well(40–43). We find support for this hypothesis through our survey-based index of self-reported water conservation habits (SI Table S8), particularly in the NP-treated households some of whom (i.e., group T3) had received habit-enhancing tips. NP-treated households with weak habits have 20% higher lpcd than households with strong habits. Both interventions significantly affect the weak-habits households, with NP-treatment nearly three times as effective as price-treatment (Figure 3). Strong-habit households also reduce their usage during NP-intervention by 35 lpd (liters-per-day), regardless of whether they received the NP-treatment (SI Table S15). The condominium-level announcement that an NP-intervention is starting for randomly selected households seems to have drawn enough attention to water conservation actions in households with high water conservation habits.

The gap between stated attitudes and actual behavior is observed by measuring attitudes toward the environment on the NEP scale. High-NEP households use more water but respond to both interventions (Figure 3). Expectedly, those with low-NEP did not respond much to either intervention. Both interventions helped bridge the gap between high attitude and low agency towards conservation (SI Tables S17 to S20).

The results for attitude toward water (measured using a new Water-NEP scale) are slightly different from those for the generic NEP. This is expected as the NEP distinguishes the attitude toward each resource (e.g., water) from the broader attitude toward ecology or environment (38). While there is not much difference in price-effect based on the level of water-NEP (Figure 3), NP-intervention reveals a stark difference in response. Those with high (i.e., positive) attitudes towards water responded very favorably, while those with low attitudes did not respond. This result supports the relevance of a new water-NEP scale as a measure of alignment to water conservation.

Homeownership, or in general principal-agent incongruity in behavior, is seen in our interventions (Figure 3, high refers to owners, and low refers to tenants). NP-intervention is very effective for tenants, suggesting a strong role of their agency as tenants are less likely to invest in structural changes, such as more efficient washing machines. Owners use less water to start with (SI Table S14) and respond to price.

Households using water at an above-median level responded to both interventions (Figure 3, last column), similar to another recent study where high users responded to price (44).

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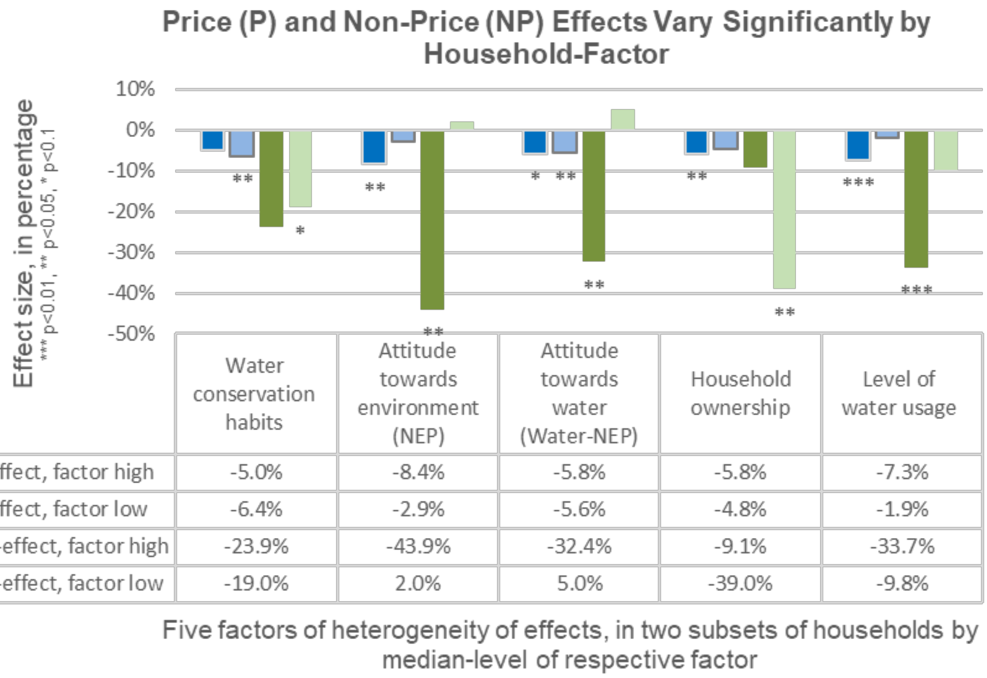
[5] For the estimation of NP-effects for each subset, we tested the same set of assumptions as for the aggregate, namely parallel trends, and balance in each of the subsets (SI Table S4). The assumptions hold. For the estimation of price-effect, there are no additional assumptions about the data and no additional tests are needed.

Figure 3. Heterogeneity of effects of price (P) and Non-price (NP) interventions comparing the role of five common factors.



	Water conservation habits	Attitude towards environment (NEP)	Attitude towards water (Water-NEP)	Household ownership	Level of water usage
P-effect, factor high	-5.0%	-8.4%	-5.8%	-5.8%	-7.3%
P-effect, factor low	-6.4%	-2.9%	-5.6%	-4.8%	-1.9%
NP-effect, factor high	-23.9%	-43.9%	-32.4%	-9.1%	-33.7%
NP-effect, factor low	-19.0%	2.0%	5.0%	-39.0%	-9.8%

Note: We juxtapose the average treatment effects (ATE) of the two interventions by dividing households into two subsets based on median-value for five household-level factors (e.g., the values in the row P-Effect, Factor High refers to ATE of price intervention in above-median water conservation habit households, above-median attitude towards environment households, etc.). ATE from panel data analysis is estimated in lpcd (liters per capita-day) and converted to percent change using corresponding lpcd in the respective baseline stage for the subsample of households. NP-intervention effects shown in this summary chart are based on ATE in the cooling-off stage (i.e., without any effect of price) for a pool of all three NP-treated groups. For detailed results see SI Tables S14 to S24. *** p<0.01, ** p<0.05, * p<0.1.

We also examined the role of several other household-level factors, including loss or gain from switchover to the priced-regime when a volumetric fee replaced a fixed fee. We find that being at a monetary loss or gain after the switchover made little or no difference to the effect. A loss or gain was possibly not even noticed by the residents till it became much more evident with the second quarterly bill in July (SI Tables S38-42). We find that the effect of NP-treatment is strong and large in the kitchen-utility area and in the primary bedroom. Both these meters also support the price-effect but of a lower size. The effect is missing in the shared bathroom in both interventions (SI Tables S25-S27).

Using our panel data model for effect during the days between receipt of the bill and payment (model 3 in SI), we find that people use relatively less water after receiving the bill than on other days in the priced stage (SI Table S47). However, NP-treated households do not support a significant reduction in the bill-to-pay period although they support price-effects. This suggests that the water use behavior in these households is more consistent over time, regardless of the bill-to-pay period.

3.3 Time-series results

Time-series results support the absence of an effect on aggregate water usage during price-introduction. We observe a pulse-shaped transient response-pattern with a non-significant positive effect size and no long-term effect (SI Table S50). Similarly, we do not observe a persistent or strong effect in most subsamples.

However, we find that at the household level, nearly all the households (79% of the total) fit into a persistent pattern of response (i.e., a step change or build-up), that too a statistically significant response by a large share (53% of the total). Many households (21%) increase water use initially and over the long term; the initial increase in lpcd is 20% and 26% over the long-term (SI Tables S51 to S53). The directionally opposite responses at the household level cancel out leading to no net effect at the aggregate level. This analysis confirms the heterogeneity of response to price intervention seen in summary statistics; just 12% of the households reduced as much water use as the total reduction in water use (SI Figure S11). The price-effect at the household level has enormous variation in effect size (SI Figure S12), both negative and positive.

Results from time-series models (models 5 and 6, which split the effect of overall price structure and each bill) support that while there is no effect on the aggregate of all households at the time of introduction of price, there is an effect at the time of receipt of a bill (SI Tables S54 and S55).

4. Discussion

Adequately characterizing behavioral responses – especially of the affluent – is central to addressing diverse environmental and social conundrums (19, 45). Field experiments can generate actionable insights to promote behavior consistent with sustainability goals (46, 47). Our set of long-term field experiments in an affluent community allowed us to measure the efficacies of a typical price intervention and a novel behavioral non-price intervention, apart from providing a near-ideal setting for observing a price intervention with both before and after intervention observations at the household level.

Price-based interventions are a set of potential tools for water conservation, such as in regions where the existing water supply is not metered at the household level (48). The introduction of price is also relevant for over one-fourth of the global population where safe drinking water supply is expected by 2030 under SDG6 (4). Price is a crucial influencing tool even in the broader climate change mitigation, adaptation, and environmental conservation interventions, given the central role of money in decision-making (24, 29). However, the application of price in resource conservation is constrained by social and political barriers to its use and acceptance of a high enough price point (49–51). Price may also have a small effect size that is insufficient for policy objectives, as seen in the case of carbon pricing where it has not impacted much (50). Further, our results suggest that when price was used, it did not work uniformly across households. The presence of price even increased resource use by some users, indicating an adverse effect (14, 49, 52). This is similar to the rebound effect, where technological efficiency is interpreted as a license to inattentive usage (53).

Price and non-price interventions have been studied extensively as policy options (10, 29). One of the critical behavioral challenges with using price as a policy tool is the tension between extrinsic and intrinsic motivation (13, 14, 49, 54); market norms take over from social norms when a price is introduced. Our study shows that this tension could be partially overcome through a better design based on proven behavioral theories. While some others have found friction between price and NP interventions (14, 55), we suggest that alignment between two interventions can lead to a higher level of conservation in households that receive both treatments (Figure 2). Another evidence of this synergy is seen in the group of households that increased household-level water usage after the introduction of price (SI Table S44); NP-treated households had a much smaller increase (5 lpcd) compared to untreated households (14 lpcd). Combining price and non-price interventions also makes it possible to avoid the risk of rebound effects or, in general, worse outcomes from introducing an efficient structure or price. Some consumers may exhibit a minimal response to pricing strategies, especially when the marginal price is not high enough for affluent consumers to induce any significant income effects (34, 44). Moreover, increasing prices could potentially backfire. Alternatively, non-price mechanisms influencing habits and educating consumers could prove significantly more advantageous (8, 33).

The NP-intervention (33) can be understood as an innovative, non-binding structure that was designed to target the capability, opportunity, and motivation of individuals, i.e., all the three necessary source conditions for successful behavior change as per the comprehensive and popular COM-B model (27), aka Behaviour Change Wheel (BCW).[6] All three sources of behavior change were targeted through NP-intervention as a structure that elicits the agency of individuals. However, the price intervention did not enable user capability towards lower resource use, though it might have motivated some users (viz., by creating an economic incentive and social comparison with the median level of water usage). It also reminded them about the opportunity infrequently through a quarterly bill communication whereas the NP-intervention was once a week. NP-intervention's short duration of five weeks succeeded in a large and persistent reduction suggesting a change in habits and other structures aligned to higher water conservation, later supported by an ongoing price intervention.

Much of resource use happens automatically, driven by structures embedded in an individual, such as automatic thinking, attitudes and habits, and physical structures relevant to resource use (42, 56). Interventions can attempt to alter both the automatic and the slow, reflective thinking, leading to efficient structures and exercise of agency towards curtailment of resource use, creating a multiplier effect and a high level of conservation outcomes. While the NP-intervention was designed based on this well-established knowledge, the design of the price-intervention was similar to a typical water utility bill and it did not utilize this vital knowledge.

A central limitation of empirical research, even experiments, is that we cannot directly observe behavioral decision-making pathways. We attempted to look inside this black box through a variegated analysis of diverse potential factors underlying behavior. Low household-level attitudes toward water and the environment can hinder non-price and price interventions (Figure 3). Those with lower attitudes toward water responded to price intervention with smaller effect-size. Tenants responded well to NP-interventions though it is usually more challenging for them to make structural changes in the devices; the NP-intervention may have successfully exercised their agency towards curtailment.

While our results on the role of billing and payment events are consistent with established wisdom, namely that bill communications can serve as a reminder to conserve (57) and that effects diminish after payment (37), the near-absence of bill-to-pay period effects in NP-treated households (SI Table S48) suggests that a more persistent (low) level of water use even outside of this short duration of 2-3 weeks. Although app-based notifications, more frequent bill communications and corresponding payments can be a conservation-enhancing structure, it may not be very effective for NP-treated households for further reduction in usage, partly because there are limits to lowering water demand at the household level (58). A minimum level of water is essential, and the closer a household is to that limit, for example, in group T2 (SI Table S6), the harder it gets to reduce water usage, as seen in the absence of effects (SI Table S49). More robust NP interventions that equip households to conserve water can help in increased conservation post-billing, as seen in group T3. Households with mild NP-treatment in group T1 with higher baseline lpcd for price intervention responded mildly to bills, similar to the untreated households (in group C0), and their level of water usage remained relatively high (SI Table T6).

While our experiments are at a small scale and in a specific sequence (NP-intervention followed by price intervention), the design and implementation align with the recommended approach of piloting with local community involvement and scaling it up (9). Further, we employ a non-price intervention that nudges problematic prevalent social norms in affluent households (19) through science-based objective norms towards a more reasonable level of resource consumption.

5. Conclusion

The central goal of our research was to compare the relative efficacies of price and non-price interventions for water conservation and develop a framework for optimal conservation interventions. Our results provide evidence that combining price and non-price behavioral interventions must account for both structural and agentic resource channels to increase water conservation. A change in an

[6] The NP-intervention has been discussed extensively in the earlier article (33). In this article, we discuss the price intervention, compare it with NP-intervention and identify factors of heterogeneity of P and NP effects.

individual's behavior can be approached via diverse interventions such that heterogeneous individual structures are targeted to lower water use. While marginal pricing is associated with adverse reaction risks stemming from the replacement of social norms by market norms, such risk can be mitigated with appropriately designed non-price interventions. While the price-level is a well-known factor in reducing demand, non-price intervention can be even more powerful, such as a theoretically-grounded norm-nudging type of behavioral intervention employed in this study that can increase impact via structure and agency in recurring water use occasions. Water demand reduction interventions targeting affluent communities can help bridge the gap between demand and supply of water and accelerate progress towards SDG6. Future research must also study the feasibility of the large-scale deployment of the intervention framework we have presented here.

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Combining price and non-price interventions for water conservation

Online Supporting Information

Contents of this file

Introduction

The supporting information contains the following:

- Details of the site of the field experiments
- Survey and data details
- Details of econometric models and statistical tests
- Result tables
- List of datasets

S1. Field details

1.1. Experiment's site

The experimental setting is a set of households in an apartment community in the city of Bengaluru, India. This specific apartment complex provided a very interesting setting from research perspective. This apartment complex, that was built by the year 2008, retrofitted all the apartments with water meters in the year 2015 and kept records of household water usage. But it did not start volumetric billing for water for several years. This presence of detailed measurement of water usage made it possible to pursue novel research on non-price and price interventions. They provided permission to the researcher's institution to collect water usage records and in general to conduct water conservation research, both before and after the start of water billing. Water billing started in the year 2018.

There are 120 apartment units in this community. The units are either 2BHK, i.e., 2 bedrooms with hall and kitchen, or 3 BHK. Each unit has three water meters, one for kitchen (including utility-laundry area) and two for two bathrooms (master or primary bathroom and common or shared bathroom). The three meters make it possible to measure the location of water usage inside the house. All meters are accessible from outside the dwelling-units on a common rooftop allowing for ease of meter reading without interaction with residents. Electricity meters are also conveniently accessible at another common location on the ground floor. We collected daily meter reading of all the water and electricity meters starting Oct 2016 for over 2 years. This provided us a 738-day panel of 356 daily water consumption measurements and 120 daily electricity consumption measurements. The total number of water meters is 356 and not 360 (= 120 x 3) since 4 meters were not installed due to structural modifications before metering in those large units. Such units were later excluded from analysis. We also collected monthly meter reading records from condominium manager's office for the years 2016-2019. A household survey was conducted after start of water billing (see Survey description and survey forms).

1.2. Income profile

Table S1. Level of income by household.

Annual Income (in Indian Rupees)	Frequency
< 1 million	8
1–2 million	8
2–3 million	15
3–4 million	17
> 4 million	33
Unknown	27

The community is relatively affluent and this is reflected in their household annual income as declared by surveyed residents during the survey. The median annual income is Indian Rupees (INR) 3–4 million (i.e., 36–48 thousand US Dollars (USD) using an exchange rate of 83.38 INR = 1 USD).

1.3. Non-price and price interventions

The research site has had water meters in place since the year 2015. But the community did not start on water billing due to a variety of reasons, including change in residents' association leadership team, absence of billing software, cost of buying and using billing software and concerns about ownership and burden of billing process if billing is done manually. However, the resident volunteers who had worked on the initiative to introduce metering remained interested in billing and the association's management team was also not closed to the idea.

It is important to note the researchers did not take part in the decision-making in billing, such as what information to show or not to show. In that sense, the data collection from billing is a natural experiment or an intervention made by the society, unlike the non-price intervention that was designed by researchers.

