USING NONPECUNIARY STRATEGIES TO INFLUENCE BEHAVIOR: EVIDENCE FROM A LARGE-SCALE FIELD EXPERIMENT

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Abstract—Policymakers are increasingly using norm-based messages to influence individual decision making. We partner with a metropolitan water utility to implement a natural field experiment to examine the effect of such messages on residential water demand. The data, drawn from more than 100,000 households, indicate that social comparison messages had a greater influence on behavior than simple prosocial messages or technical information alone. Moreover, our data suggest that social comparison messages are most effective among households identified as the least price sensitive: high users. Yet the effectiveness of such messages wanes over time. Our results thus highlight important complementarities between pecuniary and nonpecuniary strategies.

I. Introduction

MOST travelers have been confronted with a strategically placed card in a hotel bathroom urging them to protect the environment by reusing their towels. Such efforts are consistent with a growing trend of employing nonpecuniary strategies (for examples, norm-based messages and social comparisons) to influence individual decision making. As Schultz et al. (2007) noted, such strategies have been applied to a range of behaviors, including alcohol and drug use, eating disorders, gambling, recycling, and energy consumption. Although the use of such strategies continues to grow in popularity, their relative efficacy remains underresearched by economists.

In an effort to fill this gap, we examine the effectiveness of nonpecuniary strategies as a means to manage residential water demand. To maintain consistency with existing policy initiatives, we focus our analysis on three commonly employed conservation strategies: (a) the dissemination of information on behavioral and technological modifications, (b) appeals to prosocial preferences and the desire to do the right thing, and (c) the provision of social comparisons to enhance appeals to prosocial preferences. To the best of our knowledge, we provide the first apples-to-apples comparison of programs based on appeals to prosocial preferences with those augmented with social comparisons.

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We focus our analysis on residential water demand for two reasons. First and foremost, policymakers frequently rely on nonpecuniary measures rather than market-based approaches to promote conservation efforts and manage water resources. For example, such strategies are the essence of the EPA's Water Sense program, a public education campaign launched in 2006 to spread the word about the importance of water efficiency and conservation.

Second, during the 20th century, global water use increased sixfold, a pattern that has prompted many to identify the availability of freshwater as one of the most critical issues confronting policymakers in the twenty-first century. The U.N. Environmental Program estimates that by 2025, over two-thirds of the world's population will reside in regions considered water stressed. Similar concerns abound in the United States, where a recent government survey suggests that at least 36 states are anticipating some form of water shortage by 2013.[1] Thus, water scarcity concerns are likely to magnify over time.

We begin by developing a conceptual framework based on the work of Levitt and List (2007) to identify channels through which norm-based strategies may influence household water consumption. The framework affords a rank ordering over the expected influence of commonly enacted conservation strategies on consumption decisions. Empirically, we investigate the relative effectiveness of such strategies by partnering with a metropolitan water utility to implement a large-scale, natural field experiment. Our field experiment offers data on more than 100,000 residential households randomized into four treatments: a control group, a group that received technical advice, a group that received both technical advice and an appeal to prosocial preferences, and a group that received technical advice and an appeal to prosocial preferences augmented with a social comparison.

Our study builds on two distinct literatures. The first is a growing body of work that examines the use of prosocial messages or social comparisons in the context of charitable giving (Bryan & Test, 1967; Reingen, 1978; Frey & Meier, 2004; Croson & Shang, 2008; Martin & Randal, 2008; Shang & Croson, 2009). Despite the seemingly amorphous nature of public goods and common pool resource games, it is not clear that results from the former would necessarily generalize to the latter. As Sandler and Arce (2003) noted, "Individuals appear to place a premium on inaction which requires sacrificing a right, so that the commons problem may pose a greater policy dilemma." Moreover, many of these studies (such as Frey & Meier, 2004; Croson & Shang, 2008; Shang & Croson, 2009) focus on the decisions

[1] See http://www.epa.gov/watersense/docs/ws_supply508.pdf.

of individuals along the intensive margin—previous donors or those actively planning to donate at the time of intervention.[2] Hence, this literature provides little insight regarding the effectiveness of such strategies on behavior along the extensive margin.

The second is a growing body of work in social psychology that examines the use of social-norm marketing, feedback, and tailored information campaigns to promote environmental conservation (Hutton & McNeill, 1981; Luyben, 1982; Winett, Love, & Kidd, 1982–1983; Hirst & Grady, 1982–1983; Siero et al., 1996; Staats, Harland, & Wilke, 2004; Kurz, Donaghue, & Walker, 2005; Schultz et al., 2007; Goldstein, Cialdini, & Griskevicius & 2008; Nolan et al., 2008). However, almost all of these studies rely on small samples that were often informed about the study prior to any intervention (Luyben, 1982; Hirst & Grady, 1982–1983; Kurz et al., 2005; Schultz et al., 2007; Nolan et al., 2008).[3] Further, many of these studies rely on self-reported measures of behavioral change (Hutton & McNeill, 1981; Luyben, 1982; Nolan et al., 2008), which may introduce a powerful confound when attempting to generalize results to other settings (social desirability bias).

Several insights emerge from our field study. First, nonpecuniary motivations influence water consumption in ways consonant with our conceptual framework. For example, technical advice has a small impact on water use: households in this treatment consume approximately 1% less than counterparts in the control. Augmenting technical advice with an appeal to prosocial preferences and a social comparison generates a substantially larger reduction—approximately 4.8%. From a policy perspective, these differences suggest that conservation initiatives should focus on explaining why customers should reduce water consumption rather than outlining how best to reduce water use.

