Conservation Behavior: From Voluntary Restraint to a Voluntary Price Premium*

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Abstract

This paper provides a theoretical and empirical investigation of conservation behavior that is motivated by concern for the environment. Two types of behavior are considered. First, individuals who care about environmental quality may voluntarily restrain their consumption of goods and services that generate a negative externality. Second, individuals may choose to pay a voluntary price premium for goods and services that are more "environmentally friendly." A theoretical model highlights the relationship between such voluntary restraint and a voluntary price premium. We test predictions of the model in an empirical study of household electricity consumption with introduction of a price-premium, green-electricity program. We find evidence of voluntary restraint and its relation to a voluntary price premium. The empirical results are consistent with the model of conservation behavior, as none of the theoretical predictions can be rejected.

JEL Classification Numbers: D1, Q4, Q5.

And I'm asking you for your good and for your Nation's security to take no unnecessary trips, to use carpools or public transportation whenever you can, to park your car one extra day per week, to obey the speed limit, and to set your thermostats to save fuel. Every act of energy conservation like this is more than just common sense—I tell you it is an act of patriotism.

—U.S. President Jimmy Carter, 1979

Conservation may be a sign of personal virtue, but it is not a sufficient basis for a sound, comprehensive energy policy.

—U.S. Vice-President Dick Cheney, 2001

1 Introduction

Political leaders debate whether conservation can play a meaningful role in national energy policy. Yet economists know very little about conservation itself. Without price incentives or government regulation, do people actually exhibit voluntary conservation? If so, under what circumstances? To what extent? And why? This paper provides a theoretical and empirical investigation of conservation behavior that is motivated by concern for the environment. The primary focus of environmental economics over the last three decades has been the design of policy instruments that induce agents to internalize their environmental externalities. Our approach here is different: we examine the extent to which consumers internalize their externalities *voluntarily*—through conservation that arises without policy interventions.

We develop a theoretical model of consumer behavior to explain the relationship between two potential types of voluntary conservation. The first is that consumers who care about environmental quality may demand less of a good that causes a negative externality. The second is that consumers may choose to pay a premium for goods and services that are more "environmentally friendly." We refer to these two behaviors as *voluntary restraint* and a *voluntary price premium*, respectively. After developing the model, we test its predictions in an empirical study of household demand for electricity in Traverse City, Michigan. The study period spans the date when the public utility initiated a voluntary green-electricity program to reduce air pollution emissions.[1] To participate in the program, households must agree to pay a price premium of 25 percent (on average) for their electricity consumption. The revenues from the premium are then used to finance a centralized wind turbine that displaces generation at the local coal-fired power plant. This empirical setting—which includes panel data on electricity consumption that we combine with an original household survey—provides a unique opportunity to investigate conservation behavior as it relates to voluntary restraint of conventional electricity and to a voluntary price premium for green electricity.

Prior economic research has investigated various empirical aspects of voluntary restraint in the context of energy consumption. A few studies have analyzed whether appeals for conservation following the energy crisis of 1973 had an effect on household energy use. Peck and Doering (1976) study household demand for heating fuel and find no significant effect of a conservation campaign aimed at changing residential fuel-use patterns. Other studies find different results. Walker (1980) reviews several of these studies and provides evidence in support of the hypothesis that the energy crisis stimulated conservation beyond that which can be explained by changes in price or income. Estimates of this conservation effect range from 4 percent for electricity to 10 percent for natural gas. Lee (1981) finds a similar result, with estimates ranging from 1 to 4 percent, for voluntary conservation of electricity due to a public relations campaign in the Central Valley of California during the mid-1970s.

Another line of research investigates voluntary participation in utility-sponsored conservation programs, such as energy audits, rebates, and time-of-use rates (e.g., Train, McFadden, and Goett, 1987; Hartman, 1988; Waldman and Ozog, 1996; and Baladi, Herriges, and Sweeney, 1998). While the primary incentive for enrolling in such programs is cost savings, attitudes about natural resources and conservation play a significant role in explaining household participation (Train, McFadden, and Goett, 1987).

A recent empirical literature also investigates willingness to pay a voluntary price premium for green electricity. Many of these studies employ stated- or revealed-preference techniques to derive estimates of willingness to pay for various types of green electricity

[1] "Green" electricity is electricity generated from renewable sources of energy, including wind, solar, and geothermal energy. Most conventional electricity in the United States is generated from coal, which produces several air pollutants as by-products (e.g., CO, CO_2, NO_x, SO_2, particulates, lead, and mercury).