The non-price intervention was conducted in November and December 2016. It consisted of five weekly water usage reports (Figure S1).[1]

We came across this setting in the year 2016 (year 1 in our study). It took nearly one and a half years (mid-2016 to end 2017) for them to get their internal alignments to move forward with household level water billing. This also provided a long baseline (or before price-experiment) period with daily recording of metering readings from 24th Oct 2016 and weekly readings from 17th Oct 2016. The initial target date for start of billing was January 2017 but it eventually happened in January 2018. In this period, the association sent information-only bills, i.e., bills that were not to be paid but they served to inform the residents about their usage and bill amount, if they were to be billed. Such bills were sent for three periods at the end of each period, namely the first three quarters of the calendar year 2017. No such bill was sent for the last quarter, i.e., no information-only bill was received by residents in Jan 2018. Further, a bill amount was calculated for all the months of year 2016 (based on associations record of monthly meter reading) and sent to all residents as information. The tariff used in these diverse bills allowed the association to work out the final tariff that was later used in actual bills.

[1] Details of the NP-intervention and its results can be found in earlier research (1).

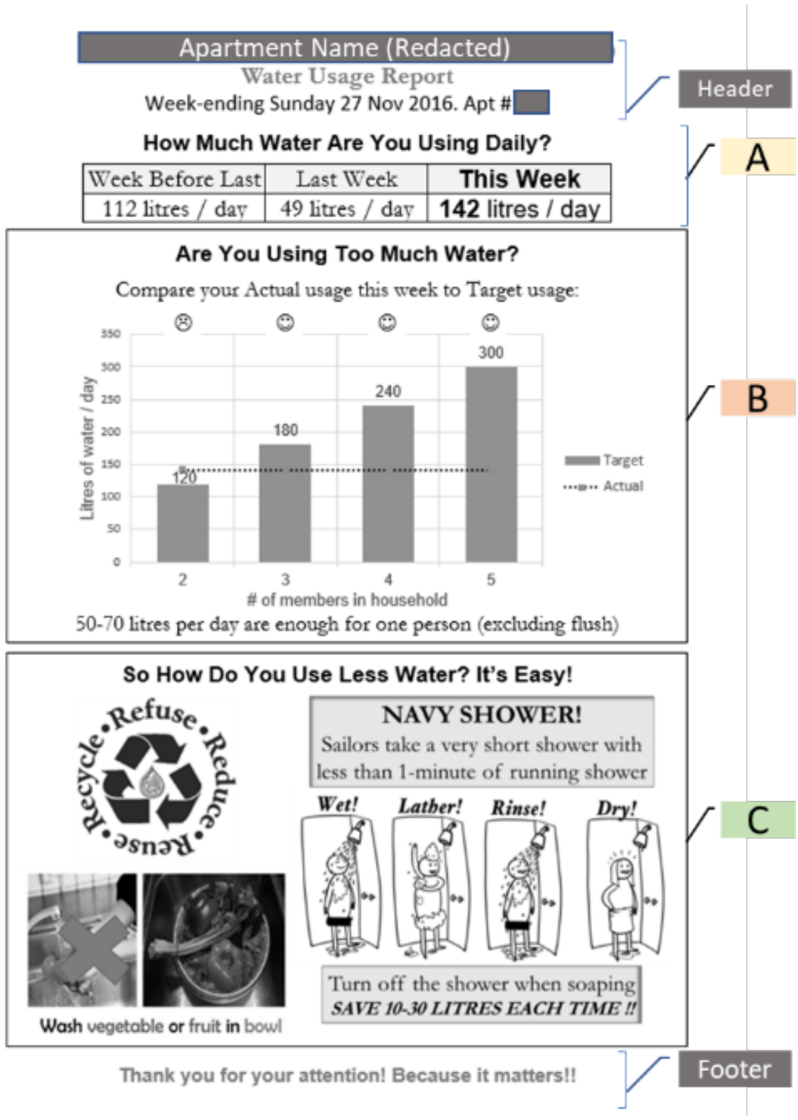

Figure S1. Sample non-price intervention report (Source: (1). Report contained one, two or three components depending on the treatment group; component A-simplified usage information for Group T1, component B-a suggested water usage goal, comparison with actual usage and injunctive feedback (additional component for Group T2), and C- water saving tips (additional component for Group T3). Control group did not receive any weekly report, only a one-time announcement sent to all the resident before the non-price intervention.

The lowest slab of water charge was 13 paise per liter whereas the market rate from tankers was less than 10 paise per liter (one Indian Rupee = 100 paisa). Tankers constitute the costliest source of local water supply as compared to municipal supply, own groundwater from a well or rainwater. This tariff was intentionally a little high in order to encourage conservation and to keep a buffer against rising cost of water procurement.

Table S2. Water tariff. Water tariff blocks and rates as used initially in information-only bills and the actual bills. One paise is one-hundredth (1/100) of a rupee.

Information-only bills		Actual bills	
Tariff blocks (liters per month)	Rate (paise per liter)	Tariff blocks (liters per month)	Rate (paise per liter)
0 to 6,000	13	0 to 6,000	13
6,001 to 8,000	15	6,001 to 8,000	15
8,001 to 10,000	18	8,001 and above	18
10,001 to 13,000	22		
13,001 and above	28		

There were two main changes in tariff that happened from information-only bills to actual bills. One, the number of volumetric tariff blocks was curtailed from original five to final three blocks. Two, the fixed monthly charges were revised downwards from INR 350 in the first informational bill (Jan–Mar 2017), to INR 200 in the second informational bill (Apr–Jun 2017) and finally down to Rs 100 in the actual bill (Jan 2018 onwards).

No changes in tariff or fixed charges were made in the entire observed period of actual bills (Jan 2018 to March 2019) used in this article.

The actual water bills were communicated in two ways to each household – one, as part of an electronic quarterly maintenance notice as a line item on water charges and two, as a single-sheet paper delivered in-person by association's condominium management. The information-only bills were sent either electronically to people's email (first two quarterly bills) or as paper (3rd quarterly bill).

A sample bill is shown in Figure S2. The layout of the paper bill includes monthly charges and volume by meter. It also includes median volume used in the apartment community in that quarter.

Abc Xyz Pqr Apartment Association - Water Bill

Apartment Number: NNN

Dear Resident,

Please find the summary of your Q4 quarterly water bill for the period shown below:

From	To	Volume (litres)	Water Bill (Rupees)
01-01-2018	**31-03-2018**	**31,644**	**4,956**

Please find the details of your Q4 quarterly water bill by monthly periods as shown below:

From	To	Volume (litres)	Kitchen (litres)	Common Bathroom (litres)	Master Bathroom (litres)	Volume Only Value (A)	Fixed Charges (B)	Water Bill (A+B) (Rupees)
01-01-2018	31-01-2018	6,662	4,561	1,040	1,061	879	100	979
31-01-2018	28-02-2018	9,000	5,741	1,682	1,577	1,260	100	1,360
28-02-2018	31-03-2018	15,982	9,017	4,672	2,293	2,517	100	2,617
TOTALS		**31,644**	**19,319**	**7,394**	**4,931**	**4,656**	**300**	**4,956**

The water bill has been added as a separate item in the maintenance charge notice.
Payment has to be done together as mentioned in the maintenance charge notice.
This bill is being given to residents for information purpose.

For your information, the median or middle level of volume used per apartment in this quarter is: **24,369** litres

The water volume only value part (A) of water bill has been calculated using the following tariff.
It is based on volume of water used in a monthly period as on date of reading:

Tariff Blocks (A)		Rate	
0 to 6,000	litres	13	Paise / litre
6,001 to 8,000	litres	15	Paise / litre
8,001 and above	litres	18	Paise / litre

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Apartment Owners Association

Figure S2. Sample of water bill at experiment's apartment complex. Informational bills followed the same layout but were not to be paid.
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S2. Survey description and survey forms

A household survey was conducted at the apartment complex to cover the entire population, i.e., all the apartment units in the complex. Out of 115 households across 120 numbered apartment units, 107 were successfully surveyed. Most of the household survey was conducted in Jun–Sep 2018, i.e., after they had received the first bill and paid for it.

Since number of residents change with time (largely due to travel or visitors), and it is a key determinant of water usage, we collected this information as part of the survey. We found that 49 of 107 households that we surveyed had a change in number of residents in our period of interest (from Oct 2016 till date of survey). Some apartment units were visited twice to collect data, e.g., when there was a move in or move out. After the survey, the number of residents in each household and movements information was complemented through data from the condominium management office. This included subsequent changes in family size, such as births and deaths, and to collect number of residents for the few households that were not surveyed; those were largely vacant units or households that moved out before the survey. Information about the exact number of residents was unavailable for a small number of un-surveyed households. In such cases, we used the average number of residents as per size of the dwelling unit (2.44 for 2 BHK and 2.97 for 3 BHK, a total of 1991 rows in the final filtered dataset of 59,563 rows) for days when water was used. This data collection from the office was done through multiple iterations in the years 2018 and 2019.

Each interaction with residents is likely to contaminate the effects that we intend to measure. We avoided in-person interactions with residents other than a one-time survey. Further, it is not feasible to do extensive interactions as part of a large public policy rollout; by doing limited interactions we expect our results to be closer to larger policy-rollout setting.

2.1. Scales used

2.1.1. Preparation and testing of indices

The two new indices, Water NEP (New Ecological Paradigm) and Water-Habits, were tested for reliability, both before and after the survey while NEP was tested only after survey since it is a well-established scale. We used Cronbach's Alpha, i.e., scale reliability coefficient, in STATA®. We found good level of reliability of both water NEP and Water Habits in pre-survey that was conducted on 167 students at a management school. The reliability was somewhat lower in the actual survey data but the level is considered acceptable.

Table S3. Reliability of scales. Summary of test of reliability of survey-based indices used in this study. Cronbach's Alpha (scale reliability coefficient) ranges from 0.71 to 0.75, which is an acceptable level.

Reliability Items	NEP	Water NEP	Water Habits
Pre-survey sample		**167 students**	
Average interitem covariance:	NA	0.27	0.76
Scale reliability coefficient:	NA	0.84	0.81

Actual Survey		**119 surveyed adults**	
Average interitem covariance:	0.12	0.12	0.29
Scale reliability coefficient:	0.71	0.75	0.72
Mean value	3.73	3.95	3.69
Standard error	0.040	0.041	0.067
Median value	3.73	4	3.73

2.2. Survey questions

Before responding to the survey, respondents were asked to provide formal consent. Consent was sought and recorded from every household. No household declined consent while some residents took time to understand the consent form and later provided consent.

CERTIFICATE OF CONSENT

I understand that there is a survey named **Apartment Water Survey** and it is being conducted at this apartment with approval from my apartment association. This survey is a part of research in water management by Redacted Redacted

The basic objective of this survey is to collect basic information about each household, such as number of residents, and resident's views towards a few important issues covered in this research, such as water consumption and environment. This would help the research in analysis of water consumption data and in doing interesting analysis on people's response to water management policies as prevalent at Redacted

I have understood the objective of this survey. I understand that the survey would take about 15 (fifteen minutes).

I have had the opportunity to ask questions about it and any questions I have asked, have been answered to my satisfaction. **I consent voluntarily to be a participant in this study.**

In case I refuse to be a part of the survey or if I refuse later during the survey, the refusal will not be held against me, nor will it be shared with association.

I understand that the information provided by me will be kept strictly confidential, anonymous and protected. It will not be shared with association without my explicit permission.

I understand that the survey is not likely to cause any damage to me or my property. It is likely to benefit the general society and my apartment association in better understanding of water management policies and in improving water management, with support from Redacted

Yours sincerely,

Name of participant ___________________________________

Apartment number ___________

Signature of participant ___________________________________

Date ____________

Figure S3. Consent form. The form to grant permission to be surveyed.

Date and Time: ____________ ____________

Questions asked by surveyor

1	Apartment number	____________
2	How many persons currently live in your apartment, including any full-time domestic staff and children?	____________
3	When did you move into this apartment unit? If you moved in Oct 2016 or later, were you living in another unit within the same apartment complex? If YES, which apartment number and from when to when?	____________ YES / NO Apt No _____ From-date To-date __________ __________
4	Do you have any domestic staff, whether full-time or part-time? IF YES, please provide current number of full-time and part-time staff, and start date of role	YES / NO No. of full-time: _______ Since move-in? or later? Role & Date: ___________ Role & Date: ___________ No. of part-time: _______ Since move-in? or later? Role & Date: ___________ Role & Date: ___________
5	Has there been any change in number of persons living in your apartment since Oct 2016? In other words, have you had long-term visitors staying with you, people moving out or in, or babies since 2016 Dasara? Long-term is defined as one month or more. If YES to either question, can you please provide number of residents by time-period, i.e. net number of persons by date?	YES / NO From-date To-date Persons __________ __________ _____ __________ __________ _____ __________ __________ _____ __________ __________ _____
6	Are you the owner or tenant?	OWNER / TENANT
7	IF TENANT, (A) Do you pay maintenance charge? (B) Do you pay water bill? (C) Do you pay electricity bill?	 YES / NO YES / NO YES / NO
8	What is your household's total annual income? You need not share the exact income. A range is enough. This is not personal income or salary but total across all persons and all sources of income.	< 10 Lakhs 10-20 Lakhs 20-30 Lakhs 30-40 Lakhs > 40 Lakhs

Figure S4. Main questions. The standard set of main questions asked by surveyor.

The surveyor conducted survey with a standard set of questions as per a questionnaire that was approved by an Institutional Review Board (IRB) that was registered with the U.S. Department of Health and Human Services (HHS). The surveyor asked the questions in Figure S4 using a printed copy and recorded answers on the same paper.

The surveyor asked the questions on the first page and recorded answers, except for the question 8 on income that was filled by respondents. After the first page was completed, the surveyor handed over a printed 2-sheet (4 page) survey form on attitudes and habits. One or more resident per household was allowed to answer separately. In most cases, only one resident answered. Wherever more than one resident answered, the responses were averaged to arrive at household level values.

Instructions to resident to fill the survey

Apt Number: _____________

In this part of the survey, you need to provide your level of agreement or disagreement for each statement.

Examples

Statement	**Strongly Agree**	**Agree**	**Unsure**	**Disagree**	**Strongly Disagree**
1. We have a lot of restaurants that provide home delivery to our community.		✓			
2. The number of good schools is going down in this city.				✓	

Please turn to the next page to fill survey responses.

Figure S5. Survey instructions to resident. The first page of the resident survey form with instruction to residents on how to fill the survey.

Questions Set 1

Please provide your level of agreement or disagreement for each of the following fifteen statements. Kindly mark only one of boxes against each statement.

Statement	Strongly Agree	Agree	Unsure	Disagree	Strongly Disagree
1. We are approaching the limit of the number of people the Earth can support.					
2. Humans have the right to modify the natural environment to suit their needs.					
3. When humans interfere with nature it often produces disastrous consequences.					
4. Human imagination will insure that we do not make the Earth unliveable.					
5. Humans are seriously abusing the environment.					
6. The Earth has plenty of natural resources if we just learn how to develop them.					
7. Plants and animals have as much right as humans to exist.					
8. The balance of nature is strong enough to cope with the impacts of modern industrial nations.					
9. Despite our special abilities, humans are still subject to the laws of nature.					
10. The so-called "ecological crisis" facing humankind has been greatly exaggerated.					
11. The Earth is like a spaceship with very limited room and resources.					
12. Humans were meant to rule over the rest of nature.					
13. The balance of nature is very delicate and easily upset.					
14. Humans will eventually learn enough about how nature works to be able to control it.					
15. If things continue on their present course, we will soon experience a major ecological catastrophe.					

Figure S6. Survey questions on NEP. The second page of the resident survey form with standard NEP (New Ecological Paradigm) questions. Minor changes were made to the standard text to tailor it for local use of language.

Questions Set 2

Please provide your level of agreement or disagreement for each of the following fifteen statements. Kindly mark only one of boxes against each statement.

Statement	Strongly Agree	Agree	Unsure	Disagree	Strongly Disagree
1. There is acute and growing water scarcity.					
2. Humans have the right to take water from natural environment to suit their needs.					
3. Human interference with natural water resources has often produced disastrous consequences.					
4. Human imagination will ensure that we continue to get water.					
5. Humans are seriously abusing water resources, both groundwater and surface water.					
6. The Earth has plenty of fresh water if we just learn how to develop water resources.					
7. All living beings have as much right to water as humans.					
8. The balance of nature is strong enough to cope with the impact of human water extraction from surface and ground.					
9. Despite our special abilities to extract water, we humans are still limited by nature.					
10. The so-called "water crisis" facing cities is greatly exaggerated.					
11. As water is limited, water conservation is important.					
12. Humans were meant to rule over nature and need not worry about water scarcity.					
13.Water conservation is necessary because water is scarce and valuable.					
14. Humans will eventually learn enough about water resource management to provide as much water as we want.					
15. If things continue on their present course, we will soon experience a major water crisis.					

Figure S7. Survey questions on Water NEP. The third page of the resident survey form with questions on water modelled after NEP (New Ecological Paradigm).