Interestingly, this estimated social comparison effect is equivalent to that which would be expected if average prices were to increase approximately 12% to 15%.[4] Under the current pricing system, such a price increase would translate into an approximate $5 per month increase in water bills for the median user in our sample. Moreover, the estimated treatment effect is more than twice that observed across recent programs using social comparisons to affect energy conservation (see Allcott, 2011; Ayres, Raseman, & Shih, 2009).

Second, we find a fundamental difference in the efficacy of norm-based messages across low- and high-use households. For example, there is an approximate 94.1% difference in the relative treatment effect across user groups in our strong social norm treatment. From a policy perspective, heterogeneity in the effectiveness of norm-based appeals is notable as high-use households tend to be less price sensitive than others (Mansur & Olmstead, 2007). Thus nonpecuniary strategies provide a useful complement to pecuniary measures because they are most effective among the group that is least sensitive to price changes.

Finally, the effectiveness of nonpecuniary strategies wanes over time. In the month following intervention, households in our strong social norm treatment use approximately 5.62% less water than counterparts in our control group. Four months later, the estimated difference across these groups declines by 35.4%. This observed waning is consonant with previous work suggesting the impermanence of nonpecuniary incentives (see, Gneezy & List, 2006; Curtis & Price, 2009; Landry et al., 2010). Interestingly, our data suggest that waning is driven almost entirely by the high user group.

II. Conceptual Framework

We develop a conceptual framework in the spirit of Levitt and List (2007) to identify possible channels through which policy measures such as information transfers and prosocial messages may influence household water consumption. Our framework posits an agent with utility that is additively separable over two terms: consumption utility, c, and a moral payoff, M. Both of these terms depend on a single action, a, the choice of water consumption, and a vector of individual specific characteristics, θ. As in Levitt and List (2007), M captures nonpecuniary impacts associated with the choice of action and depends on the extent to which the decision maker's actions are scrutinized, s, and the perceived salience (strength) of the set of social norms, n, that dictate acceptable levels of water consumption.

The utility function for agent i is specified as

$$U_i(a, n, s; \theta) = c_i(a; \theta) - M_i(a, n, s; \theta),$$

where consumption utility, $c(\cdot)$, is strictly increasing and concave in a. Given the common nature of water supplies, consumption imposes negative externalities on others through the depletion of resource stocks. Hence, $M(\cdot)$ is assumed increasing and convex in a. As in Levitt and List (2007), we assume that moral costs are strictly increasing in the extent to which actions are scrutinized (observed) by others and the extent to which actions deviate from the perceived social norm.

Our conceptual framework highlights how policymakers could influence water use by employing nonpecuniary strategies that target and affect the realization of s and n. For example, consider a program, such as the EPA's Water Sense, that frames conservation as a social norm. Under our framework, this frame should map into an increased realization of n and an associated increase in the disutility (moral

[2] Frey and Meier (2004) examine the effect of social comparisons among all students, but find a significant effect only when the sample is restricted to students who contributed to the charity in the past.

[3] For example, Kurz et al. (2005) use a final sample of 166 households allocated into one of eight treatment conditions. Participants were recruited by way of an initial information letter detailing the nature of the study, which had a response rate for the different treatments ranging from 29.1% to 48.9%.

[4] This comparison is based on recent estimates of price elasticity of demand for U.S. metropolitan residential customers, which fall in the range of −0.33 to −0.36 (Mansur & Olmstead, 2007; Olmstead et al., 2007).

cost) of any prior consumption level. As consumption utility is assumed increasing and strictly concave in *a,* we would therefore expect a reduction in overall water use to offset this increased "marginal cost."

We implement a series of experimental treatments designed to systematically augment the realization of these factors, allowing us to rank the expected ordering of each treatment. Our treatments are based on existing conservation programs and focus on three commonly employed strategies: (a) the dissemination of information on behavioral and technological modifications, (b) requests to voluntarily restrict use and preserve scarce resources, and (c) the provision of social comparisons to induce conformity and make salient the norm of conservation. Moreover, to maintain consistency with existing policy initiatives, we consider interventions that combine technical and behavioral information and norm-based appeals.

Our first treatment, a technical advice letter, works though a single channel, increased scrutiny, and therefore is predicted to have the smallest effect on overall patterns of consumption. Our second treatment augments the technical advice letter by including an appeal to prosocial preferences highlighting the importance of conserving water. To the extent that such appeals highlight a social norm—conservation and concern for the environment—we would thus expect to see additional reductions in average use. Our final treatment makes the social norm more salient by including a social comparison that contrasts the household's use in the previous year with median use in the county. We would thus expect this treatment to generate the largest reductions in overall water consumption, particularly among high-use households.

Conceptually, the inclusion of the weak social norm treatment affords a better understanding of the channels through which appeals to prosocial preferences and social comparisons influence behavior. Importantly, this treatment allows us to differentiate our model from alternatives that focus on imperfect information in the spirit of Becker's (1965) household production framework. The weak social norm treatment reveals no information about the behavior of others that a household could use to update beliefs and reevaluate consumption decisions. Consequently, models based solely on imperfect information would predict similar patterns of consumption across our technical advice and weak social norm treatments. In contrast, our framework predicts very different patterns of use across these treatments.

III. Experimental Environment and Design

Cobb County is part of the metropolitan statistical area of Atlanta, Georgia. In 2006, it contained an estimated 679,325 people, 71% of whom self-identified as white/Caucasian and 23% as black.[5] The county is not known for environmentalism. The current congressmen have some of the lowest League of Conversation Voter scores recorded in 2007 and 2008.[6] During this same time period, Georgia's Senate delegation tied for last place in the league's scorecard. Hence, we have not selected a subject pool particularly known for proenvironmental preferences. As Costa and Kahn (2010) noted, the conservative nature of our subject pool may serve to mitigate observed treatment effects from social comparisons.