(e.g., Goett, Hudson, and Train, 2000; Champ and Bishop, 2001; and Roe, *et al.*, 2001). Other studies analyze factors that influence participation in a particular green-electricity program (e.g., Oberholzer-Gee, 2001; Rose, *et al.*, 2002; and Clark, Kotchen, and Moore, 2003). In general, this literature finds that many households state a willingness to pay a premium for green electricity, yet actual participation in a green-electricity program depends on program structure, household characteristics, attitudes related to the environment, and the existence of "warm-glow" motives for participation.[2]

This paper makes several contributions. The theoretical model is the first to examine the relationship between voluntary restraint and a voluntary price premium. The model draws on insights from psychology research on altruism and economic research on motives for private provision of public goods. Although very simple, the model generates a series of new predictions that relate conservation based on quantities to conservation based on prices. The empirical setting of electricity consumption with introduction of a green-electricity program is ideal for testing these predictions. The data come from the combination of an original household survey and eight years of monthly panel data on household electricity consumption. An advantage of the data is its basis in revealed preferences rather than stated preferences. Furthermore, the paper goes beyond identifying differences between participants and nonparticipants in a green-electricity program; for the first time, questions are addressed about differences in behavior before and after participation. Finally, the analysis takes advantage of a natural experiment in which program participants are compared with a control group of households on the program's waiting list.

The empirical results provide evidence of voluntary restraint and its relation to a voluntary price premium. Households identified as conservationists (through membership in an environmental organization) consume approximately 10 percent less conventional electricity than nonconservationists. Conservationist households are also more likely to participate in the green-electricity program. Interestingly, upon participation in the green-electricity program, differences in electricity demand between conservationists and nonconservationists

[2] A "warm-glow" motive captures the idea that households may participate in a green-electricity program because it makes them feel good about "doing their part" to protect the environment. This motive is a private benefit that is distinct from any public benefit that may arise from reduced pollution (see Andreoni, 1989, 1990).

are no longer apparent. This occurs because the price premium for green electricity does not change consumption for conservationists, but it does change consumption for nonconservationists. The fact that participating conservationists do not change their electricity consumption suggests that the price premium for green electricity is approximately equal to the subjective externality that they were voluntarily internalizing with conventional electricity.

As for participating nonconservationists, we find a reduction in consumption as if there had been an increase in the price of conventional electricity equal to the premium for green electricity. This reduction is used to show that willingness to pay a voluntary premium for green electricity is motivated, in part, by a lump-sum benefit that is unrelated to electricity consumption. Possible explanations include psychological and social benefits related to social approval, prestige, and warm-glow satisfaction. We show that these results and others are consistent with the model of conservation behavior, as none of the theoretical predictions can be rejected by the empirical analysis.

2 A Simple Model

The extensive psychology literature on conservation behavior provides the starting point for the economic model developed here. Much of this literature is based on the model developed by Schwartz (1970, 1977) concerning the activation of norms for altruistic behavior. In general, these norms consist of the personal obligation to act in ways that prevent harm to others or that promote the welfare of others, even if it entails personal cost. Activation of these norms, however, depends critically on the presence of two beliefs: awareness that harmful consequences may come to others from inaction, and ascription of responsibility to oneself for those consequences. According to the model, individuals who possess these beliefs consider it their duty to behave altruistically; otherwise they experience a feeling of guilt from shirking their responsibility.

Psychologists have used the Schwartz model to investigate conservation behavior as it relates to electricity consumption (e.g., Black, Stern and Elworth, 1985). In this context, the necessary beliefs to motivate conservation are interpreted as awareness of pollution that arises from generating conventional electricity, and ascription of personal responsibility for some of the social costs. Because studies have repeatedly documented the importance of these beliefs for motivating household energy conservation (see Stern, 1992), the insights of the Schwartz model provide a reasonable starting point for developing an economic perspective.

Our model is based on the simplest setup capable of illustrating the relevant issues of voluntary conservation in the context of electricity consumption. We consider two types of households: conservationists and nonconservationists, where only conservationists satisfy the necessary conditions of Schwartz's norm-activation model. We then consider differences in electricity consumption between conservationists and nonconservationists, before and after introduction of a price-premium, green-electricity program.

Assume initially that only conventional electricity is available. Households seek to maximize a utility function that has the following form:

$$U\left(x_i, y_i^c; \gamma_i\right) = l\left(x_i\right) + f\left(y_i^c\right) - \gamma_i h\left(y_i^c\right),$$

where x_i is a numeraire consumption good, y_i^c is conventional electricity, and γ_i is an indicator variable such that $\gamma_i = 1$ if household i is a conservationist type, and $\gamma_i = 0$ if household i is a nonconservationist type.[3] The functional form assumptions are as follows: all functions map into R_+^1, all first derivatives are strictly positive, and the second derivatives satisfy $l'' \leq 0$, $f'' < 0$, and $h'' \geq 0$. This setup implies that, relative to nonconservationists, conservationists care about a negative aspect of their conventional-electricity consumption. We assume this is related to pollution, which causes conservationists to experience guilt from consuming conventional electricity. The functional form of $h\left(y_i^c\right)$ implies that conservationists feel strictly guiltier (at a weakly increasing rate) when they consume more conventional electricity.

Each household is endowed with exogenous income m, which (for simplicity) we assume is the same for all households. Conventional electricity is available at a constant per unit price p_c.[4] Assuming interior solutions (here and throughout), the first-order condition that

[3] Additive separability of x_i and y_i^c is only a simplifying assumption and does not affect any of the results.
[4] We first develop the model with a constant price per unit of electricity. We then show how the results generalize to situations with increasing block-rate schedules, which are common for electricity.