Questions Set 3

Please provide your level of action for each of the following statements on your habits. Kindly mark only one of boxes against each statement.

In the last six months, I have…	**Never**	**Sometimes**	**Often**	**Very Often**	**Always**	*Not Applicable*
Checked and fixed leaks						
Taken shorter showers						
Used half-flush or not flushed every time						
Only done full loads of clothes for washing						
Used minimal water in kitchen						
Turned off taps when brushing teeth						
Watered plants only in the mornings and evenings, not when Sun is high up						
Used bucket to save water when starting hot shower						
Washed vegetables and fruits in a bowl, not under open tap						
Washed dishes in sink or tub filled with water						
Used mop to wash floor, not by throwing water						

Figure S8. Survey questions on water habits. The fourth page of the resident survey form with questions on water habits. Since this page has a different set of responses, the instructions were explained to the respondents when they reached this page. Meaning of Not Applicable was explained as an activity that they may not be doing, such as doing dishes or mopping the floor.

After completing the resident survey form, the resident answered a few more questions at the household level, time permitting. Almost everyone responded to this last set of questions.

Questions asked by surveyor at the end (time-permitting)

1	How many litres of water do you think that your household uses, say in litres per day or per month? *(If unable to answer, prompt them to answer in terms of 20 litre buckets)*	____________ litres per d / m ____________ buckets per d / m Unable to answer
2	How much do you want your household to use?	____________ litres per d / m ____________ buckets per d / m N/A (not applicable if unable to answer previous question)
3	Do you support the decision to move to apartment level billing of water?	YES / NO
4	Do you agree with the current price of water?	YES / NO
5	IF NO, should be price of what be HIGHER or LOWER than current price?	HIGHER / LOWER
6	What should be the average price of water as compared to current price, or in any other unit of your choice? *(Also note down slab-wise or another structure specified by respondent)*	__________ times current price Avg. Price: _______ paise / litre OR Another Price: ____________

Space for recording qualitative inputs:

____

____

____

Figure S9. Survey's last page. Second set of questions asked by surveyor, at the end of completing the resident survey form.

Comments were noted on the survey form or on a notebook. These were also recorded into a computer system, apart from all the data elements.

Note that in almost all the households, only one resident responded to household survey and thus that one resident (typically 1 out of a total of 3 residents per household) represents the household in this data. This is a limitation for measurement of habits and attitudes but it is not important for household characteristics, especially number of residents which is the single most important explanatory variable of interest.

2.3. Data preparation

2.3.1. Data description

The primary dataset consists of daily water meter readings for each of the three water meters for each apartment unit. This gives us daily usage for three meters and total for each apartment unit. We use this daily data to sub-select those households that stayed during the transition to priced-stage. Families that moved out before start of price or that moved in after start of price are excluded from this paper as we examine the effects of price and non-price interventions. Further, only families with at least one month of water usage on both sides of the date of introduction of price were retained. This filtered set of apartment unit level daily data serves as the base for tests and further transformations of data, such as aggregations at various levels of granularity.

For time series analysis, a weekly summary is used for timeseries test at apartment unit (aka household) level, non-price experiment's group level and pooled aggregate level across groups. We have taken households on basis of at least ten observations in two stages, i.e., cooling-off stage after NP-intervention (also called before-price stage) and priced-stage. For t-tests, an apartment unit level summary is created for these two stages. Further filters and aggregations are used as appropriate for the specific tests.

2.3.2. Outliers and data

There are no instances of reported water leakage within a household in this entire data. Two unusual cases of water usage (lpcd and total usage in a day) are excluded as outliers.

We cannot identify all the possible small movements, such as travel and visitors over a few days, but large movements lasting a month or more than are included. Periodic or scheduled movements, such as regular work-related travel or outstation work, are captured as part of the household level survey and number of residents by date is updated, including as fraction, based on average time spent in the household (e.g., an average of 25% days spent away from home is taken as 0.75 number of resident).

2.3.3. Attrition and filtering

Out of the total of 120 apartment units, 101 units are in the filtered daily dataset for testing of effect of price. This attrition of 19 units is due to 4 4BHK units (made of 8 2BHK units), one family that lives across two 3BHK units on ground floor (2 3BHK units), resident volunteers for price intervention (2 units), and other reasons (either vacant units or family movements, 7 in all). The large size households are excluded as they receive two bills each quarter unlike rest of the households that get only one such bill.

Further filtering of data was done as appropriate based on the nature of the test or statistic leading a slightly smaller number of households in several of the tests. For time series analysis, we aggregated household data at weekly level for smoothening.

S3. Econometric models and statistical tests

3.1. Panel data models

3.1.1. Main model for non-price effect

The non-price intervention's effect is estimated as an ATE (average treatment effect) using a difference in differences (DiD) panel data model with fixed effects. It is same as the model used in the earlier publication (1). The suffix i is for household (aka apartment) and t is for day:

$$W_{ijt} = \beta_0 + \beta_1 StageN_t + \beta_2 Month_t + \beta_3 Weekend_t + \beta_4 Nores_{it} + \delta_1 T1_i StageN_t + \delta_2 T2_i StageN_t + \delta_3 T3_i StageN_t + FEHH_i + e_{it} \qquad (1)$$

Where:

W_{ijt} is volume of water consumed by household i, at within-household location j, on day t (we use both aggregate volume and lpcd as dependent variables (DV)),
$StageN_t$ are three experimental stage dummies, one each for During-intervention-stage, Cooling-off-stage and Priced-stage (dummy is 1 if day t falls in that stage, 0 otherwise),
$Month_t$ is calendar month of the year (as a factor variable),
$Weekend_t$ is a dummy indicating end of week (Saturday and Sunday),
$T1_i$, $T2_i$ and $T3_i$ are three treatment dummies for respective treatment group (1 if household i is part of that treatment group, 0 otherwise),
$Nores_{it}$ is the number of residents (aka size of the family) living in household i on day t,
$FEHH_i$ is the fixed effects term for household i,
and e_{it} is the error-term.

Further, the outcome variable W_{it} can also be lpcd, or water usage in one of the three meters. We also test by adding three weather variables $Weather_t$, namely average temperature in degree centigrade, average humidity and rainy-day dummy (i.e., whether it rained on that day).

We test using the above rigorous model for all the analysis of non-price effects and a modified version of this model for price-effect.

3.1.2. Main model for price-effect

We use the equation below to estimate the marginal impact of price on water consumption. In the regression specification, α_i captures the household-level fixed effects, γ_t captures the month fixed effects, δ is the effect of marginal-price on water consumption, priced-stage is a household level dummy variable which equals one for periods after the implementation of price tariff and zero otherwise, β_i represent the coefficient on the time-varying control variables X_{it}, such as weather.

$$Y_{i,t} = \alpha_i + \gamma_t + \delta \times priced\ stage_t + \beta_i X_{i.t} + \epsilon_{i,t}$$

The estimate of δ is biased if there are unobserved time-varying confounders that are correlated with the priced stage indicator. Temperature is a time-varying variable that we control for in the specification. However, other unobserved variables, such as water conservation awareness programs in Bangalore or the community, could happen and coincide with the timing of the price tariff rule. We requested the condominium management office in this community not to conduct any such intervention during our study, and we are not aware of any unobserved time factors that influence water consumption.

Further, several water sector reviews (2, 3) have documented that factors such as household income, number of residents, housing characteristics, habits, and outdoor use impact water consumption. The duration of our price experiment is close to two years, and these house-hold level variables (dwelling unit size, household income, water use habits, etc.) remain fixed and do not vary over time. The household-level fixed effects will account for these variables even though they are not explicitly included as control variables in the regression specification.

Although a difference-in-differences (DiD) approach is a more robust method, it requires a control group. Political and ethical considerations usually prevent a random assignment of individuals or households. Due to restrictions by the condominium management office, it was not feasible for us to create a randomized control group, i.e., we could not randomly assign the new marginal-price tariff on water to randomly selected apartments and the existing fixed flat rate to the remaining apartments.

Based on the above rationale, it is not possible to estimate the effect of price using a DiD model. We estimate the marginal effect of price on water consumption using the panel data model (2). In this regression specification, we use household-level fixed effect and include all measured time-varying control variables, both at day level (e.g., weather variables) and household level (e.g., number of residents). The following panel data model has been used where suffix i is for household (or apartment unit) and t is for day:

$$W_{it} = \beta_0 + \beta_1 Priced_t + \beta_2 Weekend_t + \beta_3 Month_t + \beta_4 Weather_t + \beta_5 NoOfRes_{it} + FEHH_i + e_{it} \qquad (2)$$

Our dependent variable W_{it} is in lpcd (liters per capita per day), and our main coefficient of interest is β_1 which gives ATE of price intervention. If W_{it} is another usage variable, such as water usage in one of the three meters, it gives ATE in the corresponding usage variable. $Priced_t$ is a priced-stage dummy (1 if day t falls during the price intervention period, 0 if before the start of intervention).

Rain is modeled as a dummy since whether it rained or not on a particular day is considered a better predictor of water usage than when it is modeled linearly as the amount of rain (2).

Note that the cooling-off and price stages are about a year long, and the usage in these stages covers all seasons. Since two stages also constitute "before and after" stages for price-intervention. Thus, even a simple difference in usage in lpcd for price intervention can provide a reasonable estimate of the change in behavior and we use that in summary statistics.

3.1.3. Model for salience of bill and payment

We modify the main model for price-effect to estimate the salience effect of bill-to-pay days by replacing priced-stage dummy with this salience stage dummy. We use only priced stage data to estimate the effect of bill-to-pay days as compared to other priced days.

$$W_{it} = \beta_0 + \beta_1 BillToPayDays_t + \beta_2 Weekend_t + \beta_3 Month_t + \beta_4 Weather_t + \beta_5 NoOfRes_{it} + FEHH_i + e_{it} \qquad (3)$$

$BillToPayDays_t$ is bill-to-pay dummy (1 if day t falls between bill communication and payment-due-date, 0 if before or after this period). Thus, the main coefficient of interest is β_1 which gives us ATE.

Note that we ignore the date of the physical water bill's delivery, typically spread over 3-4 days starting from the date of the quarterly e-mail containing the maintenance and water bill. We also ignore the actual date of payment by each household. Our definition of bill-to-pay period overlaps entirely with household-specific bill-to-pay period, and this is the best approximation in the absence of household-specific data on these two dates.

3.2. Time series models

Besides panel data analysis, we employ intervention time series (ITS) models to triangulate our findings and to estimate effects at the household level. Linear regression, estimated using ordinary least squares (OLS), is less suitable for time-series analysis due to the violation of the assumption of independent errors in time-series observations. A more suitable approach involves utilizing Autoregressive Moving Average (ARMA) models with intervention analyses. Readers may refer to the book (4) for a good discussion on the intervention analysis model. ARMA models can account for seasonal and local temporal effects, and when integrated with intervention analysis, the model can evaluate a specific effect's initiation, extent, and persistence.

3.2.1. Model for initial effects of price

$$Y_{it} = X_t'\beta + \frac{\omega}{1 - \delta B}\xi_t + N_{it} \qquad (4)$$

Y_{it} is the average water use in lpcd for apartment i in week t. X_t is a vector of weekly covariates (average temperature, humidity, rainfall, and a constant). X_t' represents transpose of X_t. The vector β represents the regression coefficients. The term $(\omega/(1 - \delta B))\xi_t$ represents the effects of the intervention in terms of the deterministic input series ξ_t and N_{it} is the noise which represents the observed series without the intervention effects. It is also assumed that N_{it} follows an ARMA(p, d, q). B is the backshift operator defined by $B(y_t) = y_{t-1}$.

The parameter ω is the initial effect, which measures the magnitude of the intervention's effect from the first week of the priced stage. A positive (negative) ω value indicates that the water use level has increased (decreased) after the intervention. δ stands for the decay parameter with the condition $|\delta| < 1$. This parameter indicates how long the effect remains in case of a transient effect or how long the effect accumulates in the long run. The long-run impact is estimated as detailed below by model.

We employ two distinct deterministic input variables ξ_t for studying the permanent and transient impact on water consumption. The first variant of the input variable ($\xi_t \equiv I_t$) is a step function that captures the permanent effect. I_t is defined as $I_t = 0$ when $t < T$ where T is the period of price-intervention and $I_t = 1$ when $t \geq T$. The second variant of the input variable ($\xi_t \equiv P_t$) is a pulse function that captures the temporary effect. P_t is defined as $P_t = 1$ when $t = T$ and $P_t = 0$ otherwise.

a) Model 1 refers to the step pattern, where the impact on water consumption is assumed to be constant and permanent, which implies δ equals zero in equation 3 and $\xi_t = I_t$, therefore ωI_t

component of the equation (3) reflects a permanent step change ω after time T. The long-run impact is ω.

b) Model 2 describes the build-up pattern; the impact of intervention on water consumption is assumed to be constant and increasing with time. The $(\omega/(1-\delta B))I_t$ (see equation (3)) component of the equation captures a gradual change with rate δ, which eventually converges to $\omega/(1-\delta)$ in long run. The long-run impact is estimated as ω / $(1-\delta)$.

c) Model 3 stands for the pulse pattern; the impact on water consumption is assumed to be sudden and transient, which is defined by δ equals zero in equation 3 and $\xi_t = P_t$. The ωP_t component of the equation captures a sudden change. The intervention effect is transient and has no impact after time T. The long-run impact is zero.

d) Model 4 analyses the decay pattern; the intervention's impact on water consumption is assumed to be constant and decreasing with time. The $(\omega/(1-\delta B))P_t$ (see equation (3)) component of the equation captures a sudden change ω after time T and decays with rate δ and finally converges to the pre-intervention level. The long-run impact is zero.

All the models are estimated using R-studio software. We use the package "TSA" to estimate all four models described above. For each apartment level, the best-fitted model among the four has been chosen by the AIC (Akaike information criterion) criterion.

3.2.2.Models for price and bill effects

Next, we analyze the impact of price intervention after receiving the bill. For this study, we use the following model:

$$Y_{it} = X_t'\beta + \omega_{Price}I_t + \omega_{Bill}D_t \qquad (5)$$

X_t is a vector of weekly covariates (average temperature, humidity, rainfall, and a constant). X_t' represents transpose of X_t. The vector β represents the regression coefficients. I_t is defined as $I_t = 0$ when $t < T$ where T is the period of price-intervention and $I_t = 1$ when $t \geq T$. D_t is defined as $D_t = 1$ when apartment i receives a bill in week t and $D_t = 0$ otherwise.

Further, we discuss the impact on water consumption after receiving two bills, i.e., the first bill in April and the second in July. We follow the model defined below for this study.

$$Y_{it} = X_t'\beta + \omega_{Price}I_t + \omega_{April}D_1 + \omega_{July}D_2 \qquad (6)$$

I_t is defined as $I_t = 0$ when $t < T$ where T is the period of price-intervention and $I_t = 1$ when $t \geq T$. D_1 is defined as $D_1 = 1$ when apartment i receives a bill in April and $D_1 = 0$ otherwise. $D_2 = 1$ when apartment i receives a bill in July and $D_2 = 0$ otherwise.

3.3. Other models

3.3.1.Logistic model

We also use a logit regression to study the factors that impact change in water consumption using the following model:

$$y = \alpha + \beta_1 NEP + \beta_2 Water\ NEP + \beta_3 Water\ Habit + \beta_4 Median\ lpcd + \varepsilon \qquad (7)$$

$$y = 1\ if\ there\ is\ a\ reduction\ in\ lpcd, \text{else } 0$$

The dependent variable y is based on the change in water consumption (lpcd), which equals one if there is a reduction in lpcd in the priced regime as compared to the before-price stage, and it is zero otherwise. The independent variables are survey scores on NEP (New Ecological Paradigm), water NEP, and self-reported water curtailment habits (Water Habit), and the dummy variable median lpcd (which equals one if the household's lpcd is above the median level for the community in the before-price stage).

S4. Results

4.1. Tests for validity of DiD Assumptions

4.1.1. Balance Test

We checked if randomization worked or not through a set of tests of balance. The tests of balance support that randomization worked correctly. We do not find any systematic differences in the main parameters of interest, i.e., lpcd, usage and number of residents. We find a difference in floor, but only between Control and T1. We do not find any difference in block (which is a number based on location of apartment unit).

Note that there are minor differences between the mean values of lpcd in this test of balance as compared to the summary statistics of lpcd. This is due to difference in the two calculations. For this test, we have used mean of daily lpcd value by apartment unit, excluding days of zero usage. For summary statistics, we have used the same daily data excluding days of zero usage but without first averaging it by apartment unit. The 2-step process used in balance test leads to a slightly different weighted average that is needed for comparison of apartment units.

Table S4. Comparison of baseline parameters. Mean (s.d.) values in before interventions stage by treated groups (Tn) and pool (T) of all treated groups. p-T columns are p-values of t-test of equality of control (C0) and treatment (Tn) means for the three treated groups T1, T2, and T3, and the pool (T) of all treated groups.