The Cobb County Water System (CCWS), an agency of the Cobb County government, distributes treated surface water for about 170,000 Cobb County customers. Of these, about 150,000 are residential customers who reside in single-family dwellings.[7] CCWS obtains its water from disputed surface supplies that have been affected by periodic drought conditions that began in 1998. Starting in 2006, the CCWS created a number of initiatives to encourage water conservation among its customers. On January 1, 2006, it introduced a new tiered-rate pricing scheme to replace the previously fixed-price-per-gallon pricing scheme. Concurrently, CCWS also initiated a number of supplemental programs designed to inform consumers how and why to conserve water. These initiatives, however, were not targeted toward individual households and remained available to all households throughout the postintervention period of analysis. As such, our experiment likely provides a conservative test of the ability of policymakers to harness prosocial preferences to achieve policy goals.

A. *Experimental Design*

To reduce water use among its residential customers in summer 2007, the CCWS agreed to initiate a targeted, mail-based residential customer conservation education program through a randomized experimental design.[8] The aim of the program was to provide CCWS empirical evidence on the relative effectiveness of providing residential customers a message about ways in which they could reduce their water use most effectively, (the how of reducing water use) and a message that appealed to prosocial preferences (the why of reducing water use). Each treatment was designed in collaboration with CCWS employees and pretested using small focus groups of residential customers from neighboring counties.

B. *Treatment 1: Technical Advice*

Our first treatment provided households an information-only message: a two-sided tip sheet listing ways to most effectively reduce water use and who to contact for more information (see the online appendix). All letters were personalized and sent to households in official CCWS envel-

[5] Additional information about Cobb County can be viewed at http://quickfacts.census.gov/qfd/states/13/13067.html.

[6] See http://www.lcv.org/scorecard-archives/pdf/scorecard-2008.pdf.

[7] In 2000, Cobb County was Georgia's second largest user of the public water supply, accounting for almost 8% of statewide consumption. Within the county, residential water use is highly variable, with about 5% of the customers using about 18% of the water (unpublished data, CCWS).

[8] In the taxonomy of Harrison and List (2004), our approach would be considered an example of a natural field experiment.

opes as first-class mail, and thus we expect that households perceived increased scrutiny over consumption decisions. Because moral costs are increasing in scrutiny, we would expect an increase in the disutility (moral cost) associated with any prior level of consumption. Because consumption utility is strictly concave in a, the household must lower overall consumption to offset this increased marginal cost. We would thus expect to observe a reduction in average water use relative to households in our control group.

Undoubtedly, there are other channels through which this treatment could operate if households were unaware of the strategies highlighted on the tip sheet. However, because the information contained in the tip sheet was widely available prior to our intervention, it is unlikely that such effects would be very pronounced. Yet we cannot rule out this possibility. It would thus be remiss if we did not note that increased scrutiny is not the only reason one might observe reduced water use in this treatment.

C. Treatment 2: Weak Social Norm

Our second experimental treatment augments treatment 1 by including a personally addressed letter on official CCWS stationary signed by the Water Conservation coordinator. The letter includes standard, norm-based language from water conservation materials used both nationally and in Georgia, as well as information found on the customer's month bill (and tip sheet) including who to contact for more information about water conservation. The letter in part reads:

> As you know, Cobb County's water resources are stretched because of population growth and many years of low rainfall. Cobb County residents consume almost one of out every ten gallons of Georgia's public water supply. As a result, our water use has a large impact on the ability of Georgia's waterways to protect wildlife and dilute pollutants that threaten human health. We all need to work together to use water wisely. . . .
> We need your help. Act on the tips listed in the enclosed tip sheet. We all have to do our part to protect Cobb County's precious water resources. Reducing our water consumption today is important for preserving our environment and our economy for future generations. Please don't waste water. Remember: every drop counts!

In addition to the effects on scrutiny, the inclusion of prosocial appeals may enhance the disutility associated with any level of consumption through an increased realization of n—the set of social norms affecting water use. We would thus expect larger reductions in average water use than those observed in treatment 1.

D. Treatment 3: Strong Social Norm

Social psychologists often stress that attention can be drawn to social norms most saliently through social comparisons. Our final treatment takes the prosocial appeals from our weak social norm treatment and adds a comparison of the household's water use from June to October 2006 to the median county household use for the same period and the percentile in which the household fell during this period.[9] This comparison reads:

> As we enter the summer months, we thought that you might be interested in the following information about your water consumption last year:
> **Your own total consumption June to October 2006: 52,000 gallons**
> *Your neighbors' average (median) consumption June to October 2006: 35,000 gallons*
> You consumed more water than 73% of your Cobb County neighbors.

Based on focus groups and prior work from social psychology (Cialdini et al., 2006; Schultz et al., 2007), the percentile text was framed in a negative way to emphasize how many people do not engage in the targeted behavior. (See the online appendix for an example of the full letter.)

This final treatment message is expected to influence behavior through two distinct channels. First, the inclusion of a social comparison may strengthen the perceived social norm—i.e., the realization of n in our model. Second, the provision of such detailed information may also enhance the extent to which the household perceives its actions are scrutinized. Ceteris paribus, we would therefore expect a greater reduction in average water use than that observed in treatment 2.