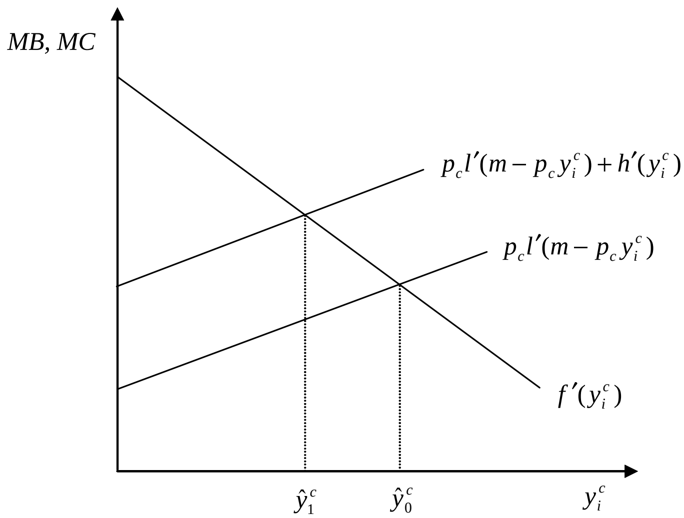

Figure 1: Voluntary restraint by conservationists

implicitly defines each household's demand for conventional electricity $\hat{y}_i^c$ can be written as

$$f'\left(\hat{y}_i^c\right) = p_c l'\left(m - p_c \hat{y}_i^c\right) + \gamma_i h'\left(\hat{y}_i^c\right). \tag{1}$$

Figure 1 illustrates the way $\hat{y}_i^c$ is determined for households of different types. For all households, $f'\left(y_i^c\right)$ is the marginal benefit of consuming conventional electricity. For nonconservationists, $p_c l'\left(m - p_c y_i^c\right)$ is the marginal cost, due to forgone consumption of the numeraire only. The marginal cost of consuming conventional electricity for conservationists, however, is $p_c l'\left(m - p_c y_i^c\right) + h'\left(y_i^c\right)$, which includes guilt as well. It follows that optimally chosen levels of conventional electricity for conservationists and nonconservationists are given by $\hat{y}_1^c$ and $\hat{y}_0^c$, respectively.

The fact that $\hat{y}_1^c < \hat{y}_0^c$ illustrates the notion of conservation behavior through voluntary restraint: the guilt from generating pollution causes conservationists to restrain their consumption of conventional electricity. We state this result in the following proposition, which provides the first testable hypothesis of the model.

Proposition 1 *Conservationist households will consume less conventional electricity than nonconservationist households.*

Now assume green electricity becomes available. Assume that households can participate in the green-electricity program only if they volunteer to pay a fixed premium of $\pi > 0$ per unit of electricity consumption, for *all* of their electricity consumption. The price of green electricity is therefore $p_g = \pi + p_c$. Green electricity and conventional electricity are perfect substitutes in all respects other than the fact that green electricity does not generate pollution.[5] As a result, conservationists have no reason to feel guilty if they consume green electricity; that is, $h(y_i^g) = 0$ for any level of green electricity y_i^g. It follows that, depending on the magnitude of π, conservationist households may choose to participate in the green-electricity program in order to avoid the guilt of generating pollution through their consumption of conventional electricity.

Other factors may also prompt households to participate in the green-electricity program. Many programs, including the one studied in this paper, offer decals for the home and car to signal participation, along with newsletters about program and participant updates. Social benefits that are unrelated to electricity consumption may therefore motivate participation; the range of possibilities includes social approval, prestige, and signaling about household income.[6] Psychological benefits, which are similarly unrelated to electricity consumption, may also play a role, as participation can be associated with the "purchase of moral satisfaction" (Kahneman and Knetsch, 1992) or a feeling of "warm glow" (Andreoni, 1989, 1990).[7]

To capture the possibility for these social and psychological benefits, we assume that, conditional on participation, each household enjoys a lump-sum benefit $k_i \geq 0$, regardless of whether the household is of the conservationist or nonconservationist type. Note that the lump-sum benefit implies that even nonconservationists may have a reason to participate.

The decision of whether to participate in the green-electricity program depends on a

[5] An implicit assumption is that the green-electricity program creates new capacity, or that the level of active capacity depends on the level of participation. This ensures that purchasing green electricity actually displaces generation of conventional electricity, and thereby causes a reduction in pollution emissions.

[6] The importance of social benefits of this type has been examined in the literature on private provision of public goods. For examples, see Hollander (1990), Glazer and Konrad (1996), and Harbaugh (1998a, 1998b).

[7] In a study of contributions to a green-electricity program in Switzerland, Oberholzer-Gee (2001) finds empirical support for such psychological benefits. He concludes that "The warm-glow part of the motivation to contribute appears to be independent of the value of the public good in the sense that individuals participate in the program even if they do not believe that their use of solar energy will improve the quality of the environment. For these individuals, it is sufficient that they contribute to a cause which they believe to be important" (p. 433).