Parameter	C0	T1	T2	T3	T	p-T1	p-T2	p-T3	p-T
lpcd	109.7 (42.0)	117.7 (45.1)	113.6 (60.4)	119.1 (56.1)	116.6 (53.2)	0.56	0.81	0.56	0.59
Usage (total per day)	302.46 (183.4)	363.1 (142.6)	253.2 (140.1)	356.4 (185.2)	322.0 (160.9)	0.24	0.33	0.37	0.64
Usage in kitchen	163.0 (98.0)	209.3 (108.5)	139.8 (71.6)	181.8 (100.6)	176.6 (97.5)	0.15	0.39	0.57	0.58
Usage in master bathroom	72.4 (54.6)	92.7 (61.9)	49.4 (35.5)	105.3 (67.0)	80.9 (59.8)	0.27	0.11	**0.10**	0.57
Usage in common bathroom	67.0 (70.7)	61.1 (42.3)	63.9 (66.6)	69.3 (40.4)	64.5 (51.1)	0.74	0.89	0.90	0.86
No. of Residents	2.75 (1.30)	3.28 (1.23)	2.42 (1.20)	3.00 (0.71)	2.89 (1.14)	0.18	0.40	0.48	0.63
Tenants*	47%	47%	56%	27%	44%	1.0	0.63	0.23	0.82
Habit score*	3.92 (0.65)	3.75 (0.48)	3.74 (0.72)	3.47 (0.71)	3.67 (0.63)	0.38	0.44	**0.07**	0.15
NEP*	3.70 (0.40)	3.70 (0.43)	3.80 (0.41)	3.81 (0.41)	3.77 (0.41)	0.98	0.45	0.42	0.53
Water NEP*	4.04 (0.39)	3.84 (0.42)	3.96 (0.46)	3.92 (0.36)	3.91 (0.41)	0.16	0.58	0.38	0.24
No. of Observations	21	21	21	17	59	42	42	38	80

* Note that the number of observations for these rows is slightly lower than the number of observations mentioned in the last row:

Number of observations					
Parameter	**C0**	**T1**	**T2**	**T3**	**T**
Tenants	19	19	18	15	52
Habit score	18	19	16	14	49
NEP	18	19	17	14	50
Water NEP	18	19	14	14	50

The measurement of water usage parameters and number of residents is from the baseline period. Water conservation habits and two NEP score were measured during priced-stage through a household survey (section S2).

We note that habit score is highest in the control group. T3 group and C0 groups are slightly different on habit score, something we expected as T3 has gone through a behavioral intervention that educated them on water saving habits, repeated 5-times. T3 residents might understand that there are many actions needed for saving water unlike residents in all the other groups. Score of T3 is lowest; they possibly rate themselves relatively lower after knowing many ways to conserve water that they did not appreciate earlier.

4.1.2. Parallel Trends Test

The DiD model relies on parallel or common trends across groups. This is important to test in case of pre-existing groups or identities. It is less of a concern in an experiment where groups are created artificially and their identities are not announced, as in this experiment. Nevertheless, we validate this assumption through formal tests.

We use week level summary of lpcd by household in the two weeks before start of treatment and four weeks during the treatment. We find support for parallel trend assumption in all the ways that we test, i.e., through use of different DV's (total usage, meter-wise usage or lpcd), different combination of control and treatment groups (overall control groups vs all treated groups, or pairs of control and each treated group). We used STATA command didq with the same model as in the main regression.

Table S5. **Test of parallel trends assumption.** We used STATA command didq to compare the control group and treatment group, with two different DV's. The results support parallel trends assumption. p-Tn columns are p-values of common pre-dynamics across control group and the respective treated group T1, T2 and T3, and T, the pool of all treated groups for DV's total usage and each of three meters (k-kitchen & utility, mb – master bathroom and cb – common bathroom).

DV	p-T1	p-T2	p-T3	p-T total	p-T k	p-T mb	p-T cb
lpcd	0.2945	0.1132	0.1640	0.1163			
Usage in lpd	0.7118	0.3012	0.4767	0.4321	0.2290	0.8600	0.4391
No. of Observations	378	376	342	718	718	718	718

4.2. Descriptive statistics

The amount of water used in this community reduced through both these interventions. This is observed in multiple ways - the total water usage recorded by community, water tankers purchased by the community, and in the detailed daily data recorded by us. We report all statistics and results using our daily data which has several advantages over the monthly data records from condominium management, such as exclusion of days of zero usage which are not observable at monthly level and daily value of liters per capita-day (lpcd) based on survey of number of residents.

4.2.1. Usage by stage in NP-treatment groups

Table S6. **Summary statistics by group**. Water use in households in lpcd (liters per capita-day) arranged by chronological stages of study and divided by group. Treated households were randomly allocated to one of the three non-price (NP) treatments (named T1, T2 and T3). Untreated households belong to the Control group for the NP-treatment, or those that moved in post-intervention (called PI).

Stage of study (chronological)	**(1) NP-treated Households**				**(2) Untreated Households**			**(3) All Households**
Group	**T1**	**T2**	**T3**	**All**	**C0**	**PI**	**All**	
Before interventions	117.7	113.6	119.1	116.6	109.7	-	109.7	114.1
During NP-intervention	117.9	108.5	104.1	110.6	121.3	-	121.3	112.6
Cooling-off Stage	111.4	104.7	102.8	106.5	139.0	112.9	126.3	113.7
Priced-stage	103.3	103.4	98.5	102.0	129.8	111.9	121.1	109.0

4.2.2.Water habits, NEP, and Water NEP

We start with correlation coefficient between lpcd and these indices. Most correlations are weak or negligible except for water habit in treated households. We also note the slight change in treated households in priced-stage suggesting reduced gap between attitudes and behavior. The changes are minor but they point to impact of treatment and impact of price.

Table S7. Correlation coefficients. Between lpcd and indices of water habits and attitudes.

Household:	**All**		**Treated**		**Untreated**	
Stage:	**Cooling**	**Priced**	**Cooling**	**Priced**	**Cooling**	**Priced**
Water Habit	-0.21	-0.22	*-0.34*	*-0.32*	-0.15	-0.16
NEP	0.12	0.09	*0.10*	*0.03*	0.18	0.21
Water NEP	0.07	0.06	*-0.05*	*-0.10*	0.15	0.21

Table S8. **Summary of lpcd and change in lpcd by level of self-reported water curtailment habits**. Low and high refer to below and above median level of water habits in the population. The upper panel is for all households and the lower panel is for households that had received a non-price treatment. The treated households show a strong difference based on level of water habits. NA = Not available.

Parameters	**Cooling-off stage**	**Priced-stage**	**Decrease**	**t-test (p-value)**	**No. of households**
All Households					
Low-habit lpcd (L)	118.0	113.3	-4.7	0.07	44
High-habit lpcd (H)	107.6	103.2	-4.4	0.14	42
Difference (L-H)	10.4	10.1	-0.3		
t-test of difference (p-value)	0.14	0.11	0.48		
Habit NA lpcd	123.6	117.9	-5.7	0.11	15
All households	114.5	109.7	-4.7	0.02	101
Households that received a non-price treatment					
Low-habit lpcd	115.2	110.4	-4.8	0.14	28
High-habit lpcd	93.9	90.8	-3.1	0.17	22
Low-high difference	21.2	19.5	-1.7		
t-test of difference (p-value)	**0.02**	**0.02**	0.38		
Habit NA lpcd	109.0	103.2	-5.8	0.11	10
All treated households	106.4	102.0	-4.4	0.04	60

4.3. Main effects of interventions using panel data models

We first present results from panel data models for non-price and price interventions using the two main models described under section 3.1.1 and 3.1.2, respectively. We provide additional summary statistic and t-tests where relevant, such as before-after values of lpcd for various subsets of households, to contextualize estimates with relevant baseline values and tests. We compute robust standard errors clustered at the household level.

4.3.1.Main effects: price vs non-price

For both the intervention results, columns 2 and 4 include weather controls (average temperature, whether it rained or not that day, and average humidity). Weather controls do not change the results materially. We report regression results including weather controls unless specified otherwise.

Table S9. Main result for non-price intervention. Non-price effects are estimated as average treatment effect on treated groups by stage (coefficient of variables T*) using the main model (1).

VARIABLES and DV	(1) Main model lpcd	(2) Main model, weather added lpcd	(3) Main model Total usage	(4) Main model, weather added Total usage
Dummy for During stage	7.309	7.170	8.978	8.792
	(11.42)	(11.38)	(25.12)	(25.03)
Dummy for Cooling-off stage	**21.32***	**20.64***	36.72	35.46
	(11.72)	(11.54)	(27.83)	(27.13)
Dummy for Priced stage	11.06	10.19	10.18	8.922
	(11.38)	(11.26)	(30.76)	(30.23)
Dummy for weekend	**-5.571*** **	**-5.420*** **	**-13.41*** **	**-13.00*** **
	(1.252)	(1.258)	(3.073)	(3.150)
T1 During	-6.953	-6.938	-2.550	-2.611
	(12.88)	(12.89)	(31.64)	(31.64)
T2 During	-14.18	-14.16	-22.39	-22.36
	(12.17)	(12.17)	(26.05)	(26.05)
T3 During	-21.48	-21.43	-48.33	-48.21
	(13.00)	(13.01)	(30.76)	(30.80)
T1 Cooling-off	**-30.55** **	**-30.53** **	**-60.98** **	**-61.04** **
	(12.82)	(12.82)	(30.35)	(30.33)
T2 Cooling-off	**-35.71** **	**-35.69** **	**-61.50** **	**-61.51** **
	(13.65)	(13.65)	(30.61)	(30.60)
T3 Cooling-off	**-39.65*** **	**-39.61*** **	**-87.97** **	**-87.88** **
	(13.41)	(13.40)	(34.87)	(34.89)
T1 Priced	**-30.42** **	**-30.52** **	-54.07	-55.31
	(12.86)	(12.80)	(36.28)	(36.15)
T2 Priced	**-26.35** **	**-26.30** **	-36.67	-37.24
	(12.74)	(12.71)	(32.15)	(32.07)
T3 Priced	**-35.98** **	**-36.05*** **	**-80.90** **	**-81.40** **
	(13.67)	(13.65)	(37.71)	(37.80)
No. of residents in an apartment	**-20.19*** **	**-20.15*** **	**32.87*** **	**32.60*** **
	(3.229)	(3.193)	(7.521)	(7.591)
Constant	183.1***	183.4***	248.3***	251.5***
	(9.964)	(12.25)	(24.93)	(35.50)
Observations	55,083	53,440	55,083	53,440
R-squared	0.036	0.036	0.023	0.022
Number of apartments	80	80	80	80

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Note that the result in this table is based on 80 households whereas the corresponding table in the earlier article was based on 99 households (1). The difference is due to additional conditions needed for comparison of non-price and price effects, such as continued residence all the four stages of study. Secondly, additional data filters were applied in the earlier article as a part of tests of robustness of results and not in the main table. Based on these stricter conditions for comparison in this article, these updated results support stronger NP-effects than in the corresponding table in the earlier article.

Table S10. Main result for price intervention. Price-effect estimate (coefficient of variable priced) using the main model (2).

VARIABLES and DV	(1) Main model lpcd	(2) Main model, weather added lpcd	(3) Main model Total usage	(4) Main model, weather added Total usage
Priced	**-6.175*****	**-6.580*****	**-14.04****	**-15.13****
	(2.233)	(2.187)	(6.066)	(6.127)
Weekend	**-5.096*****	**-4.899*****	**-12.18*****	**-11.63*****
	(1.052)	(1.063)	(2.648)	(2.721)
Number of residents	**-18.52*****	**-18.45*****	**40.35*****	**40.17*****
	(3.509)	(3.481)	(7.926)	(7.977)
Constant	173.2***	165.1***	210.0***	188.2***
	(10.36)	(11.63)	(23.43)	(33.83)
Observations	58,928	56,886	58,928	56,886
R-squared	0.026	0.026	0.021	0.021
Number of households	101	101	101	101

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Price had an effect but it is much smaller in size than the effect of the non-price intervention. Price-effect across households is only 6.6 lpcd (p<0.01) whereas non-price effect is at least triple of that in the post-intervention cooling-off stage and priced-stage (e.g., the NP-effect in T3 group in cooling off is 39.6 lpcd, which is more than six-times the price-effect). Price-effect is about 6% of baseline usage (about 114 lpcd) whereas NP-effect is about 22-34% in the cooling-off and priced-stage. The effects of non-price treatment are seen in both lpcd and usage based ATE only in the group T3 in both cooling-off and priced stages.

In terms of broader pattern of water usage seen in this data, usage is lower in the weekends. Since we include a weekend dummy in regression, our effect size estimates are marginally lower than otherwise. Usage increases with number of residents but lpcd reduces.

4.3.2. Comparison of P and NP effects: NP-treated and untreated households

We divide households into two pools, those who received a behavioral treatment (called NP-treated) and those who did not (called Untreated). We estimate non-price effect on treated households and price-effect on both these pools.

Table S11. Effect of non-price intervention on treated pool. The three treated groups (T1, T2 and T3) are pooled into one pool.

VARIABLES and DV	**(1) Main model lpcd**	**(2) Main model, weather added lpcd**	**(3) Main model Total usage**	**(4) Main model, weather added Total usage**
Dummy for During stage	7.274	7.135	8.891	8.709
	(11.42)	(11.38)	(25.11)	(25.02)
Dummy for Cooling-off stage	**21.26***	**20.54***	36.57	35.21
	(11.72)	(11.54)	(27.82)	(27.12)
Dummy for Priced stage	11.01	10.10	10.04	8.668
	(11.38)	(11.26)	(30.74)	(30.20)
Dummy for weekend	**-5.568*****	**-5.417*****	**-13.40*****	**-13.00*****
Treated During	-13.70	-13.67	-22.88	-22.86
	(11.88)	(11.89)	(26.67)	(26.68)

Treated Cooling-off	**-34.99***	**-34.97***	**-69.04**	**-69.03**
	(12.34)	(12.33)	(28.70)	(28.70)
Treated Priced	**-30.58**	**-30.61**	**-55.81***	**-56.59***
	(12.03)	(11.99)	(31.50)	(31.42)
Number of residents	**-19.89***	**-19.85***	**33.46***	**33.21***
	(3.245)	(3.206)	(7.796)	(7.856)
Constant	182.2***	182.3***	246.7***	249.4***
	(9.982)	(12.24)	(25.37)	(35.74)
Observations	55,083	53,440	55,083	53,440
R-squared	0.035	0.035	0.022	0.021
Number of households	80	80	80	80

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table S12. Non-price intervention and price-effect. The three treated groups (T1, T2 and T3) are pooled into one pool.

VARIABLES and DV	(1) Untreated households lpcd	(2) Untreated households Total usage	(3) Treated households lpcd	(4) Treated households Total usage
Priced	-7.425	-15.93	**-5.935**	**-14.13**
	(4.551)	(12.72)	(2.305)	(6.820)
Weekend	**-3.180***	-5.563	**-5.919***	**-15.14***
	(1.667)	(3.348)	(1.367)	(3.766)
Number of residents	**-24.93***	**58.69***	**-16.88***	**35.64***
	(8.889)	(16.75)	(3.448)	(9.124)
Constant	157.2***	46.65	173.4***	247.1***
	(24.93)	(72.39)	(12.36)	(33.59)
Observations	20,791	20,791	36,095	36,095
R-squared	0.029	0.023	0.037	0.029
Number of households	41	41	60	60

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Untreated households support only a marginally higher effect size with borderline significance (p=0.11 for lpcd) whereas treated households support a stronger effect. Further diving treated households into original groups (Control CO, Treatments 1, 2 and 3) and a group for Post-Intervention (PI) movements-in, only the untreated control group and the treated T1 group (the group that received only usage information) support a strong and relatively large effect-size as compared to the other groups, or pooled groups (at treated/untreated level or overall pool or all HH).

Table S13. Non-price intervention and price-effect by treatment group. The three treated groups (T1, T2 and T3) and each of the two untreated groups (C0 and PI) are examined individually.

VARIABLES and DV	(1) C0 lpcd	(2) PI lpcd	(3) T1 lpcd	(4) T2 lpcd	(5) T3 lpcd
Priced	**-11.06***	-0.661	**-10.81**	0.212	-7.420
	(6.102)	(8.204)	(4.522)	(3.067)	(4.319)
Weekend	-3.117	**-3.308**	**-6.380**	**-7.264***	-3.693
	(2.563)	(1.547)	(2.587)	(2.343)	(2.125)
Number of residents	**-34.79***	-3.396	**-17.15***	**-17.19***	**-18.78**

	(10.99)	(5.198)	(5.692)	(5.275)	(6.958)
Constant	183.4***	88.99***	186.1***	159.7***	183.8***
	(30.49)	(27.24)	(25.28)	(13.42)	(27.08)
Observations	12,719	8,072	12,596	13,050	10,449
R-squared	0.050	0.013	0.046	0.038	0.045
Number of households	21	20	21	22	17

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

We see that there is large variation in price-effects depending on non-price treatment group.