Before proceeding to the results section, a few key features of our experimental design should be highlighted. First, the CCWS required a minimum detectable treatment effect of a 2% decline in average water use and statistical power of at least 0.90, a request that required a sample size of 11,600 for each treatment message group and a control group of at least 69,600 households.[10] Second, the three treatment mailings were sent out on the same day during the week of May 21, 2007. All mailings were sent by first-class mail in official CCWS envelopes to maximize the likelihood that they would be opened by customers and to clearly associate the messages with CCWS. A follow-up tip sheet was sent four weeks later in the same manner to all treated customers. For treatments 2 and 3, copies of the original personalized letters did not accompany this mailing because the CCWS indicated that it would not have sent follow-up letters in a nonexperimental version of its education program.[11]

[9] Technically, the data presented to the household are for billed use dated June to October 2006 (May–September use). Focus groups indicated that recipients may wish to verify the information in the letter and would look to their recent bill as the relevant source. Monthly bills show prominently, near the top of the first page, a histogram documenting the billed month's use and each of the previous twelve billed months' use.

[10] These sample sizes were derived using the desired minimum treatment effect, water use data from summer 2006, an assumed 0.70 intrahousehold annual correlation of water use (based on CCWS data), and a type 1 error rate of 0.05.

[11] Our single-treatment "dose" contrasts with previous work (Allcott, 2011; Ayres et al., 2009) in which conservation materials are sent monthly or quarterly without cessation.

TABLE 1.—SUMMARY STATISTICS: USE IN THOUSANDS OF GALLONS

	Summer 2007 Use	% Change Relative to Summer 2006	Water 2006 Use	March and April 2007 Use
Control group ($N = 71,643$)	36.47	−7.83%	58.29	15.89
	(29.25)		(41.38)	(12.02)
Treatment 1: Technical advice ($N = 11,675$)	36.35	−8.41	58.43	15.98
	(30.42)		(39.96)	(11.74)
Treatment 2: Weak social norm ($N = 11,675$)	35.43	−10.08	58.18	15.88
	(28.13)		(41.25)	(11.69)
Treatment 3: Strong social norm ($N = 11,676$)	34.86	−12.01	58.43	15.98
	(26.34)		(40.67)	(11.53)

Cell entries are average use levels in thousands of gallons and associated standard deviations (in parentheses).

Third, meters are read and bills are sent out daily based on a household's assignment to one of 390 meter routes. To ensure that we have no systematic differences across treatments on the day of the month that an outcome is measured, we randomize treatment assignment within meter routes that correspond to neighborhood sections. Such stratification has the additional benefit of increasing the precision of the estimates, provided that unobservables affecting treatment response are more similar within rather than between meter routes.[12]

Fourth, the strong social norm message requires the communication of baseline water use for summer 2006. Although the water system billed 156,326 residential customers in April 2007, this requirement limits the set of households eligible for treatment assignment to 139,693 households whose customer billing names had not changed between May 2006 and March 2007.

Fifth, under a nonrandomized conservation message program, CCWS would not send messages to individuals who consume fewer than 4,000 gallons per month or who use 0 gallons for most of the summer water season. Households that met these criteria for May through September 2006 were excluded from our final sample. Using these procedures, 11,699 households (HHs) were assigned to treatment 1, 11,695 HHs were assigned to treatment 2, 11,699 HHs were assigned to treatment 3, and 71,779 HHs were assigned to the control condition.[13] Finally, monthly pre- and postexperiment water use data come from the CCWS billing department.

IV. Experimental Results

We begin by examining the effect of our experimental treatments on household water use for June through September 2007. The first column of table 1 summarizes water use for this period and the second column the percentage change in average use relative to that observed during this same time period in 2006. The data in table 1 exclude 187 households whose water was turned off from June through September 2007, 13 households for whom we cannot determine with certainty actual water use due to billing mistakes, and 3 households with large catastrophic leaks of at least 1 million gallons.

As noted in the second column of table 1, average water use in summer 2007 declined relative to that observed for summer 2006 across all household types. However, the observed decline across our three treatment groups is approximately 7.41% to 53.38% greater than that observed among our control group. Moreover, the observed rank ordering of treatment effects corresponds to that predicted by our conceptual framework. We observe the smallest decline in treatment 1 and the largest decline in treatment 3. Importantly, the estimated differences in treatment effects are statistically significant at the $p < 0.05$ level using parametric and nonparametric tests.[14]

Taken jointly, these differences suggest result 1: nonpecuniary motivations influence average water use. As we increase the scrutiny of actions and the perceived saliency of social norms, we observe greater reductions in average consumption. Result 1 is consistent with the hypothesis that moral payoffs influence consumption decisions for the average household in our sample. Consonant with the rank ordering predicted by our conceptual framework, we observe the smallest effect in our technical advice treatment, which works through a single channel: scrutiny. We observe the largest effect in our strong social norm treatment, which operates through multiple channels. Result 1 also accords well with Goldstein et al. (2008), who observe that significant increases in reuse rates could be achieved by augmenting normative appeals to reuse hotel towels with social comparisons that report the percentage of prior guests who engaged in such behavior.

Importantly, we observe a significant reduction in consumption when augmenting the technical advice letter to include an appeal to prosocial preferences. Treatment 2's impact calls into question alternate explanations for the observed data patterns that focus on imperfect information

[12] For over 90% of the routes in our sample, the coefficient of variation in 2006 summer water use is lower within routes than across routes.

[13] Using STATA 10 "sample" command and "by" option.

[14] A one-way ANOVA with Sidak adjustment for multiple hypotheses indicates that each treatment effect is significantly different from 0 and that the effect of treatment 3 is larger than that observed in the other treatments. Similarly, a nonparametric Jonckheree-Terpstra test for trends in summer 2007 water use indicates a significant trend as one moves from treatment 1 to treatment 2 to treatment 3.