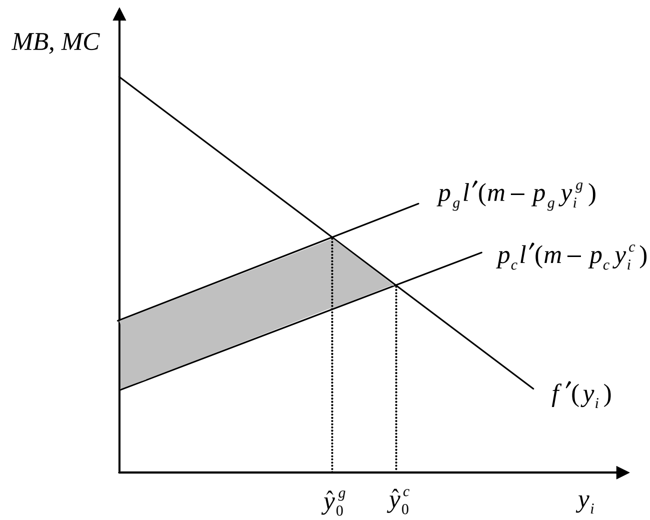

Figure 2: A nonconservationist's consumption before and after participation

comparison of two potential levels of utility. These levels can be written as

$$V^c(p_c, m; \gamma_i) \equiv \max_{y_i^c} \{l(m - p_c y_i^c) + f(y_i^c) - \gamma_i h(y_i^c)\}$$

and

$$V^g(p_g, m; \gamma_i) \equiv \max_{y_i^g} \{l(m - p_g y_i^g) + f(y_i^g) + k_i\}.$$

It follows a household will choose to participate in the green-electricity program only if $V^c(p_c, m; \gamma_i) \leq V^g(p_g, m; \gamma_i)$. But what does participation imply about the guilt from consumption of conventional electricity and the existence of a lump-sum benefit? How will participation affect the quantity of electricity consumption? And what differences in behavior will occur between participating conservationists and nonconservationists? We now turn to these questions.

Consider nonconservationist households first. It is clear that nonconservationists must enjoy a lump-sum benefit if they participate in the green-electricity program. This follows because k_i is the only benefit they enjoy from participation: unless k_i is positive, nonconservationists have no incentive to pay the price premium for green electricity. Figure 2 demonstrates this point. Demand for conventional electricity is $\hat{y}_0^c$. Then, conditional on participation, demand for green electricity will be $\hat{y}_0^g$, which must satisfy the first-order condition

$$f'(\hat{y}_i^g) = p_g l'(m - p_g \hat{y}_i^g). \tag{2}$$

Because $\hat{y}_0^c > \hat{y}_0^g$, electricity consumption declines, and there is a loss in surplus equal to the shaded area. Thus, participation requires a lump-sum benefit k_i that is large enough to offset the loss in surplus.

A further result pertaining to nonconservationists follows from the fact that k_i affects participation, but not the marginal decision about the quantity demanded of green electricity. A nonconservationist's demand for electricity is determined by price only. This implies that a nonconservationist's behavioral response to participation in the green-electricity program will be as if there had been an exogenous increase in the price of *conventional* electricity equal to the premium π. To see this, simply add π to p_c in equation (1), and note that the resulting level of $\hat{y}_i^c$ for a nonconservationist would be the same as $\hat{y}_i^g$ in equation (2).

The following proposition summarizes the results for nonconservationists.

Proposition 2 *If a nonconservationist household participates in the green-electricity program, then: (a) the household must enjoy a lump-sum benefit from participation; and (b) after participating, the household's electricity consumption will decline by as much as it would if there had been an increase in the price of conventional electricity equal to the premium for green electricity.*

Now consider conservationist households. It turns out that if the price of green electricity is sufficiently high, the necessary condition for participation is similar to that for nonconservationists. To see this, assume π is large enough so that the marginal cost curve of consuming green electricity lies above the marginal cost curve of consuming conventional electricity. Figure 3 provides an illustration with the price of green electricity set at $\bar{p}_g$. In this case, a participating conservationist will reduce electricity consumption from $\hat{y}_1^c$ to $\bar{y}_1^g$. Yet because there is a loss in surplus equal to the shaded area, participation requires an offsetting lump-sum benefit. Thus, even conservationists may require a sufficiently large lump-sum benefit in order to participate in the green-electricity program. In fact, it is straightforward to show that whenever a participating conservationist reduces electricity consumption, it must be the case that $k_i > 0$. This follows because the assumption that $h''(y_i^c) \geq 0$ implies that if $\hat{y}_1^g < \hat{y}_1^c$, there must be a loss in surplus, as the marginal cost for conventional electricity is lower than for green electricity for all $y_i < \hat{y}_1^c$. Thus, to offset the loss in surplus, participation requires a sufficiently large $k_i > 0$.