These tests support that even as a pool of treated households, we observe the same pattern: there are large effects of non-price intervention and these effects persist through the priced stage of the experiment. The effect size for non-price treatment is much larger (about 30 to 35 lpcd) than the size of price-effect (maximum of 11 lpcd observed in the control group)

4.3.3. Comparison of P and NP effects by household-level factors

Table S14. Summary of baseline lpcd and effects by factors. Baseline refers to respective pre-intervention stage, i.e., before all the interventions in case of NP-intervention and the cooling-off stage after NP-intervention in case of P-intervention. Households are divided into two subsets based on high and low level for five household level factors. Results for each such subset are presented for effect of price and non-price intervention. *** p<0.01, ** p<0.05, * p<0.1

	Price effect		**Non-Price (NP) effect**	
Level of factor	***High***	***Low***	***High***	***Low***
Factor of heterogeneity	**lpcd in baseline**			
1. Water conservation habits	107.6	118	112.3	118.7
2. Attitude (NEP)	117.9	106.7	115.6	115.1
3. Water attitude	121	106.7	119.8	110.9
4. Ownership (high)-Tenancy	104.5	118.6	110.5	116.6
5. Median lpcd	148.9	79.4	159	73.4
	ATE (average treatment effect) of intervention			
1. Water conservation habits	-5.4	**-7.6****	-26.8	**-22.5***
2. Attitude (NEP)	**-9.9****	-3.1	**-50.8****	2.3
3. Water attitude	**-7***	**-6****	**-38.8****	5.5
4. Ownership (high)-Tenancy	**-6.1****	-5.7	-10.1	**-45.5****
5. Median lpcd	**-10.8*****	-1.5	**-53.6*****	-7.2
	ATE as % of baseline lpcd			
1. Water conservation habits	-5%	**-6%**	-24%	**-19%**
2. Attitude (NEP)	**-8%**	-3%	**-44%**	2%
3. Water attitude	**-6%**	**-6%**	**-32%**	5%
4. Ownership (high)-Tenancy	**-6%**	-5%	-9%	**-39%**
5. Median lpcd	**-7%**	-2%	**-34%**	-10%

We now present the detailed regression results for each of these five factors for non-price and price interventions. For water conservation habits, NEP and Water-NEP, weaker refers to low and stronger refers to strong.

Table S15. Effect of non-price intervention by level of water conservation habit.

VARIABLES and DV	(1) Weaker habits lpcd	(2) Stronger habits lpcd	(3) Weaker habits Total usage	(4) Stronger habits Total usage
Dummy for During stage	15.74	-10.68	69.93	**-34.88****
	(14.70)	(8.710)	(54.32)	(17.06)
Dummy for Cooling-off stage	8.509	13.53	48.85	-3.815
	(10.63)	(14.55)	(47.19)	(23.89)
Dummy for Priced stage	1.834	1.857	33.81	-30.05
	(12.29)	(13.70)	(57.08)	(31.17)
Treated During	-18.50	1.143	-78.00	16.89
	(14.93)	(10.26)	(55.60)	(22.91)
Treated Cooling-off	**-22.52***	-26.75	**-95.12***	-15.75
	(11.81)	(15.91)	(50.62)	(29.55)
Treated Priced	-21.96	-20.08	-91.19	-4.482
	(12.97)	(14.59)	(59.10)	(35.62)
No. of residents in an apartment	**-27.91*****	**-14.74*****	10.00	**48.43*****
	(3.073)	(3.733)	(8.276)	(10.30)
Constant	238.2***	151.4***	409.7***	166.7***
	(13.61)	(14.05)	(46.25)	(40.71)
Observations	21,951	23,880	21,951	23,880
R-squared	0.067	0.034	0.013	0.049
Number of apartments	32	35	32	35

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Stronger habits households manage to reduce their usage during non-price intervention (35 liters per day) regardless of whether they went through NP-treatment or not. Further, the weaker habit households also reduce both usage and lpcd.

Table S16. **Effect of price intervention by level of water conservation habit**.

VARIABLES and DV	(1) Weaker habits lpcd	(2) Stronger habits lpcd	(3) Weaker habits Total usage	(4) Stronger habits Total usage
Priced	**-7.562****	-5.379	**-15.66***	-12.67
	(2.966)	(3.703)	(9.131)	(9.995)
Weekend	**-5.383*****	**-2.846***	**-14.93*****	**-7.067***
	(1.496)	(1.505)	(4.195)	(3.803)
No. of residents in an apartment	**-27.00*****	**-12.87*****	**18.34***	**55.35*****
	(3.518)	(4.281)	(10.45)	(9.681)
Constant	206.2***	140.9***	296.2***	118.7***
	(14.79)	(11.10)	(52.71)	(37.26)
Observations	24,969	24,783	24,969	24,783
R-squared	0.053	0.021	0.014	0.046
Number of apartments	44	42	44	42

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Weaker habit households support an effect of price but stronger habit households do not (the coefficient is smaller and not statistically significant).

Comparing non-price and price interventions, the effect of both these treatments is on households with weaker habits. These results also support that the weaker habits households have a higher effect size of non-price intervention as compared to price intervention.

Table S17. Effect of non-price intervention by level of attitude towards the environment measured by NEP (New Ecological Paradigm) scale.

VARIABLES and DV	(1) Weaker NEP lpcd	(2) Stronger NEP lpcd	(3) Weaker NEP Total usage	(4) Stronger NEP Total usage
Dummy for During stage	**-12.41***	6.690	**-51.13****	40.30
	(7.107)	(12.33)	(24.35)	(26.57)
Dummy for Cooling-off stage	-10.88	**34.86***	**-44.58***	**65.32*****
	(8.701)	(17.84)	(25.53)	(19.07)
Dummy for Priced stage	-16.41	18.89	-66.87	**37.84****
	(14.02)	(13.48)	(44.92)	(18.16)
Dummy for weekend	**-4.643*****	**-4.841****	**-10.80****	**-13.94*****
	(1.685)	(1.984)	(4.588)	(4.798)
Treated During	7.876	-12.17	40.11	-50.82
	(7.726)	(13.71)	(26.34)	(32.15)
Treated Cooling-off	2.291	**-50.81****	22.16	**-104.5*****
	(9.703)	(18.82)	(27.60)	(25.67)
Treated Priced	5.417	**-43.09*****	40.30	**-97.76*****
	(14.06)	(14.03)	(45.65)	(24.07)
No. of residents in an apartment	**-19.85*****	**-21.19*****	**28.09***	**33.62*****
	(4.328)	(4.729)	(13.91)	(10.34)
Constant	179.3***	200.1***	268.9***	278.8***
	(15.06)	(19.90)	(47.35)	(56.13)
Observations	23,250	23,293	23,250	23,293
R-squared	0.041	0.054	0.019	0.033
Number of apartments	34	34	34	34

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table S18. Effect of price intervention by level of attitude towards the environment measured by NEP (New Ecological Paradigm) scale.

VARIABLES and DV	(1) Weaker NEP lpcd	(2) Stronger NEP lpcd	(3) Weaker NEP Total usage	(4) Stronger NEP Total usage
Priced	-3.138	**-9.915****	-7.089	**-22.01****
	(2.796)	(3.863)	(9.974)	(8.498)
Weekend	**-4.359*****	**-4.370****	**-10.45*****	**-11.93****
	(1.316)	(1.794)	(3.565)	(4.532)
No. of residents in an apartment	**-17.14*****	**-21.09*****	**41.49*****	**36.05*****
	(4.756)	(5.331)	(14.00)	(9.877)
Constant	156.3***	187.6***	176.0***	228.2***
	(15.37)	(17.86)	(47.48)	(55.21)
Observations	26,944	23,451	26,944	23,451
R-squared	0.025	0.045	0.022	0.030
Number of apartments	47	40	47	40

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Non-price effect is seen in treated households with higher NEP but not in those with lower NEP. Introduction of price elicits an effect in households with higher NEP. Combing results from both price and non-price effect, both non-price intervention and price intervention helped bridge the gap between attitude (i.e., high NEP) and action (lower water use).

Table S19. **Effect of non-price intervention by level of attitude towards the water measured by a water NEP (New Ecological Paradigm) scale**.

VARIABLES and DV	(1) Weaker Water NEP lpcd	(2) Stronger Water NEP lpcd	(3) Weaker Water NEP Total usage	(4) Stronger Water NEP Total usage
Dummy for During stage	**-17.42****	1.024	**-71.87*****	17.30
	(7.046)	(10.26)	(25.41)	(25.67)
Dummy for Cooling-off stage	**-15.80****	20.87	**-59.60*****	33.13
	(7.223)	(14.61)	(20.04)	(25.79)
Dummy for Priced stage	-20.63	7.936	**-90.61*****	11.30
	(14.46)	(13.23)	(33.06)	(34.50)
Dummy for weekend	**-4.497*****	**-4.998****	**-9.411****	**-15.36*****
	(1.626)	(2.036)	(3.623)	(5.545)
Treated During	**14.77***	-10.53	**68.26****	-40.31
	(8.376)	(11.22)	(28.91)	(29.10)
Treated Cooling-off	5.520	**-38.76****	28.66	**-69.16****
	(8.194)	(15.78)	(23.35)	(31.33)
Treated Priced	5.153	**-32.07****	47.25	-61.68
	(14.39)	(13.96)	(36.33)	(36.54)
No. of residents in an apartment	-27.68***	-16.84***	14.86	40.60***
	(3.717)	(3.845)	(10.83)	(9.816)
Constant	216.4***	177.4***	343.4***	232.4***
	(14.51)	(16.04)	(42.74)	(48.61)
Observations	23,357	23,186	23,357	23,186
R-squared	0.053	0.043	0.015	0.033
Number of apartments	34	34	34	34

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table S20. Effect of price intervention by level of attitude towards the environment measured by a water NEP (New Ecological Paradigm) scale.

VARIABLES and DV	(1) Weaker Water NEP lpcd	(2) Stronger Water NEP lpcd	(3) Weaker Water NEP Total usage	(4) Stronger Water NEP Total usage
Priced	**-5.994****	**-6.964***	**-18.10****	-10.78
	(2.884)	(3.624)	(7.776)	(10.70)
Weekend	**-4.406*****	**-4.346****	**-9.383*****	**-12.85*****
	(1.414)	(1.646)	(3.210)	(4.588)
No. of residents in an apartment	**-25.58*****	**-15.55*****	**28.32****	**44.57*****
	(3.968)	(4.409)	(11.87)	(9.905)
Constant	187.7***	164.5***	238.2***	180.6***
	(14.24)	(14.40)	(46.26)	(49.18)
Observations	24,334	26,061	24,334	26,061
R-squared	0.045	0.027	0.018	0.029
Number of apartments	41	46	41	46

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Non-price effect is seen in treated households with higher water NEP but not in those with lower NEP. We do not see much different in price-effect based on water NEP. Combing results of both price and non-price effect, both non-price intervention and price intervention helped bridge the gap between attitude towards water and action.

Table S21. Effect of non-price intervention by ownership or tenancy of residence.

VARIABLES and DV	(1) Owners lpcd	(2) Tenants lpcd	(3) Owners Total usage	(4) Tenants Total usage
Dummy for During stage	-7.837	20.24	**-46.29****	**58.36***
	(8.260)	(20.64)	(21.88)	(29.84)
Dummy for Cooling-off stage	-1.234	**30.81***	-36.85	**66.80*****
	(12.63)	(16.21)	(25.65)	(18.55)
Dummy for Priced stage	-8.373	**20.21***	**-69.51***	**56.67****
	(16.12)	(11.07)	(36.86)	(22.55)
Dummy for weekend	**-3.167***	**-6.461*****	**-8.453***	**-14.85*****
	(1.648)	(2.021)	(4.197)	(5.178)
Treated During	2.835	-25.14	38.03	**-70.97****
	(9.166)	(21.76)	(26.27)	(33.03)
Treated Cooling-off	-10.12	**-45.47****	2.112	**-92.53*****
	(12.63)	(19.16)	(27.29)	(28.57)
Treated Priced	-8.703	**-39.53****	16.13	**-88.96*****
	(16.10)	(15.05)	(39.15)	(28.34)
No. of residents in an apartment	**-14.05*****	**-21.99*****	**31.47***	**32.65*****
	(3.789)	(4.517)	(15.75)	(9.429)
Constant	172.0***	182.8***	288.6***	229.8***
	(16.24)	(18.80)	(59.44)	(49.73)
Observations	26,866	21,693	26,866	21,693
R-squared	0.019	0.054	0.025	0.025
Number of apartments	39	32	39	32

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table S22. **Effect of price intervention by ownership or tenancy of residence**.

VARIABLES and DV	(1) Owners lpcd	(2) Tenants lpcd	(3) Owners Total usage	(4) Tenants Total usage
Priced	**-6.143****	-5.702	**-21.85****	-6.929
	(2.520)	(3.740)	(8.107)	(10.28)
Weekend	**-3.298****	**-5.035*****	**-8.143***	**-12.02*****
	(1.545)	(1.506)	(4.062)	(3.937)
No. of residents in an apartment	**-13.51*****	**-20.05*****	**36.41*****	**40.76*****
	(3.422)	(4.655)	(12.59)	(10.15)
Constant	159.1***	162.1***	228.5***	161.0***
	(12.86)	(16.48)	(45.85)	(50.02)
Observations	24,709	27,505	24,709	27,505
R-squared	0.017	0.038	0.026	0.025
Number of apartments	40	50	40	50

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Non-price intervention has a large and strong effect on tenants. Owners respond differently. They do not respond much to the behavioral intervention per-se but they do reduce usage during the behavioral intervention and in priced stage, regardless of whether they received a behavioral intervention or not. Owners' group reduce water usage in price-intervention but tenants' group has an insignificant effect.

Table S23. Effect of non-price intervention by median level of lpcd in pre-intervention stage.

VARIABLES and DV	(1) Below median lpcd	(2) Above median lpcd	(3) Below median Total usage	(4) Above median Total usage
Dummy for During stage	-6.071	17.01	-21.45	27.65
	(5.255)	(17.42)	(21.12)	(37.33)
Dummy for Cooling-off stage	-0.994	**34.63***	-9.651	60.92
	(5.931)	(17.60)	(19.72)	(41.43)
Dummy for Priced stage	1.433	15.51	-5.953	13.93
	(10.04)	(17.23)	(33.62)	(44.60)
Dummy for weekend	**-2.954****	**-7.632*****	**-7.431***	**-18.03*****
	(1.398)	(1.992)	(4.069)	(4.647)
Treated During	2.060	-25.59	16.68	-51.85
	(6.432)	(18.45)	(24.48)	(39.56)
Treated Cooling-off	-7.236	**-53.58*****	-6.275	**-112.9****
	(7.109)	(18.73)	(22.19)	(43.34)
Treated Priced	-13.75	**-41.71****	-20.21	**-84.02***
	(10.48)	(18.57)	(35.69)	(45.72)
No. of residents in an apartment	**-14.05*****	**-29.39*****	**34.34*****	**33.26*****
	(3.005)	(4.690)	(10.49)	(11.06)
Constant	137.6***	230.1***	184.3***	305.4***
	(12.32)	(15.99)	(44.96)	(53.37)
Observations	25,495	27,945	25,495	27,945
R-squared	0.041	0.043	0.031	0.022
Number of apartments	38	42	38	42

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table S24. Effect of price intervention by median level of lpcd in pre-intervention stage.

VARIABLES and DV	(1) Below median lpcd	(2) Above median lpcd	(3) Below median Total usage	(4) Above median Total usage
Priced	-1.450	**-10.76*****	-1.747	**-26.53*****
	(2.227)	(3.502)	(8.659)	(8.894)
Weekend	**-2.776****	**-7.139*****	**-6.629***	**-16.84*****
	(1.253)	(1.739)	(3.721)	(4.076)
No. of residents in an apartment	**-12.18*****	**-28.91*****	**42.46*****	**37.64*****
	(3.234)	(5.138)	(9.434)	(13.54)
Constant	122.8***	213.0***	130.1***	240.3***
	(11.53)	(15.42)	(39.18)	(57.02)
Observations	27,149	27,858	27,149	27,858
R-squared	0.024	0.038	0.034	0.020
Number of apartments	48	48	48	48

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Households below median level of lpcd in the pre-intervention stage do not support an effect of intervention. Households above median level of usage support a strong effect. Both the interventions helped to reduce usage in high-usage households. The size of the effect is larger for non-price treatment.

4.3.4. Location within household: price vs non-price

For price-intervention, we can also test for price-effect using simple t-tests for household level average by stage of intervention. We compare lpcd before and after introduction of price, for total usage and for each of the three submeter locations.

The data for before-price stage refers to the cooling-off stage unless specified otherwise.