TABLE 2.—AVERAGE TREATMENT EFFECTS: LINEAR REGRESSION MODELS

	Model A	Model B	Model C
Constant	2.18**	1.87	4.59**
	(0.43)	(1.59)	(0.26)
Indicator for treatment 1:	−0.24	−0.24	−0.37*
Technical advice	(0.19)	(0.19)	(0.16)
Indicator for treatment 2:	−0.99**	−0.99**	−1.01**
Weak social norm	(0.17)	(0.17)	(0.16)
Indicator for treatment 3:	−1.74**	−1.74**	−1.66**
Strong social norm	(0.17)	(0.17)	(0.16)
Water use, May–October 2006	0.37**	0.35**	0.34**
	(0.01)	(0.01)	(0.01)
Water use, March and	0.79**	0.83**	0.74**
April, 2007	(0.04)	(0.04)	(0.04)
Route fixed effects	No	Yes	No
Trimming rule	None	None	Yes
Number of observations	106,669	106,669	105,885
R^2	0.62	0.63	0.60

Cell entries are parameter estimates (standard errors in parentheses) for a series of linear regression models of aggregate water use (in thousands of gallons) for summer 2007 on the included covariates. The models differ in whether route-specific fixed effects are included and the rules used to trim the overall sample. The third column excludes observations from the top and bottom 0.25 percentile of the distribution for summer 2007 water use. Cell entries can be read as follows: as indicated in column 1, households that were randomly assigned into the strong social norm treatment consumed approximately 1,740 fewer gallons on average than those in the control group. Statistical significance at the $*p < 0.05$ level and $**p < 0.01$ level.

in the context of Becker's (1965) household production model.[15] Our weak social norm treatment reveals no information about the behaviors of others that could lead the household to update beliefs and reevaluate its own consumption decisions.

To increase the precision of the estimated treatment effects, we regress summer 2007 water use for the ith household (Y_{i2007}) on three dummy variables representing the three treatments (T_1 = technical advice; T_2 = weak social norms; T_3 = strong social norms):

$$Y_{i2007} = \alpha + \beta_1 \times T_1 + \beta_2 \times T_2 + \beta_3 \times T_3 + \beta_4 \times Y_{i2006} + \beta_5 \times Y_{iSpring} + \varepsilon. \quad (1)$$

We include as covariates household water use for the watering season in 2006 (Y_{i2006}) and spring 2007 ($Y_{iSpring}$).[16] This latter variable aims to capture any home or landscaping changes since 2006 but before the experiment began. To control for heteroskedasticity, we estimate robust standard errors.

These empirical estimates (in thousands of gallons) are contained in model A of table 2 and provide evidence consistent with our unconditional analysis: households in all three treatment groups consume less water than those in our control group. Figure 1 depicts the estimated effects from table 1 as percentage changes relative to the baseline group. For example, the average household in treatment 3 (strong social norm) is predicted to consume approximately 4.8% (or 1,740 gallons) less water than the average control group household. To better understand the magnitude of this difference, consider that a five-minute shower uses anywhere from 10 to 25 gallons of water and the average top-load washing machine between 40 and 45 gallons of water per load.

The final two columns of table 2 augment this basic specification. Model B augments the model to include route-specific dummy variables to capture unobserved neighborhood-specific characteristics that influence water consumption.[17] Model C trims the data to exclude observations from the extreme tails of the underlying distribution of use. Empirical results from these models are qualitatively similar to those presented in model A: we observe the smallest (largest) reductions in consumption in our technical advice (strong social norm) treatment. Although the estimated technical advice effect in model C is statistically different from 0, the observed reduction in average consumption level is less than the desired minimal detectable treatment effect of 2%. From a policy perspective, this calls into question the economic significance of information-only conservation efforts.

A. *Heterogeneity in Treatment Effects: Low versus High Users*

Result 1 refers to mean treatment effects. Our experimental design, however, allows us to explore treatment effects at a deeper level by examining heterogeneous impacts across user types. A key feature of our strong social norm treatment is the inclusion of a social comparison designed to increase the saliency of social norms. As highlighted in our conceptual framework, such comparisons should have a greater effect on households whose consumption exceeded that of the median Cobb County resident. To the extent that it is easier for high-use households to identify easy, low-cost means to curtail consumption and adhere to a conservation norm, our framework would predict a similar but less pronounced difference across the highest- and lowest-user groups in our weak social norm treatment.

To examine this conjecture, we split our data into two household types—low users whose consumption in summer 2006 was less than the median Cobb County resident and high users whose consumption in summer 2006 was greater than the median Cobb County resident—and reestimate equation (1).[18] Columns A and B of table 3 present the empirical estimates, which suggest that appeals to social norms are most effective among high-use households. Figure 2 shows that this conclusion holds for relative as well as

[15] For example, one could envision a situation where a household has incorrect beliefs regarding the marginal cost of increasing efficiency. Observing that the median household in Cobb County uses significantly less water could signal to such a household that the actual marginal cost of improving efficiency is lower than their original belief and lead them to reconsider consumption patterns.

[16] Water use in 2006 is aggregate household consumption for May through October. Spring water use captures aggregate consumption for March and April.

[17] The route dummy variables are designed to capture factors such as local variations in rainfall totals or neighborhood-specific requirements or social pressures to maintain a green lawn.