More generally, however, conservationists differ from nonconservationists because their electricity consumption need *not* fall after participating in the green-electricity program, and participation does *not* require a lump-sum benefit. Figure 3 provides an illustration with the lower price of green electricity $\tilde{p}_g$. In this case, electricity consumption increases from $\hat{y}_1^c$ to $\tilde{y}_1^g$, and participation occurs even if $k_i = 0$. This follows because there is a gain in surplus, rather than a loss. Note that, in this case, households choose to pay a *higher price* for electricity and then *consume more*. In order to understand this somewhat counterintuitive possibility, the important comparison is between the marginal guilt from consumption of conventional electricity at $\hat{y}_i^c$ and the increased marginal cost from the price premium of green electricity at the same level of electricity consumption. If the former is greater than (less than, or equal to) the latter, then electricity consumption will increase (decrease, or remain the same).[8]

The following proposition summarizes the results for conservationists.

Proposition 3 *If a conservationist household participates in the green-electricity program, then: (a) the household's electricity consumption can increase, decrease, or remain the same, and (b) if consumption decreases, the household must enjoy a lump-sum benefit from participation.*

The model generates further predictions about similarities and differences between conservationists and nonconservationists that participate in the green-electricity program. We have shown how conservationists have no incentive to voluntarily restrain their consumption of green electricity, as it generates no pollution. Conservationists and nonconservationists

[8]Considering a special case makes this idea clear. Assume utility is quasilinear in x_i (i.e., $l'(x_i) = 1$) and marginal guilt is constant such that $h'(y_i^c) = \mu$. In this case, it is straightforward to show that, electricity consumption will increase, decrease, or remain the same if $\pi < \mu$, $\pi > \mu$, or $\pi = \mu$, respectively.

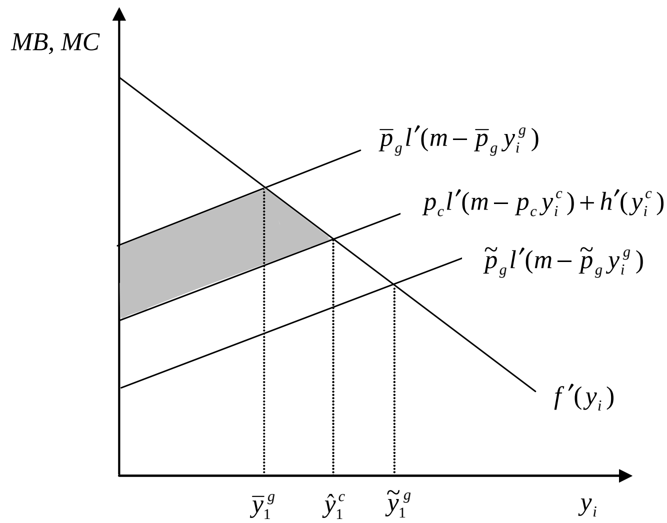

Figure 3: A conservationist's electricity consumption can increase or decrease

are therefore indistinguishable in terms of their demand for green electricity, which must satisfy equation (2) regardless of the household's type. Accordingly, a prediction of the model is that *all* participating households in the green-electricity program will consume the same amount of green electricity. Moreover, because only conservationists were exhibiting voluntary restraint before participating, the model also predicts that they will reduce their consumption by less (if at all) than nonconservationists, who will respond as if there had been an increase in the price of conventional electricity (see Proposition 2). The following proposition summarizes these additional results.

Proposition 4 *If both conservationists and nonconservationists participate in the green-electricity program, then: (a) households of both types will consume the same amount of green electricity, and (b) conservationists will reduce their electricity consumption by less (if at all) than nonconservationists.*

Thus far we have assumed a constant per-unit price of electricity. Yet residential electricity pricing is often structured with an increasing block-rate schedule. The public utility studied in the empirical portion of this paper provides such an example. So how do the results of the model change with an increasing block-rate schedule? The answer is very little. To see why, consider a two-tiered increasing block rate, where the price of conventional electricity can be written as

$$p = \begin{cases} p_c & \text{for } 0 \leq y_i^c \leq y^* \\ p_c^* & \text{for } y^* < y_i^c, \end{cases}$$

where $p_c < p_c^*$ and y^* is the quantity threshold between rates.[9] If we continue to assume a constant premium π for green electricity, it is straightforward to modify the preceding analysis to account for the block rate. Graphically, the only difference is that all marginal cost curves have a discontinuity at $y_i = y^*$; they all shift up by at least $p_c^* - p_c$ for $y_i > y^*$. After reconstructing Figures 1 through 3 with this modification, it is straightforward to see that only two results change slightly: the voluntary restraint of Proposition 1 holds with a weak (rather than strict) inequality, and the second part of Proposition 4 holds weakly (rather than strictly) as well. Both of these changes occur because of the possibility that demand is clustered at the threshold between block rates.