Table S25. Before-after comparison of water usage for price intervention by location within household. Summary of average water usage per household in the two stages of field experiment with measurements for three sub-meters for each household. The p-value corresponds to one-sided t-test of significant difference.

Parameter	Before-price	Priced-stage	Decrease	% Decrease	t-test (p-value)
lpcd (liters per capita-day)	114.5	109.7	4.7	4.1%	**0.02**
lpcd - Common Bathroom	23.7	22.6	1.1	4.8%	0.16
lpcd - Master Bathroom	28.2	26.8	1.5	5.2%	**0.01**
lpcd - Kitchen & Utility	62.6	60.4	2.1	3.4%	0.06
lpd (liters per day)	318.9	307.0	11.9	3.7%	**0.02**
No. of residents	2.95	2.93	0.01	0.4%	0.38

There is a decrease of 4.7 lpcd (or 4%) in average water usage. Most of the water usage occurs in the kitchen & utility area. Master bedroom has a relatively large reduction and a statistically significant reduction. There is no substantial change in number of residents per households across the two stages of field experiment.

Table S26. **Effect of non-price intervention by location within household**. We test using the main model with total usage and usage in each of the three sub-meters as the DV.

VARIABLES and DV	(1) Total usage	(2) Kitchen & utility usage	(3) Master bathroom usage	(4) Common bathroom usage
Dummy for During stage	8.709	12.26	3.524	-7.073
	(25.02)	(13.97)	(5.727)	(10.11)
Dummy for Cooling-off stage	35.21	24.28	10.44	0.491
	(27.12)	(15.44)	(7.674)	(12.41)
Dummy for Priced stage	8.668	15.46	1.756	-8.543
	(30.20)	(16.36)	(10.13)	(15.83)
Dummy for weekend	**-13.00*****	**-6.345*****	**-5.560*****	-1.091
	(3.151)	(2.036)	(1.465)	(0.943)
Treated During	-22.86	-21.34	-6.359	4.847
	(26.68)	(15.07)	(6.591)	(10.65)
Treated Cooling-off	**-69.03****	**-45.06*****	**-19.04****	-4.930
	(28.70)	(16.19)	(8.770)	(12.96)
Treated Priced	**-56.59***	**-45.72****	-13.91	3.040
	(31.42)	(17.58)	(11.29)	(16.14)
No. of residents in an apartment	**33.21*****	**16.37*****	**5.140****	**11.70*****
	(7.856)	(4.873)	(2.123)	(3.539)
Constant	249.4***	140.2***	71.35***	37.86**
	(35.74)	(23.11)	(9.718)	(15.49)
Observations	53,440	53,440	53,440	53,440
R-squared	0.021	0.013	0.012	0.013
Number of apartments	80	80	80	80

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table S27. Effect of price intervention by location within household. We test using the main model with total usage and usage in each of the three sub-meters as the DV.

VARIABLES and DV	(1) **Total usage**	(2) **Kitchen & utility usage**	(3) **Master bathroom usage**	(4) **Common bathroom usage**
Priced	**-15.13****	**-7.464***	**-4.050****	-3.616
	(6.127)	(4.355)	(2.003)	(2.623)
Weekend	**-11.63*****	**-5.492*****	**-5.245*****	-0.888
	(2.721)	(1.867)	(1.248)	(0.790)
No. of residents in an apartment	**40.17*****	**20.62*****	**5.356*****	**14.19*****
	(7.977)	(4.764)	(1.861)	(3.598)
Constant	188.2***	105.3***	59.81***	23.10*
	(33.83)	(20.60)	(7.826)	(13.84)
Observations	56,886	56,886	56,886	56,886
R-squared	0.021	0.012	0.009	0.017
Number of apartments	101	101	101	101

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

The effect of non-price treatment is strong and large in kitchen & utility meter and in master bedroom meter. However, the share of reduction in kitchen & utility is much higher in the non-price intervention. While that share in price effect is only about half of the total reduction, which is proportionate to its share in total usage, it is up to 80% in non-price intervention. Further, in price intervention, a statistically stronger result is seen in the master bathroom as compared to other meters. Effect is missing in the common bathroom in both the interventions.

4.3.5. Further comparison using more household level factors: price vs non-price

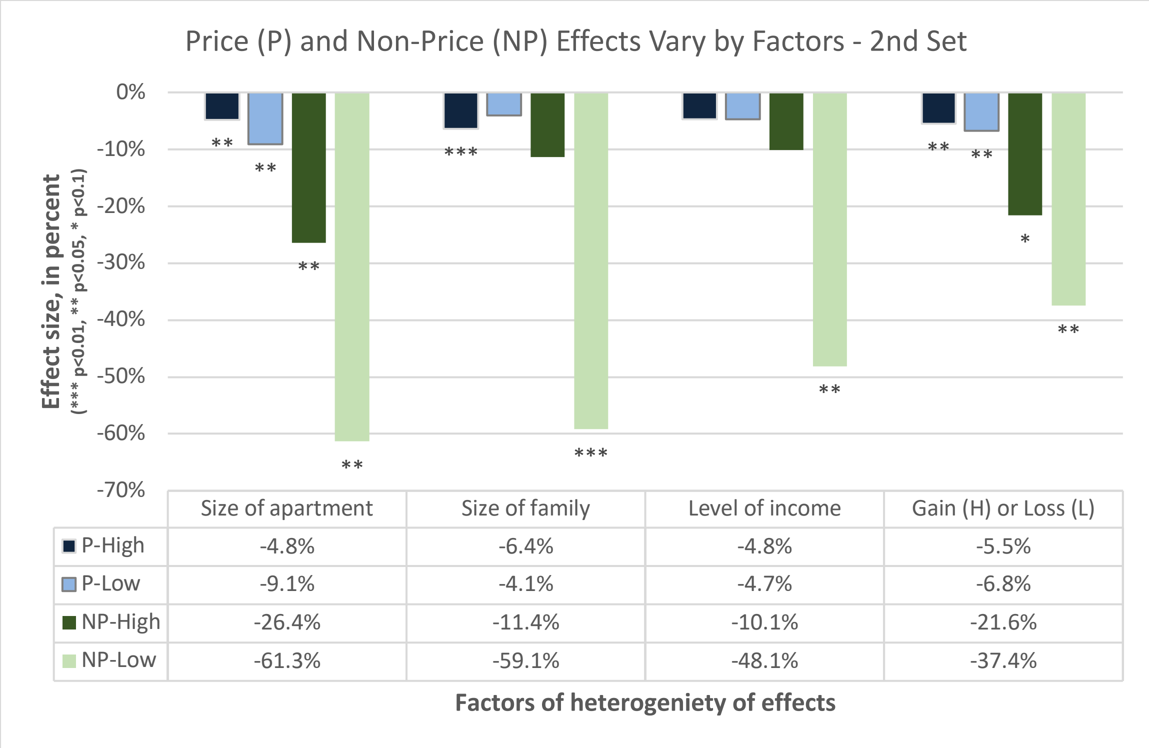

Figure S10. Heterogeneity of effects of price (P) and Non-price (NP) interventions comparing role of a second set of common factors. We compare average treatment effects (ATE) of the two interventions by dividing households into two subsets based on high and low level for four household level factors (e.g., P-High refers to ATE of price intervention in households living in high or larger size apartments). ATE from panel data analysis are estimated in lpcd (liters per capita-day) and converted to percent change using corresponding lpcd in respective baseline stage and subset of households. NP-intervention effects shown in this summary chart are based on ATE in cooling-off stage (i.e., without any effect of price) for a pool of all three NP-treated groups. For detailed results see SI Tables S30 to S37. *** p<0.01, ** p<0.05, * p<0.1.

Table S28. Summary of baseline lpcd and effects by factors. Baseline refers to respective pre-intervention stage, i.e., before all the interventions in case of NP (non-price) intervention and the cooling-off stage after NP-intervention in case of P-intervention. Households are divided into two subsets based on high and low level for five household level factors. Results are presented for each such subset for effect for price and non-price intervention. *** p<0.01, ** p<0.05, * p<0.1

	Price effect		**Non-Price (NP) effect**	
Level of factor	***High***	***Low***	***High***	***Low***
Factor of heterogeneity	**lpcd in baseline**			
1. Size of apartment	114.2	111.9	116.9	102.9
2. Size of family	103	127.5	106.8	124.5
3. Level of income	110.2	118.3	105.7	118.7
4. Gain (H) or Loss (L)	96.2	123.8	90.5	131.2
	ATE (average treatment effect) of intervention			
1. Size of apartment	**-5.5****	**-10.2****	**-30.9****	**-63.1****
2. Size of family	**-6.6*****	-5.2	-12.2	**-73.6*****

	Price effect		Non-Price (NP) effect	
Level of factor	***High***	***Low***	***High***	***Low***
3. Level of income	-5.2	-5.6	-10.7	**-57.1****
4. Gain (H) or Loss (L)	**-6.8****	**-6.5****	**-28.4***	**-33.9****
	ATE as % of baseline lpcd			
1. Size of apartment	**-4.8%**	**-9.1%**	**-26.4%**	**-61.3%**
2. Size of family	**-6.4%**	-4.1%	-11.4%	**-59.1%**
3. Level of income	-4.8%	-4.7%	-10.1%	**-48.1%**
4. Gain (H) or Loss (L)	**-5.5%**	**-6.8%**	**-21.6%**	**-37.4%**

We now present the detailed regression results for each of these five factors for non-price and price interventions.

4.3.5.1. Size of home (dwelling unit)

The smaller size apartment units (called 2BHK, i.e., 2 bedrooms with hall and kitchen) use marginally less water than the larger 3BHK units before introduction of price. They also reduced somewhat more on introduction of price thus increasing the gap in lpcd between 2BHK and 3BHK units.

Table S29. Summary of lpcd and change in lpcd during priced stage by size of dwelling unit.

Size	No. of residents - before-price	lpcd - before-price (cooling-off) stage	lpcd increase	lpcd - priced-stage	Number of households
Small (2BHK)	2.4	111.8	-7.0	104.8	22
Large (3BHK)	3.1	115.2	-4.1	111.1	79
Average	2.9	114.5	-4.7	109.7	101

Table S30. Effect of non-price intervention by size of home.

VARIABLES and DV	(1) Small home lpcd	(2) Large home lpcd	(3) Small home Total usage	(4) Large home Total usage
Dummy for During stage	**49.28***	-0.0827	**145.2***	-13.92
	(24.44)	(12.12)	(72.86)	(23.57)
Dummy for Cooling-off stage	**55.11****	14.79	**160.9****	14.93
	(23.98)	(12.40)	(75.00)	(26.44)
Dummy for Priced stage	29.16	7.145	89.12	-3.626
	(21.79)	(12.45)	(65.23)	(32.61)
Dummy for weekend	**-5.399***	**-5.432*****	**-13.88***	**-12.80*****
	(2.827)	(1.416)	(7.803)	(3.451)
Treated During	**-49.16***	-8.117	**-138.1***	-5.900
	(24.77)	(12.83)	(73.34)	(26.27)
Treated Cooling-off	**-63.08****	**-30.90****	**-176.9****	**-54.00***
	(25.09)	(13.43)	(77.99)	(28.14)
Treated Priced	**-45.75***	**-28.60****	**-132.4***	-45.93
	(23.07)	(13.35)	(67.76)	(34.22)
No. of residents in an apartment	**-20.52****	**-19.66*****	36.76	**33.42*****
	(7.067)	(3.543)	(24.37)	(8.385)
Constant	174.2***	184.2***	209.6**	256.7***
	(26.12)	(13.69)	(81.17)	(40.55)

Observations	10,784	42,656	10,784	42,656
R-squared	0.056	0.033	0.038	0.021
Number of apartments	16	64	16	64

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Families living in smaller houses responded much more to non-price treatment than those living in larger units.

Table S31. Effect of price intervention by size of house.

VARIABLES and DV	(1) Small home lpcd	(2) Large home lpcd	(3) Small home Total usage	(4) Large home Total usage
Priced	**-10.20****	**-5.477****	**-29.90****	-10.75
	(4.054)	(2.627)	(13.97)	(6.969)
Weekend	**-5.140****	**-4.838*****	**-12.07***	**-11.52*****
	(2.149)	(1.225)	(6.059)	(3.066)
No. of residents in an apartment	**-22.89****	**-17.80*****	**26.40**	**42.41*****
	(9.816)	(3.701)	(28.99)	(8.163)
Constant	181.0***	162.1***	247.7***	175.8***
	(26.03)	(12.79)	(72.23)	(38.19)
Observations	12,088	44,798	12,088	44,798
R-squared	0.034	0.026	0.020	0.024
Number of apartments	22	79	22	79

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Effect is more in smaller size homes (note that in last column, there is a borderline effect with p = 0.13).

4.3.5.2. Size of family

Smaller families (i.e., those below the median family size) reduced somewhat more than the larger families but they also started with a much higher lpcd. Thus, smaller families (less than 3 persons on an average) continue to have a relatively high lpcd after introduction of price.

Table S32. Summary of lpcd and change in lpcd during priced stage by size of family (above or below median family size).

Size	No. of residents - before-price	lpcd - before-price stage	lpcd increase	lpcd - priced-stage	Number of households
Large family	3.8	104.0	-3.6	100.4	56
Small family	1.9	127.5	-6.2	121.3	45
Average	2.9	114.5	-4.7	109.7	101

Table S33. Effect of non-price intervention by size of family.

VARIABLES and DV	(1) Small Family lpcd	(2) Large Family lpcd	(3) Small Family Total usage	(4) Large Family Total usage
Dummy for During stage	16.89	1.757	5.037	12.56
	(23.67)	(10.87)	(25.94)	(36.14)

Dummy for Cooling-off stage	**56.28****	-0.273	**83.73****	7.658
	(20.88)	(10.90)	(38.68)	(35.38)
Dummy for Priced stage	**46.21****	-10.15	**73.14****	-27.88
	(17.82)	(11.56)	(35.39)	(41.02)
Dummy for weekend	**-7.765*****	**-3.745*****	**-12.71*****	**-13.29*****
	(2.269)	(1.391)	(3.735)	(4.737)
Treated During	-30.36	-3.100	-37.15	-12.21
	(24.65)	(11.40)	(28.03)	(38.99)
Treated Cooling-off	**-73.64*****	-12.19	**-114.4*****	-43.41
	(22.74)	(11.43)	(39.90)	(38.48)
Treated Priced	**-67.65*****	-8.756	**-107.2*****	-29.86
	(19.61)	(12.17)	(35.90)	(43.81)
No. of residents in an apartment	**-30.19*****	**-15.74*****	**34.44****	**31.67*****
	(8.451)	(2.709)	(14.83)	(8.964)
Constant	191.1***	174.1***	198.0***	291.0***
	(21.15)	(13.50)	(48.82)	(49.92)
Observations	22,397	31,043	22,397	31,043
R-squared	0.040	0.049	0.024	0.026
Number of apartments	35	45	35	45

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Smaller families responded much more to non-price treatment than larger families.

Table S34. Effect of price intervention by size of family.

VARIABLES and DV	(1) Small Family lpcd	(2) Large Family lpcd	(3) Small Family Total usage	(4) Large Family Total usage
Priced	-5.182	**-6.556*****	-4.954	**-21.60****
	(3.626)	(2.415)	(5.874)	(9.277)
Weekend	**-7.376*****	**-3.173*****	**-12.17*****	**-11.27*****
	(1.942)	(1.165)	(3.267)	(4.039)
No. of residents in an apartment	**-30.03*****	**-13.80*****	**35.92****	**41.04*****
	(9.495)	(2.801)	(16.26)	(8.842)
Constant	185.1***	148.4***	182.0***	194.8***
	(18.98)	(13.79)	(37.53)	(50.41)
Observations	23,254	33,632	23,254	33,632
R-squared	0.033	0.031	0.018	0.026
Number of apartments	43	58	43	58

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The effect is borderline (p = 0.16) in case of small families with lpcd as the DV.

4.3.5.3. Income level

The site for experiment is an affluent community with limited variation of wealth and income. Nevertheless, we collected self-reported income and we find some difference in effect by income. Further, the subset without income information (i.e., the 21 households that did not share their level of income and the 13 households that could not be surveyed) reduced much more than others.

Table S35. Water usage by income level. Summary of lpcd and lpd (liters per day) and respective changes during priced stage by level of self-reported household income. NA refers to not available.

Parameters	High income	Low income	NA	Average
lpcd - before-price stage	110	118	117	114
lpcd increase	-2.7	-3.6	-8.0	-4.7
lpcd - priced-stage	107	115	109	110
lpd - before-price stage	327	304	321	319
lpd increase	3	-16	-27	-12
lpd - priced-stage	330	288	295	307
Number of households	41	26	34	101
No. of residents - before-price	2.8	2.8	2.8	2.8
No. of residents - priced-stage	3.2	2.7	2.8	2.9

Table S36. Effect of non-price intervention by level of family income.