[18] The experiment excluded households whose summer 2006 consumption was fewer than 4,000 gallons per month (see the final paragraph of section IV), effectively removing users who fell in the lower quartile of the distribution over summer 2006 use. As such, we observe approximately twice as many high-use households in our data.

FIGURE 1.—ESTIMATED TREATMENT EFFECTS: ALL AND TRIMMED DATA

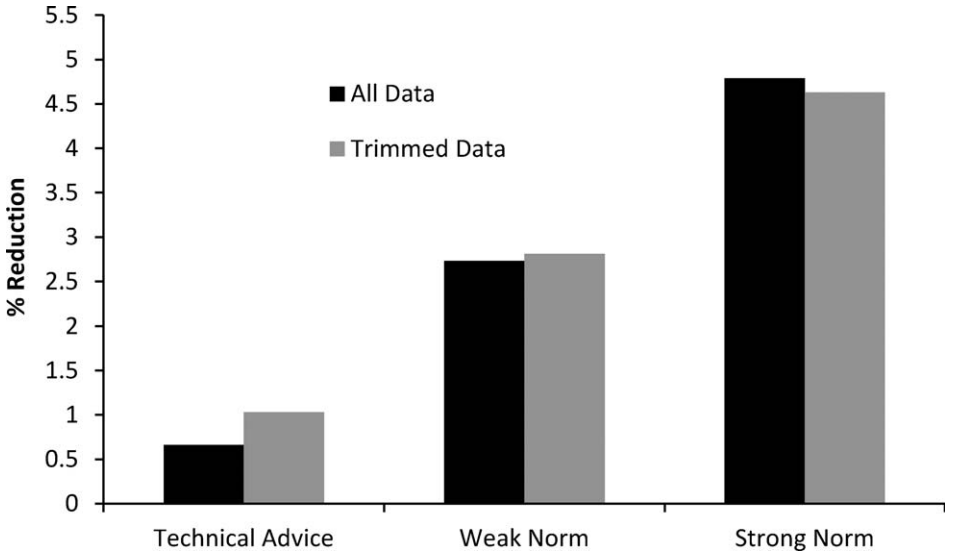
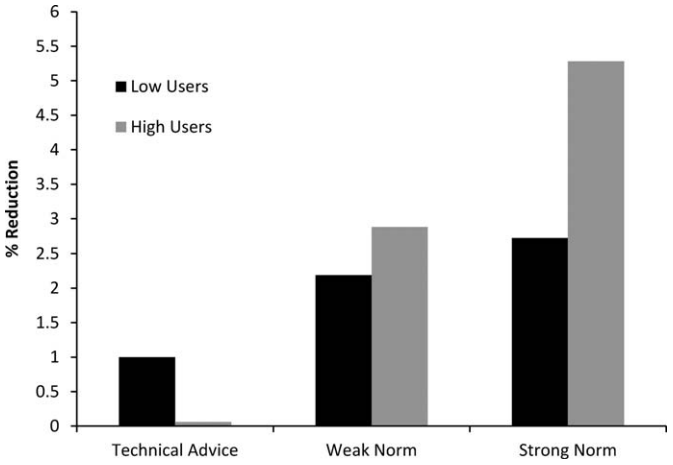


TABLE 3.—HETEROGENEITY IN TREATMENT EFFECTS: LOW- VERSUS HIGH-USER GROUPS

	Model A	Model B
Constant	6.68**	2.21**
	(2.31)	(0.69)
Indicator for treatment 1:	−0.21	−0.25
Technical advice	(0.18)	(0.28)
Indicator for treatment 2:	−0.46**	−1.28**
Weak social norm	(0.16)	(0.26)
Indicator for treatment 3:	−0.57**	−2.35**
Strong social norm	(0.16)	(0.24)
Water use, May–October 2006	0.22**	0.37**
	(0.08)	(0.01)
Water use, March and April 2007	0.77**	0.79**
	(0.15)	(0.04)
Sample restriction	Bottom 50%	Top 50%
Number of observations	37,360	69,309
R^2	0.17	0.58

Cell entries are parameter estimates (standard errors in parentheses) for linear regression models of aggregate water use (in thousands of gallons) for summer 2007 on the included covariates. The models in the first (second) column include only households that consumed less water (more water) during the summer of 2006 than the median household in Cobb County. Denotes statistical significance at $*p < 0.05$ and $**p < 0.01$.

FIGURE 2.—ESTIMATED TREATMENT EFFECTS BY USER GROUP



absolute impacts. For example, the estimated strong social norm effect for our high-user group is approximately 94.1% greater (5.28% versus 2.72% relative reduction) than that for our low-user group, a difference that is significant at the $p < 0.05$ level.

We observe a similar, albeit less pronounced, difference in the estimated weak social norm effect across these household types. However, the approximate 31.5% difference in the estimated treatment effect across high- and low-user types (2.88% versus 2.19% relative reduction) is not significant at any meaningful level. Combined, these data suggest result 2: appeals to social norms are most effective among high-use households, these differences are most pronounced when the appeal includes a social comparison. Result 2 thus highlights an important asymmetry in the effectiveness of conservation programs based on prosocial appeals: such strategies are most salient among high-use households.

From a policy perspective, heterogeneity in the effectiveness of norm-based appeals is notable. Mansur and Olmstead (2007) highlight that because high-use households tend to be wealthier, such users are less price sensitive than others. Result 2 suggests that norm-based, nonpecuniary strategies may prove a useful complement to pecuniary measures because they are most effective among the group that is least sensitive to price changes.