3 Empirical Setting and Data Collection

We test predictions of the theoretical model in an empirical study of demand for electricity, before and after introduction of a green-electricity program in Traverse City, Michigan. The municipal utility company, Traverse City Light and Power (TCL&P), provides electricity service to approximately 7,000 residential households. In 1994, TCL&P began soliciting households to voluntarily finance a centralized wind turbine that would generate electricity and replace generation at the local coal-fired power plant. TCL&P completed construction of the wind turbine and began operating the "Green Rate" program in June 1996.[10] To participate in the program, households are required to make a three-year commitment to purchase all of their electricity at a price premium of 1.58 cents per kilowatt-hour. After accounting for the block-rate pricing schedule (described below), this translates into an

[9] Although increasing block-rate schedules often include more than two tiers, consideration of a two-tiered schedule is sufficient to demonstrate the implications for the model.

[10] At the time of construction, the wind turbine was the largest operating in the United States. It produces about 800,000 kilowatt-hours of electricity per year, which can meet the needs of approximately 125 households.

average residential premium of \$8.50 per month, or a 25-percent increase in the average household's electricity bill.

This section describes the data we use for the empirical analysis. The data come from the combination of an original household survey of TCL&P customers (including Green Rate participants, nonparticipants, and those on the program's waitlist), and monthly panel data on electricity consumption between 1994 and 2002. In this section we also describe the empirical strategy of using membership in an environmental organization to distinguish between conservationists and nonconservationists.

3.1 Survey Data

We developed and administered a mail survey of TCL&P residential customers. The survey was designed to collect data on socioeconomic characteristics, physical attributes of each residence, and household behaviors related to conservation. All households received the same version of the survey instrument.[11] The survey was conducted in 2001 using the Dillman (1978) Total Design Method. A total sample of 1,000 households included those that were (at the time of the survey) participants in the Green Rate program, on the waitlist, or nonparticipants. Specifically, the sample was stratified to include all 122 households that were participants, all 32 households that were on the waitlist, and a random sample of 846 households that were nonparticipants with utility records dating back to 1994. TCL&P provided the names and mailing addresses. After accounting for undeliverable addresses, the overall response rate for the survey was 70 percent (106 participants, 27 waitlisters, and 544 nonparticipants), which is relatively high.

The existence of a waitlist for the Green Rate program is an important feature of the data because it creates a natural experiment in which to analyze the effect of a voluntary price premium. Households choose whether or not to participate in the program, but they have no control over whether they are placed on the waitlist. From the beginning, the program was oversubscribed relative to the wind turbine's capacity, so the waitlist was created at the outset. Since that time, households have been removed from the waitlist to become

[11] Copies of the survey instrument are available from the authors upon request.

Table 1: Summary statistics for participants, nonparticipants, and waitlisters

Variable	(1) Particip. N=106	(2) Waitlist N=27	(3) Nonparticip. N=544	(4) t stat. (1) vs (2)	(5) t stat. (1) vs (3)	(6) t stat. (2) vs (3)
Income	66.064	68.462	56.949	0.303	2.302**	1.663*
	(37.163)	(29.488)	(34.611)			
FamSize	2.340	2.154	2.233	0.749	0.766	0.305
	(1.193)	(0.834)	(1.310)			
Own (1=yes)	0.961	1.000	0.915	1.017	1.606	1.552
House (1=yes)	0.876	0.923	0.867	0.668	0.243	0.823
AptCondo (1=yes)	0.105	0.077	0.104	0.422	0.018	0.446
MobHome (1=yes)	0.019	0.000	0.028	0.705	0.541	0.870
Age	56.324	55.462	60.504	0.287	2.618***	1.698*
	(13.976)	(12.465)	(14.874)			
Gender (1=male)	0.500	0.577	0.525	0.697	0.462	0.517
Education	16.349	16.444	14.528	0.149	6.028***	3.467***
	(3.01)	(2.778)	(2.802)			
EnvtOrg (1=yes)	0.471	0.444	0.158	0.240	7.367***	2.883***
kWhDay	16.105	16.439	17.950	0.214	1.806*	0.572
	(6.847)	(8.258)	(10.070)			

Notes: Standard deviations are in parentheses and reported for continuous variables only. The number of observations for each statistic varies somewhat due to item nonresponse. *Income* is household pre-tax income in year 2000 measured in 1000s of dollars. *FamSize* indicates the number of family members living in the household. *Own* indicates ownership. *House*, *AptCondo*, and *MobHome* indicate house, apartment/condominium, or mobile home. *Age*, *Gender*, and years of *Education* correspond to the respondent. *EnvtOrg* indicates membership in an environmental organization. *kWhDay* is average daily electricity consumption by month, measured in kilowatt-hours. One, two, or three asterisks indicate significance at the levels $p<0.10$, $p<0.05$, or $p<0.01$, respectively.

participants only when another household withdrew from the Green Rate program. With respect to participants and waitlisters, therefore, actual participation is virtually random. We take advantage of this exogeneity in the empirical analysis, where comparisons between participants and waitlisters provide a natural experiment in which to analyze the effect of a voluntary price premium.