VARIABLES and DV	(1) Lower Income lpcd	(2) Higher Income lpcd	(3) Unknown lpcd	(4) Lower Income Total usage	(5) Higher Income Total usage	(6) Unknown Total usage
Dummy for During stage	15.24	-1.150	9.950	13.60	-2.300	24.08
	(27.76)	(11.09)	(20.15)	(42.76)	(35.67)	(60.22)
Dummy for Cooling-off stage	33.10	0.457	38.88	34.32	-4.307	110.9
	(19.35)	(15.40)	(26.06)	(24.13)	(38.98)	(79.04)
Dummy for Priced stage	21.77	-7.759	25.37	13.95	-32.28	77.71
	(14.56)	(18.92)	(21.61)	(28.49)	(53.15)	(64.99)
Dummy for weekend	-11.26***	-0.601	-6.046***	-24.36***	-7.181	-10.44*
	(2.299)	(1.821)	(2.104)	(5.371)	(5.294)	(5.332)
Treated During	-30.20	-1.134	-15.07	-53.02	-0.820	-33.66
	(28.77)	(13.06)	(20.29)	(46.67)	(40.89)	(60.71)
Treated Cooling-off	**-57.08****	-10.70	**-51.21***	**-96.48*****	-20.42	**-137.2***
	(22.59)	(16.74)	(26.21)	(32.46)	(43.29)	(79.85)
Treated Priced	**-47.93****	-6.744	**-48.35****	**-82.09****	7.264	**-135.5****
	(19.45)	(19.38)	(21.89)	(38.84)	(55.40)	(66.08)
No. of residents in an apartment	-23.28***	-20.85***	-12.46***	38.52***	24.63**	47.06***
	(8.022)	(4.436)	(2.815)	(12.93)	(10.38)	(10.35)
Constant	179.9***	188.2***	166.7***	230.1***	273.8***	217.6***
	(24.89)	(17.76)	(19.13)	(61.82)	(56.22)	(58.24)
Observations	14,697	20,148	18,595	14,697	20,148	18,595
R-squared	0.043	0.058	0.024	0.036	0.018	0.036
Number of apartments	22	29	29	22	29	29

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Relatively lower income households and unknown income households had an effect revealing another aspect of heterogeneity; NP-intervention was effective for lower income households but not for higher income households.

Table S37. Effect of price intervention by level of family income.

VARIABLES and DV	(1) Lower Income lpcd	(2) Higher Income lpcd	(3) Unknown lpcd	(4) Lower Income Total usage	(5) Higher Income Total usage	(6) Unknown Total usage
Priced	-5.600	-5.235	**-9.468***	-13.67	-6.499	**-27.92**
	(5.423)	(3.399)	(3.010)	(8.048)	(11.52)	(10.31)
Weekend	**-9.989***	-1.680	**-4.841**	**-22.20***	**-8.590**	-7.033
	(1.893)	(1.448)	(2.002)	(4.481)	(4.224)	(5.066)
No. of residents in an apartment	**-23.72**	**-18.68***	**-10.05***	**39.20***	**36.57***	**50.34***
	(8.533)	(4.913)	(3.073)	(13.00)	(12.09)	(10.25)
Constant	173.5***	164.2***	145.3***	192.1***	176.9***	178.8***
	(23.55)	(18.28)	(15.30)	(56.05)	(57.75)	(46.87)
Observations	14,946	23,340	18,600	14,946	23,340	18,600
R-squared	0.039	0.038	0.015	0.033	0.021	0.029
Number of apartments	26	41	34	26	41	34

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Relatively lower income and relatively higher income groups do not support an effect of price but those with unknown income do. Note that unknown income household are those who did not share this optional information.

4.3.5.4. Loss vs gain from switchover to water bill

On an average, households experienced a loss of Rs 864 (about 11 US dollars) in the second bill (i.e., July bill), the bill that clearly brought home the notion of loss or gain since this was the first bill with lowered maintenance charges based on removal of embedded water charges from maintenance. The homes that gained were not only smaller size families but they also had lower lpcd. There is no difference in the effect based on loss-gain experience which suggests that loss or gain was not salient or not an important factor in their water use behavior.

Table S38. Loss vs gain. Summary of lpcd and lpd (liters per day) and respective changes for households that gained or lost monetarily after volumetric billing as compared to previous fixed bill. NA refers to not available.

Parameters	**Gain households**	**Loss households**	**NA**	**Average**
Average of loss	-1135	2097		864
lpcd - before-price stage	96	124	145	114
lpcd increase	-4	-4	-16	-5
lpcd - priced-stage	92	119	130	110
lpd - before-price stage	195	388	433	319
lpd increase	-11	-10	-47	-12
lpd - priced-stage	184	378	386	307
Number of households	37	60	4	101
No. of residents - before-price	2.2	3.4	3.0	2.9
No. of residents - priced-stage	2.2	3.4	3.0	2.9

Table S39. Effect of non-price intervention by loss or gain from switchover to priced regime.

	(1)	(2)	(3)	(4)

VARIABLES and DV	Loss lpcd	Gain lpcd	Loss Toal usage	Gain Toal usage
Dummy for During stage	7.324	10.69	14.61	8.708
	(16.36)	(7.634)	(36.85)	(8.939)
Dummy for Cooling-off stage	12.66	**24.04***	17.29	**30.91****
	(14.64)	(13.70)	(35.11)	(14.04)
Dummy for Priced stage	-1.139	22.13	-15.09	21.14
	(13.29)	(17.10)	(40.46)	(19.45)
Dummy for weekend	**-5.872*****	**-4.557****	**-16.23*****	**-7.434***
	(1.588)	(2.105)	(4.505)	(3.913)
Treated During	-15.17	-14.56	-24.33	**-26.16***
	(17.03)	(9.311)	(39.66)	(14.03)
Treated Cooling-off	**-33.88****	**-28.35***	**-64.82***	**-42.96****
	(16.08)	(14.85)	(38.27)	(19.65)
Treated Priced	-24.79	**-34.08***	-47.72	**-44.92***
	(15.06)	(17.36)	(42.90)	(24.05)
No. of residents in an apartment	-22.91***	-16.01***	29.01***	39.06***
	(3.717)	(4.484)	(9.424)	(11.82)
Constant	215.5***	139.6***	336.6***	127.5***
	(15.04)	(13.63)	(50.85)	(34.36)
Observations	31,728	20,897	31,728	20,897
R-squared	0.044	0.030	0.020	0.042
Number of apartments	46	32	46	32

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

In the gained group, we see a difference between treated and untreated households, as expected from NP-treatment; while untreated reduce usage (in cooling-off stage and in priced stage), the overall pattern is increase of usage in cooling-off stage. NP-treatment contributes to the price-effect.

Table S40. Effect of price intervention by loss or gain from switchover to priced regime.

VARIABLES and DV	(1) Loss lpcd	(2) Gain lpcd	(3) Loss Toal usage	(4) Gain Toal usage
Priced	**-6.509****	**-6.762****	**-17.08***	**-12.19****
	(3.055)	(2.974)	(9.313)	(5.768)
Weekend	**-5.029*****	**-4.570****	**-14.12*****	**-7.032****
	(1.337)	(1.822)	(3.869)	(3.402)
No. of residents in an apartment	**-20.77*****	**-15.31*****	**37.94*****	**43.23*****
	(4.015)	(5.351)	(9.869)	(12.26)
Constant	180.3***	144.4***	225.5***	127.3***
	(14.39)	(13.86)	(49.88)	(32.54)
Observations	34,601	21,222	34,601	21,222
R-squared	0.032	0.024	0.019	0.044
Number of apartments	60	37	60	37

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

There is no difference between households that gained or lost from switchover to marginal price. The price-effect is uniform regardless of loss or gain.

To understand this phenomenon in more detail, we study effects after July bill communication.

Table S41. Effect of price intervention by loss or gain from switchover to priced regime as seen in data after July bill.

VARIABLES and DV	(1) All HH lpcd	(2) Loss lpcd	(3) Gain lpcd
Priced	**-9.423***	**-11.87**	-5.683
	(3.580)	(5.142)	(4.380)
Weekend	**-4.577***	**-4.309***	**-4.957**
	(1.218)	(1.564)	(2.020)
No. of residents in an apartment	-17.48***	-18.05***	-16.53***
	(3.269)	(3.574)	(6.069)
Constant	165.3***	174.1***	148.7***
	(12.32)	(16.51)	(16.16)
Observations	39,960	24,037	14,980
R-squared	0.025	0.030	0.028
Number of apartments	101	60	37

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

We see that the overall effect size increases, loss households have a much larger effect and gain households do not have an effect. Loss-gain does matter but only after it is very clear through communication that occurred in July bill.

We turn to NP treatment's persistent effect after July bill communication

Table S42. Effect of non-price intervention by loss or gain from switchover to priced regime as seen in data after July bill.

VARIABLES and DV	(1) All lpcd	(2) Loss lpcd	(3) Gain lpcd
Dummy for During stage	7.382	7.930	10.10
	(11.39)	(16.34)	(7.652)
Dummy for Cooling-off stage	**21.28***	14.61	22.53
	(11.79)	(15.09)	(13.82)
Dummy for Priced stage	6.515	-7.689	26.43
	(11.13)	(10.80)	(21.41)
Dummy for weekend	**-5.450***	**-5.446***	**-5.318**
	(1.375)	(1.784)	(2.219)
Treated During	-13.62	-14.92	-14.49
	(11.97)	(17.15)	(9.326)
Treated Cooling-off	**-34.91***	**-33.63**	**-28.20***
	(12.24)	(15.86)	(14.86)
Treated Priced	**-28.04**	-18.33	**-41.41***
	(11.76)	(12.52)	(21.96)
No. of residents in an apartment	**-18.76***	**-19.85***	**-17.26***
	(2.952)	(3.256)	(4.946)
Constant	180.5***	203.8***	146.2***
	(14.47)	(20.41)	(15.46)
Observations	39,829	23,554	15,492

R-squared	0.033	0.040	0.035
Number of apartments	80	46	32

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The broad pattern remains the same; it is the treated households in the gain group that reduced in priced stage, even when we restrict to post-July bill communication. Also note the difference in sign of coefficient of priced in columns 2 and 3 while both are not significant.

4.3.6. Increase, decrease and median level of lpcd

We look at the summary statistics by dividing households into those who decreased lpcd and those who increased lpcd on introduction of price based on simple difference. Since before and after stages cover approximately one year each, seasonable variations are partially addressed in this simple difference.

Table S43. Increase vs decrease. Comparison of households that decreased lpcd with those that increased lpcd on introduction of price-signal. The parameter values are averages. The p-values correspond to one-sided t-test of difference (positive or negative). We see that they differ only in baseline usage (lpcd and lpd) and in water curtailment habits.

Parameters	Households that decreased lpcd (d)	Households that increased lpcd (i)	Difference (d-i)	t-test (p-value)
lpcd - before-price stage	122.4	104.7	17.7	**0.03**
lpcd - priced-stage	104.4	116.4	-12.1	**0.08**
lpcd increase	-18.0	11.8	-29.8	**0.00**
lpd - before-price stage	343.9	287.8	56.2	**0.02**
lpd - priced-stage	305.7	308.7	-3.0	0.46
lpd increase	-38.3	20.9	-59.2	**0.00**
No. of residents - before-price	3.00	2.87	0.13	0.30
No. of residents - priced-stage	3.10	2.72	0.38	**0.06**
Number of Bedrooms	2.73	2.84	-0.11	**0.09**
Loss amount	836	897	-61	0.44
Owners (% of households)	45%	44%	1%	0.46
Payers (% of households)	70%	78%	-8%	0.18
NEP	3.75	3.73	0.02	0.41
Water NEP	3.96	3.94	0.01	0.44
Water Habits	3.58	3.82	-0.24	**0.05**
Income	3.78	3.73	0.05	0.29

Even at this highly aggregated level of data, we can see that the households differ in terms of self-reported water curtailment habits, apart from level of water usage.

Nearly half (45%) of the households increased lpcd with a large average increase of 11.8 lpcd. Even when we exclude households with a small size of change, this share does not change (e.g., if we exclude households with a change smaller than ±3 lpcd, 43% of such households increased lpcd). When we exclude cases of extreme change, again the share remains unchanged (e.g., if we exclude those with more than ±100 lpcd change, 45% increased).

If we look at lpd average values in place of lpcd values, we observe the same pattern. While the aggregate response of households is in the expected direction, a very large subset of households supported a response that is not only far away from the average response, it is in the opposite direction, even though many of them were above the median level of water use. 46% of households increased usage with an average of 34 lpd as compared to 50 lpd of decrease by 54% of households. If we exclude households with a small size of change, the share of increase changes marginally (e.g., 38% if we limit to more than ±10 lpd change). When large changes are excluded, there is no change in this share (e.g., if we limit to less than ±100 lpd change, 46% increase).

Those who increased water usage were on an average relatively low water users, both in lpcd and lpd. However, many of the households that were already high-users further increased usage (Figure S11.). In the low-users subset of households, we also see a decrease in lpcd by a large share of households. This shows presence of large divergence in behavioral response to the same price-signal.

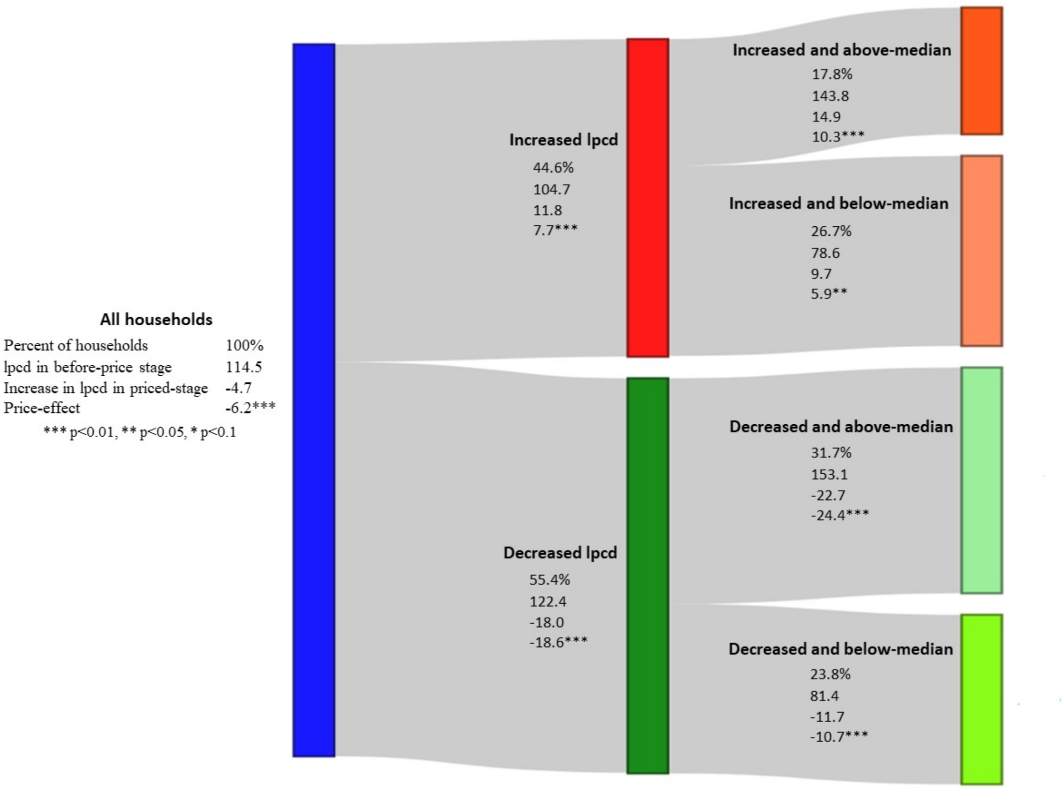

Figure S11. Divergent response to price-intervention. Change in lpcd on introduction of water-price summarized by subset of households based on response (increase/decrease) and level of water use (above/below median). First bifurcation of swim-lane is based on increase/decrease in lpcd. Second bifurcation is based on usage level of each household as above/below median lpcd level in the before-price stage. The summary statics and econometric analysis support an adverse effect on high-users (+14.9 and +10.3*** price-effect in top right swim-lane) and a favorable effect on low-users (-11.7 and -10.7*** in the bottom-right swim-lane).

We also split increased / decreased based on treated / untreated.

Table S44. Price-effect by increase/decrease and treated/untreated. Comparison of households that decreased lpcd with those that increased lpcd on introduction of price-signal, split by treated and untreated.