B. The Waning of Treatment Effects

Our analysis thus far has focused on changes in relative consumption levels aggregated over all summer months. Although we find evidence of treatment effects in this aggregated data, a growing empirical literature suggests the impermanence of nonpecuniary incentives such as unconditional gifts for workers (Gneezy & List, 2006; Curtis & Price, 2009) and the physical attractiveness of female solicitors in door-to-door fundraising (Landry et al., 2010).

TABLE 4.—THE PERSISTENCE OF TREATMENT EFFECTS: COMPARING JUNE AND SEPTEMBER USE

	Model A (June Use)	Model B (September Use)	Model C (June Use)	Model D (September Use)	Model E (June Use)	Model F (September Use)
Constant	4.07***	4.54***	4.88***	3.87***	5.28***	5.76***
	(0.17)	(0.22)	(0.06)	(0.06)	(0.28)	(0.32)
Indicator for technical advice treatment	−0.09	−0.02	−0.12**	−0.05	−0.09	−0.02
	(0.08)	(0.07)	(0.06)	(0.06)	(0.11)	(0.10)
Indicator for weak social norm treatment	−0.32***	−0.18***	−0.16***	−0.12*	−0.38***	−0.19**
	(0.07)	(0.06)	(0.06)	(0.07)	(0.11)	(0.09)
Indicator for strong social norm treatment	−0.51***	−0.29***	−0.09	−0.10*	−0.74***	−0.40***
	(0.07)	(0.07)	(0.07)	(0.06)	(0.10)	(0.10)
Water use, June 2006	0.50***		0.09***		0.46***	
	(0.02)		(0.01)		(0.02)	
Water use, September 2006		0.44***		0.30***		0.39***
		(0.03)		(0.01)		(0.03)
User type	All	All	Below Median	Below Median	Above Median	Above Median
Number of observations	106,669	106,669	37,360	37,360	69,309	69,309
R^2	0.36	0.18	0.01	0.02	0.31	0.14

Cell entries are parameter estimates (standard errors in parentheses) from linear regressions of June and September 2007 water consumption (in thousands of gallons) on the included model covariates. *Statistical significance at $p < 0.10$, **$p < 0.05$, and ***$p < 0.01$.

As Gneezy and List (2006) noted, such impermanence is consistent with nonpecuniary incentives having greatest import during initial, or hot, phases of decision making. Social comparisons and appeals to social norms trigger strong moral sentiments during the hot phase of decision making—the few weeks following intervention. Over time, however, these feelings may dissipate as the household's focus of attention shifts elsewhere. Hence, a similar pattern of decay is plausible in our setting.

By design, treatment mailings were sent to all households in our sample on the same day during the week of May 21, 2007. Our design thus allows an evaluation of whether our conservation strategies are subject to the same type of decay noted for other nonpecuniary incentives that influence decision making through psychological processes. In this spirit, we regress separately June 2007 (September 2007) water consumption for the ith household on June 2006 (September 2006) consumption for that household and a vector of indicators for our different experimental treatments.

Results for these regressions are contained in the first two columns of table 4 and provide empirical evidence of waning. For example, as noted in column A, the estimated effect of our strong social norm letter on June 2007 consumption was an approximate 5.62% reduction relative to the control group. By September, the estimated difference across these two groups falls to 3.63%. This approximate 35.4% reduction in the estimated strong social norm effect across the summer months is statistically significant at the $p < 0.05$ level.[19] We observe similar patterns of decay in both the weak social norm and technical advice treatments.

[19] A similar pattern of decay is noted in Allcott (2011) among households randomly assigned to groups receiving home energy reports on a quarterly basis. Interestingly, Allcott (2011) reports evidence from survey data suggesting that the observed pattern of decay reflects behavior consonant with "hot" and "cold" phases of decision making. Receiving a letter reminds or motivates households to conserve energy by turning off lights, unplugging electronics, and adjusting thermostats. Over time, the household tires of the change, but on receiving the next quarter's report, it is again motivated to conserve.

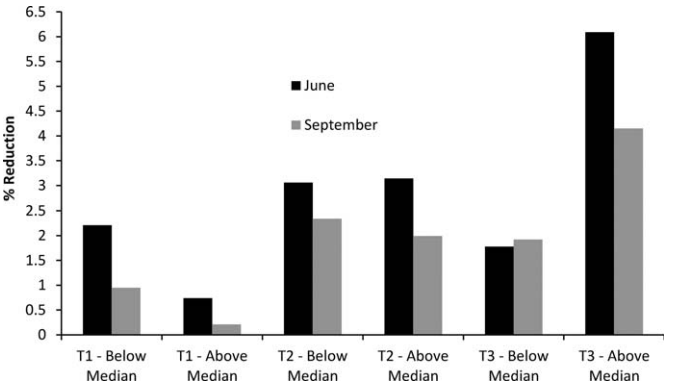
Combined, these data provide evidence consonant with previous work highlighting the impermanence of nonpecuniary incentives and suggest result 3: treatment effects are most pronounced in the month following intervention and decay over the course of the summer. For behavioral economists, result 3 adds to a mounting body of evidence from field studies suggesting that the effectiveness of incentives designed to trigger psychological processes may differ markedly across "hot" and "cold" phases of decision making. In this regard, our data accord well with Gneezy and List (2006), who show that the effects of gifts on worker effort are short-lived and decay over the course of the workday. For practitioners, result 3 suggests an important caveat on the use of norm-based management strategies: they are best reserved for situations where immediate but short-lived conservation efforts are desired. In this regard, such strategies provide a complementary measure to pecuniary-based management strategies that are often slow to implement and difficult to adjust.