At this point, we compare descriptive statistics for the key survey variables among participants, waitlisters, and nonparticipants. These statistics are reported in the first three columns of Table 1, while the latter columns report the pairwise t-test statistics. A comparison of the three groups reveals two patterns. As one might expect given the discussion above, there are no significant differences between participants and waitlisters. Nonparticipants, however, differ from participants and waitlisters with respect to several variables. On average, nonparticipants have an annual household income that is about $10,000 lower, are four years older, have two fewer years of education, and are 30 percent less likely to be a self-reported member of an environmental organization.[12]

3.2 Utility Data

TCL&P began keeping electronic records of household billing cycles in 1994. Data on electricity consumption for each billing cycle were obtained from January 1994 through May 2002, for a total of 101 months. From these data, we calculated average daily electricity consumption by month for each household in the survey sample.[13] The last row of Table 1 reports descriptive statistics for this variable ($kWhDay$) for participants, waitlisters, and nonparticipants. While the means for all three groups fall between 16 and 18 kilowatt-hours per day (kWh/day), nonparticipants consume significantly more electricity than participants. This difference is 1.85 kWh/day, or just over 10 percent.

The TCL&P data also includes monthly information on residential rate schedules for

[12] Surveys were addressed specifically to the household member whose name appeared on monthly billing statements for electricity. The fact that Traverse City is somewhat of a retirement community is reflected in the relatively high mean age.

[13] Characterizing electricity consumption in this way accounts for the different number of billing days within billing cycles.

each household. The basic residential rate is an increasing block-rate schedule.[14] Four adjustments to this basic rate are then possible. The senior citizen rate (*Senior*) charges block rates that start lower and end higher.[15] The electric water heating service (*WtrHeat*) allots households an additional 13 kWh/day at the lowest rate of their rate class. Electric space heating service (*SpcHeat*) charges households only the lowest rate of their rate class on all electricity consumption for the billing months of November through May.[16] Finally, as described previously, the Green Rate (*GrnRate*) charges an additional 1.58¢/kWh for all electricity consumption. The Green Rate became available starting in June 1996. All other rate schedules remained constant throughout the study period.

3.3 Distinguishing Conservationists and Nonconservationists

Testing predictions of the theoretical model requires distinguishing between conservationists and nonconservationists. While identifying underlying preferences poses an inherent empirical challenge, we use self-reported membership in an environmental organization to identify conservationists. One advantage of this strategy is its consistency with the psychological basis of the model. Recall the underlying distinction between conservationists and nonconservationists: only conservationists are aware of environmental problems that arise through generation of conventional electricity *and* are willing to take personal responsibility for addressing the problems. While membership in an environmental organization is likely to apply to environmental concerns more generally, it is a reasonable indicator of knowledge about environmental problems and willingness to take personal responsibility.

But how is membership in an environmental organization related to specific preferences about conservation of electricity? Part of the survey was designed to answer this question, and the responses provide a test of whether using membership in an environmental organization is reasonable for identifying conservationists. Table 2 compares the responses between those with and without membership. These comparisons are based on weighted analyses to

[14] This rate charges 6.33¢/kWh for the first 16 kWh/day, 7.31¢/kWh for the next 17 kWh/day, and 8.2¢/kWh for all consumption over 33 kWh/day.

[15] This option charges increasing block rates of 5.3¢, 8.3¢, and 9.3¢.

[16] The sample percentages to which these rate adjustments apply are as follows: 23.7 percent for *Senior*, 7.3 percent for *WtrHeat*, and 1.6 percent for *SpcHeat*.

Table 2: Comparison of responses between conservationists and nonconservationists

Survey Question	Conservationists ($EnvtOrg = 1$) N=141 Mean	Std. Err.	Nonconservationists ($EnvtOrg = 0$) N=502 Mean	Std. Err.	t stat.
If you could choose among electric companies, which of the following characteristics of a company would be important to your decision?[a]					
Electricity rates	0.940	0.024	0.922	0.013	0.677
Reliability of electric service	0.918	0.029	0.865	0.016	1.587
Environmental impacts of electricity production	0.951	0.024	0.563	0.024	11.516***
Customer service	0.790	0.044	0.717	0.022	1.488
Community involvement of company	0.449	0.053	0.313	0.022	2.344**
When considering the purchase of a major appliance, how important to you is energy efficiency compared to price?[b]	3.304	0.079	3.138	0.035	1.931*
Which of the following energy-saving activities does your household engage in?[a]					
Regularly turn off lights in unused rooms	0.937	0.025	0.962	0.009	0.929
Keep thermostat at a low temperature in winter	0.792	0.043	0.702	0.022	1.876*
Conserve on air conditioning in summer	0.456	0.052	0.381	0.023	1.311
Reduce temperature setting on water heater	0.580	0.052	0.387	0.023	3.395***
Add insulation in home	0.666	0.049	0.521	0.024	2.635***
Install energy-saving lights	0.461	0.052	0.247	0.021	3.806***
How much electricity do you think your household uses compared to other households of similar size and characteristics?[b]	2.474	0.090	2.674	0.038	-2.042***