VARIABLES and DV	(1) Increased lpcd	(2) Decreased lpcd	(3) Increased treated lpcd	(4) Increased untreated lpcd	(5) Decreased treated lpcd	(6) Decreased untreated lpcd
Priced	**7.669*** **	**-18.60*** **	**5.168*** **	**14.21*** **	**-16.90*** **	**-21.15*** **
	(1.808)	(2.509)	(1.595)	(4.751)	(3.027)	(4.514)
Weekend	**-4.926*** **	**-4.888*** **	**-5.763*** **	-3.228	**-6.096*** **	**-3.170* **
	(1.608)	(1.427)	(1.818)	(3.247)	(2.062)	(1.808)

No. of residents in an apartment	**-16.16*** **	**-15.75*** **	**-14.84*** **	**-24.09*** **	**-14.04** **	-22.45
	(3.338)	(5.653)	(3.338)	(7.154)	(5.734)	(13.85)
Constant	146.7***	167.8***	157.8***	125.4***	174.5***	168.9***
	(14.27)	(16.68)	(14.47)	(31.42)	(18.12)	(34.00)
Observations	25,935	30,951	17,713	8,222	18,382	12,569
R-squared	0.031	0.047	0.035	0.053	0.063	0.045
Number of apartments	45	56	29	16	31	25

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

We find that treated households increase by a small amount (5 lpcd) whereas untreated increase by a much larger amount (14 lpcd). Treated households decrease further by a similar amount (17 lpcd) as untreated households (21 lpcd).

4.4. Results from Bill-to-pay model to estimate effect of salience of bill and payment

Table S45. Bill-to-pay summary. Summary of level of water usage in lpcd and lpd depending on days in the bill to pay to bill cycle.

Unit of water usage	Before-price stage	Priced-stage - all days	Priced-stage - outside of bill-to-pay days	Priced-stage - bill-to-pay days
lpcd	114	109	110	105
lpd	319	304	306	294

We again see large divergence in responses at household level. One-third of households used more water in bill-to-pay days as compared to pay-to-bill days with an average increase of 11 lpcd.

Table S46. Bill-to-pay summary with increase or decrease. Summary of lpcd and change in lpcd by households that increase or decrease water usage in lpcd in the bill-to-pay days as compared to pay-to-bill days.

Households	Number of households	lpcd - before priced-stage	Relative increase in lpcd bill-to-pay days
All	101	114.4	-4
Increased usage	32	112.4	11
Decreased usage	65	113.7	-15
NA	4	141.4	NA

We also compare these effects with results from the main model with restricted data in priced-stage.

Table S47. Effect of bill to pay period. Effect of receipt of bill till payment of bill, for NP-treated and untreated households (HH), and over time.

	(1)	(2)	(3)	(4)	(5)
Subset of households (HH)	All HH	NP-Treated HH	Untreated HH	All, Post 1st Bill	All, Post 2nd Bill
VARIABLES and DV	lpcd	lpcd	lpcd	lpcd	lpcd
Bill-to-pay days	**-3.736*** **	-2.480	**-5.787*** **	**-5.847*** **	**-6.566*** **
	(1.310)	(1.656)	(2.132)	(1.731)	(2.430)
weekend	**-5.173*** **	**-6.494*** **	-3.244	**-4.895*** **	**-3.747** **
	(1.082)	(1.224)	(1.963)	(1.197)	(1.521)

No. of residents in an apartment	**-18.90*** **	**-15.39*** **	**-23.77** **	**-20.52*** **	**-17.93*** **
	(4.715)	(4.484)	(9.282)	(5.507)	(5.945)
Constant	168.2***	170.4***	162.6***	155.0***	185.7***
	(17.34)	(18.26)	(33.37)	(20.69)	(26.24)
Observations	24,934	14,965	9,969	15,766	8,008
R-squared	0.026	0.030	0.036	0.027	0.024
Number of apartments	101	60	41	97	90

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The effect of bill is observed though the size is practically not very large (3%). The effect is much larger in untreated households. When days before first bill are removed from the comparison, effect size is larger, even more so if it the days for analysis are further restricted to days after 2nd bill (July bill). Bill communication makes a difference till the payment is made.

Table S48. Effect of time. Summary of price-intervention's effects in various periods of priced stage, for all households (HH), households by treatment pools and groups. Values are price-effect (i.e., coefficient of variable priced).

	(1)	(2)	(3)	(4)	
Period	*All Priced*	*Till 1st bill*	*After 1st bill*	*After 2nd bill*	
Group	lpcd	lpcd	lpcd	lpcd	No. of HH
All	**-6.580*** **	**-4.812* **	**-7.369** **	**-9.423*** **	101
	(2.187)	(2.642)	(2.825)	(3.580)	
All NP-treated	**-5.935** **	**-6.407** **	**-5.856** **	**-6.691** **	60
	(2.305)	(2.730)	(2.510)	(3.321)	
All untreated	-7.425	2.010	-10.65	**-14.40* **	41
	(4.551)	(7.324)	(6.389)	(7.722)	
T1	**-10.81** **	**-14.36*** **	**-8.299* **	**-10.06* **	21
	(4.522)	(4.629)	(4.777)	(5.624)	
T2	0.212	2.464	-1.309	-0.440	22
	(3.067)	(3.897)	(3.423)	(4.861)	
T3	-7.420	**-7.825* **	-7.664	-9.296	17
	(4.319)	(4.428)	(5.157)	(6.310)	
C0	**-11.06* **	-3.868	-14.66	-17.22	21
	(6.102)	(6.567)	(9.565)	(11.78)	
PI	-0.661	**31.61* **	-4.097	-9.802	20
	(8.204)	(17.68)	(6.851)	(7.884)	

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table S49. Price effect in various periods of priced-stage. Details of regression using all households.

	(1)	(2)	(3)	(4)
	All Priced	Till 1st bill	After 1st bill	After 2nd bill
VARIABLES and DV	lpcd	lpcd	lpcd	lpcd
Priced	**-6.580*** **	**-4.812* **	**-7.369** **	**-9.423*** **
	(2.187)	(2.642)	(2.825)	(3.580)
Weekend	**-4.899*** **	**-5.010*** **	**-4.805*** **	**-4.577*** **
	(1.063)	(1.226)	(1.107)	(1.218)
No. of residents in an apartment	**-18.45*** **	**-19.03*** **	**-18.52*** **	**-17.48*** **
	(3.481)	(4.771)	(3.123)	(3.269)
Constant	165.1***	172.8***	161.2***	165.3***
	(11.63)	(14.38)	(12.45)	(12.32)

Observations	56,886	41,120	47,718	39,960
R-squared	0.026	0.024	0.027	0.025
Number of apartments	101	101	101	101

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

We find that people use relatively less water in the days after receiving the bill compared to other days in the priced stage. The effect is even stronger if the first pre-bill period is excluded, signifying that the effect of the introduction of price is not as strong as the salience effect of each bill. The second bill also supports this bill-to-pay effect, despite a much smaller number of observations for the regression. Similar results are supported using our main panel data model for price-effect (model 2) by excluding days till receipt of 1^{st} bill or 2^{nd} bill (Tables S48 and S49).

4.5. Results from time-series based models

We complete the main findings based on results from timeseries models.

4.5.1. Results from timeseries models for price-effect

We complement the results from panel-data based models in section 4.3 on main effects from interventions and section 4.4 on bill-to-pay salience effects by presenting the results from timeseries models (section 3.2).

The pattern of initial impact is diverse, either a step pattern or a pulse pattern. We do not detect a statistically significant effect in the pool of all houses. T1 and T2 group support an effect with low significance and in mutually opposite direction. The T1 group's initial effect is a pulse of +8.7 lpcd ($p < 0.1$) and T2 has a step pattern of -2.58 lpcd ($p < 0.1$).

These results match well with estimated effects from panel-data model based results for price-effect, especially for untreated households that had no effect till the 2^{nd} bill (SI Table S48**)**.

Table S50. Pattern of initial effect of introduction of price and size of initial effect.

Group	Initial pattern	ω Omega (size of initial effect)
C0	3 – pulse	1.59
PI	1 – step	2.08
T1	3 – pulse	**8.70***
T2	1 – step	**-2.58***
T3	1 – step	5.92
ALL	3 – pulse	4.43

4.5.1.1. Diverse patterns of initial response

At the household level, the initial response is dominated by a step change. 65% of households support an effect at statistical significance level of 10%. The share is 46% at a significance level of 5%.

Table S51. Patterns of initial response to price as percent of total population. Statistical significance at 10% is shown under each shape. All households that support pulse or decay pattern have a statistically significant effect

Best-fit pattern and significant or not	**All households**		
		Households that decreased as per	**Households that increased**
1 (Step)	72%	42%	29%
Not significant	*25%*	*14%*	*12%*
Significant	*46%*	*28%*	*18%*
2 (Build-up)	7%	4%	3%
3 (Pulse)	18%	3%	15%

Not significant	*9%*	*3%*	*6%*
Significant	*8%*	*0%*	*8%*
4 (Decay)	3%	1%	2%
Total	100%	51%	49%

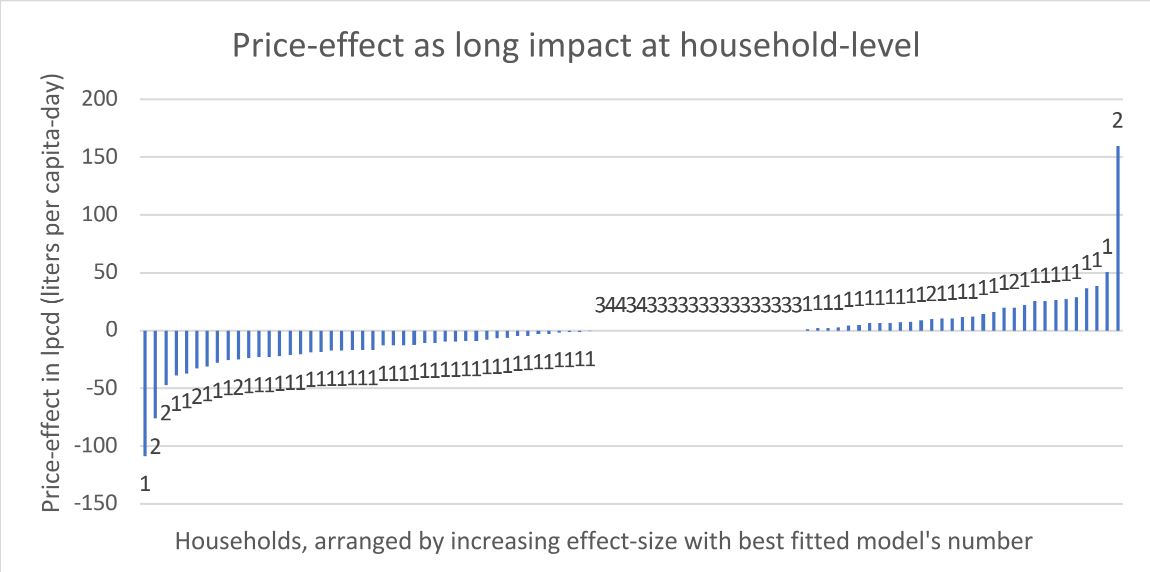

Figure S12. Household-level effects of price intervention estimated using time-series analysis. The four model numbers are 1 for step-change, 2- build-up, 3-pulse, and 4-decay. Models 1 and 2 involve a long impact equal to the estimated coefficient and 3 and 4 are transient (zero long impact). The price-effect ranges from -108.6 to 159.6 lpcd. For comparison, the aggregate level long-impact is estimated at 4.4 lpcd and it fits model 3 (pulse).

4.5.1.2. Increase vs decrease – initial and long-term

We juxtapose initial effect with household level change in average lpcd between the before-price stage and the priced-stage (shown as increase in lpcd in result tables).

Since patterns 3 and 4 imply only a transient response, they are considered a part of "no-change" in lpcd. Households that fit model 1 and 2 are also no-change if the coefficient of price variable is not statistically significant.

Table S52. Summary direction of change in water usage and effect size based on ITS model. Most households do not change and some change by increasing water usage (lpcd values).

	5% significance level		10% significance level	
Direction of change	Share of households	Avg. of initial effect (ω)	Share of households	Avg. of initial effect (ω)
Increase	13%	21	21%	22
No-change	62%	8	46%	9
Decrease	25%	-24	33%	-22
All	**100%**	**2**	**100%**	**2**

The long-term response is measured through estimation of long impact using the ITS model as detailed in section 3.2).

Table S53. Summary of initial effect and long-term effect. This is at 10% significance level and using lpcd values.

Parameters	Decrease	No-change	Increase	Total
Percent of all households	33%	46%	21%	100%
Average of initial effect ($\boldsymbol{\omega}$)	-22	9	22	2
Initial effect ($\boldsymbol{\omega}$) – minimum	-109	-105	1	-109
Initial effect ($\boldsymbol{\omega}$) – maximum	-1	157	63	157
Average of long-term effect	-25	0	28	-2
Long-term effect – minimum	-109	-23	6	-109
Long-term effect – maximum	-7	20	160	160
Average of increase in lpcd	-22	0	13	-5
Average of lpcd in before-priced stage	125	110	106	114

The price-effect at household level has enormous variation in effect-size, both negative and positive. While some of this can be due to potentially unrecorded change in number of residents in a few households, the very large number of households falling on both sides of the overall effect suggests large divergence in actual behavior. Further, change in number of residents was recorded during the survey that was conducted towards the end of daily observations in priced-stage, including details of periodic movements (Figure S4). This approach significantly reduces the scope for error in measurement of number of residents.

4.5.2. Results from timeseries models for bill-to-pay effect

We complete this section on main effects from interventions by presenting the results from timeseries models (section 3.2.2).

Table S54. Results of from model 5 for bills. Impact after receiving the bill.

	ω_{Price}	ω_{Bill}	se (ω_{Price})	se (ω_{Bill})
C0	0.09	**-4.02****	4.81	2.31
PI	2.09	-1.04	10.06	4.21
T1	3.41	-2.04	4.08	2.23
T2	-1.49	**-5.00****	1.62	2.43
T3	5.64	-3.96	5.97	2.45
ALL	3.09	**-2.52****	3.64	1.53

***, **, and * denote significance at 1%, 5% and 10% level.

We observe significant reduction in groups C0 and T2 at the time of receipt of bill.

Table S55. Results from model 6 on first two bills. Impact after April and July bills.

	ω_{Price}	ω_{April}	ω_{July}	s.e (ω_{Price})	s.e (ω_{April})	s.e (ω_{July})
C0	0.09	**-6.89****	1.05	4.75	3.99	3.91
PI	2.26	**12.13****	-7.08	9.77	7.02	6.99
T1	3.83	**-5.64***	-3.16	3.95	3.72	3.56
T2	-1.14	**-10.62*****	**-6.86****	1.43	3.96	3.69
T3	5.80	-4.70	-3.67	6.03	4.26	4.24
ALL	3.09	-1.48	**-3.76***	3.68	2.65	2.63

***, **, and * denote significance at 1%, 5% and 10% level.

We observe how some groups increased on receiving the first bill. Overall, the bill-effect is seen only after the second (i.e., July) bill.

S5. References in the Supporting Information

1. V. Vivek, D. Malghan, K. Mukherjee, Toward achieving persistent behavior change in household water conservation. *Proceedings of the National Academy of Sciences* **118** (2021).

2. F. Arbués, M. Á. García-Valiñas, R. Martínez-Espiñeira, Estimation of residential water demand: a state-of-the-art review. *The Journal of Socio-Economics* **32**, 81–102 (2003).

3. S. F. Hoque, *Water Conservation in Urban Households - Role of Prices, Policies and Technologies* (IWA Publishing, 2014).

4. G. E. P. Box, G. M. Jenkins, G. C. Reinsel, G. M. Ljung, *Time series analysis: forecasting and control* (John Wiley & Sons, 2015).

S6. Data and code files

We have the following STATA® code files (.do) and data files (.dta):

Data Set ds01. Price and Non-price Effects.do

Data Set ds02. Summary statts and tests - 1 - NP effects.do

Data Set ds03. Summary statts - 2 price effect.do

Data Set ds04. logit regression.do

Data Set ds05. daily data.dta

Data Set ds06. Apt stage summary for balance test.dta

Data Set ds07. Apt lpcd before and after price - wide.dta

Data Set ds08. 4.1.2 Summary Water Apt Price Bill2Pay – wide.dta

Data Set ds09. 4.1 weekly water apt - for TS v2.dta

Data Set ds10. 4.2 weekly water group - for TS.dta

Data Set ds11. 4.3 weekly water aggregate - for TS.dta

We have the following R files:

Data Set ds15. weekly1 bill and price effect.R

Data Set ds16. weekly2 bill and price effect.R

Data Set ds17. weekly1 price effect.R

Data Set ds18. weekly2 price effect.R

Data Set ds19. weekly3 price effect.R

Data Set ds20. aggregate group bill and price effect.R

Data Set ds21. aggregate group price effect.R

We have the following Microsoft Excel (.xlsx) and csv files:

Data Set ds22. household level bill and price effect results.xlsx

Data Set ds23. household level price effect results.xlsx

Data Set ds24. logit regression.csv

Data Set ds25. weekly best model price effect.csv

Data Set ds26. weekly best models price and bill.csv

Data Set ds27. Household Level Timeseries Results and Parameters.csv

Data Set ds28. weekly_bestmodels_priceandbill_april_july