Exploring this result a level deeper by examining the persistence of treatment effects across the highest- and lowest-user groups in our sample (columns C–F of table 4) suggests an important asymmetry. The observed pattern of decay is driven almost entirely by the highest-user groups, an asymmetry best illustrated in figure 3. Among the low-user group, there is no discernable difference in the strong social norm effect across months. However, among the highest-user group, we observe an approximate 31.7% reduction in the relative treatment effect (6.08% versus 4.15%) between June and September, a difference that is significant at the $p < 0.05$ level. We observe similar, albeit less pronounced, patterns in both our weak social norm and technical advice treatments.

C. *Implications for Scaling Up*

We can use the results in table 2 (model A) to estimate aggregate impacts and cost-effectiveness in a scaled-up version of the CCWS program. Had the strong social norm

FIGURE 3.—ESTIMATED TREATMENT EFFECTS, BY MONTH



message (treatment 3) been assigned to all 106,872 targeted households, summer water use in Cobb County would have been expected to decline by approximately 186 million gallons. For perspective, this reduction is the equivalent of shutting off the water to about 5,100 households. Based on the treatment costs in the experiment, CCWS would have spent $0.575 per thousand gallons reduced.[20] In contrast, if CCWS were to target only households at or above the median historical use, it could obtain 88% of the reduction for 65% of the total cost.

Given that there was no statistical difference in the estimated response to the weak and strong social norm treatments for below-median water users, we also consider a hybrid policy that assigns households with above-median historical use to the strong social norm treatment and all others to the weak social norm treatment. Importantly, such a policy would enable CCWS to target a larger set of households that includes those for which historical use data are missing. Under this hybrid policy, we estimate that CCWS would have effected an approximate 193 million gallon reduction in summer water use, equivalent to shutting off water to about 5,300 households. Although the estimated cost per thousand gallons reduced for such program would be approximately 10% higher than one focused solely on social comparisons, it would eliminate an important concern of CCWS officials: complaints from below-median users that could bring unwanted attention and controversy.[21]

V. Conclusion

Economists have only recently started to explore the effect of nonpecuniary strategies, such as appeals to prosocial behavior or the use of social comparisons, as a means to influence individual decision making and promote prosocial behaviors. Much of this work has focused on the use of such strategies in the context of charitable giving. Yet such approaches have been implemented across a broader range of economically relevant settings. This study seeks to further our understanding of such strategies by exploring whether they influence household-level consumption decisions. We do so by investigating the effectiveness of policy measures based on information transfers and prosocial messages in a large-scale, natural field experiment carried out in conjunction with a water utility system in metropolitan Atlanta.

Empirical results emphasize the importance of moral payoffs on consumption decisions. As we augment the range of channels targeted by a particular conservation strategy, scrutiny or the perceived salience of social norms, we observe greater reductions in average consumption levels. Thus, policymakers are better served targeting the why of conservation efforts rather than the how. Moreover, our results suggest that strategies based on appeals to prosocial preferences and social comparisons are most effective when targeting high-consumption groups. Yet the effectiveness of such policies is short-lived and wanes over time. For practitioners, this suggests an important caveat on the use of conservation strategies based on social comparisons or appeals to social norms: they are best reserved for situations where immediate but short-lived conservation efforts are desired.

Undoubtedly our research has raised more questions than it has answered. For example, our analysis does not elucidate the specific channels through which our treatments affect water consumption. Future work should augment our approach and focus on variations in the social comparison message to uncover the underlying behavioral mechanisms driving our results. Understanding which theoretical models best predict behavior will help policymakers identify the most effective strategies to promote conservation efforts.

In addition, the estimated average treatment effect for our strong social norm message is more than twice that observed in similar OPower programs targeting energy conservation (see Allcott, 2011; Ayres et al., 2009). Moreover, unlike these energy studies, we observe no evidence of a rebound effect among low-use households. While we would have preferred to explore these differences in greater detail, two important design differences confound a direct comparison of the results. First, the reference group to which household consumption levels are compared in our study is the median user for all of Cobb County. In contrast, the reference group for the OPower studies is significantly smaller: nearby households of similar size. Second, the home energy reports for the OPower studies include emoticons for both the lowest- and highest-user groups. The extent to which these design differences affect the ways in which households respond to social comparisons remains an open issue.

[20] If the June tip sheet mailing were excluded, costs would be approximately 45% lower. CCWS would also lose about $1.2 million to $1.3 million in forgone revenues, but the education program is designed to reduce demand, and thus presumably CCWS is aware of the potential for lost revenues. How much of these forgone revenues represents savings to consumers depends on the costs of the behavioral and technological changes made in response to treatment, which are unobservable to us.

[21] CCWS received some angry phone calls from such users who wanted to know why CCWS was not focusing attention and budget on above-median users.

Finally, our study focuses on the use of normative messages to promote changes in the way households use water. To the extent that such changes reflect behavioral adjustments that require vigilance to maintain over time, it is not surprising that the impacts of such programs wane over time as the HH's attention shifts elsewhere. Yet one can envision a similar program whereby normative appeals are used to encourage the adoption of new technologies such as low-flow shower heads or high-efficiency toilets. Such technologies affect consumption through efficiency gains rather than adjustments in patterns of use, and thus we would anticipate such a program to have a more persistent effect on demand. However, given the large up-front costs of purchasing such technologies, it is likely that any such program would affect fewer households than a program targeting behavioral adjustments. Which strategy would have a greater impact on aggregate use remains an open question. Studies that compare the relative impact of targeting technology adoption rather than end use would be a fruitful avenue for future work. We suspect that research in these areas will lead to insights hitherto uncovered and an improved understanding about the effectiveness of nonpecuniary strategies.

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