Notes: Statistics are based on weighted responses to correct for stratified sampling. Number of observations for each statistic varies somewhat due to item nonresponse. [a]Responses for each item are coded as 1=yes and 0=no. [b]Responses are based on a Likert scale ranging from 1=much less to 5=much more. One, two, or three asterisks indicate significance at the levels p<0.10, p<0.05, or p<0.01, respectively.

account for oversampling of participants and waitlisters in the Green Rate program. The first set of questions listed in the table ask about what company characteristics would be important to consider if given the opportunity to choose between different electric companies. While the responses of members and nonmembers do not differ significantly with respect to electricity rates, reliability, and customer service, the responses do differ significantly with respect to the environmental impacts of electricity production and community involvement of the company, with members caring more about both. Responses to the second question indicate that members place significantly more importance on energy efficiency compared to price when purchasing a major appliance. Responses to the third set of questions indicate that members also engage in more energy-saving activities, which range from temperature settings to capital investments. Finally, responses to the last question indicate that members perceive their own household to use less electricity than other households of similar size and characteristics. Note that this last result corresponds directly with the notion of voluntary restraint, which we test formally in the next section.

We also compared responses to these same questions within the samples of only participants or nonparticipants. This approach controls for participation in the Green Rate program and allows us to isolate differences that are due to membership in an environmental organization. The results for both participants and nonparticipants follow the same pattern as those in Table 2, so we do not report them separately. These results provide further evidence that the classification as either conservationist or nonconservationsist is distinct from participant or nonparticipant. That is, "participating nonconservationists" are not misidentified conservationists, and "nonparticipating conservationists" are not misidentified nonconservationists.

In sum, the differences in responses between members and nonmembers of an environmental organization provide support for using membership as a proxy variable to distinguish between conservationists and nonconservationists with respect to electricity consumption. With this result, we can begin testing the theoretical predictions of the model. Interestingly, part of the analysis evaluates whether the statements summarized in Table 2 translate into behaviors that actually affect electricity consumption.

4 Econometric Specification and Estimation

The predictions of the theoretical model relate to differences in electricity consumption along two dimensions: between conservationists and nonconservationists, and before and after participation in the Green Rate program. We test these predictions using our survey and utility data. In this section we specify the empirical models and describe our estimation strategies.

We employ a difference-in-differences methodology and estimate regression models of the general form

$$\begin{aligned} kWhDay_{it} &= \varphi EnvtOrg_i + \alpha GrnRate_{it} + \delta EnvtOrg_i \cdot GrnRate_{it} \\ &\quad + \mathbf{X}_{it}\boldsymbol{\beta} + \lambda_t + \nu_i + \varepsilon_{it}, \end{aligned} \tag{3}$$

where i indexes households, t indexes time periods, $GrnRate_{it}$ is a dummy variable that equals 1 when the household is participating in the Green Rate program and 0 otherwise, and $\mathbf{X}_{it}$ is a row vector of other explanatory variables (including income, the other rate-class schedules, and household characteristics).

The key parameters for testing the theoretical propositions in Section 2 are φ, α, and δ, which are interpreted as follows: φ estimates the average difference in *conventional*-electricity consumption between conservationists and nonconservationists; α estimates nonconservationists' average change in electricity consumption after participating in the green-electricity program; and δ estimates the average difference between conservationists' and nonconservationists' change in electricity consumption after participating in the green-electricity program. Two linear combinations of these parameters are also of interest: $\alpha + \delta$ estimates conservationists' average change in electricity consumption after participating in the green-electricity program; and $\varphi + \delta$ estimates the average difference in *green*-electricity consumption between participating conservationists and participating nonconservationists.

The coefficients in equation (3) are estimated several ways. First we use a random effects model that includes all of the observations (participants, waitlisters, and nonparticipants). The primary advantage of the random effects model is that it enables identification of the coefficient on $EnvtOrg_i$, which is a time-invariant variable. This is not possible with the alternative of a fixed effects model. Yet, to ensure consistency of the random effects estimator, we need to assume that the unobserved effect v_i is uncorrelated with the observed explanatory variables (see Wooldridge, 2002). To test whether this assumption is reasonable, we also estimate a fixed effects model using the same observations and compare its results to those of the random effects model.

The random effects estimates are reported as the Full Sample model in Table 3. We regress average daily electricity consumption on the variables listed in equation (3) along with other variables that are hypothesized to influence household electricity consumption. The other variables are the following: household income; dummy variables for the additional rate-class schedules ($Senior$, $WtrHeat$, $SpcHeat$); the variables listed in Table 1 that relate to sociodemographic characteristics and the physical attributes of each residence; and dummy variables to control for different months and years (not reported). The fixed effects estimates are reported as the Full Sample model in the Appendix.[17]

We report two sets of standard errors for all of the econometric models. A recent paper by Bertrand, Duflo, and Mullainathan (2004) demonstrates how failure to account for potential serial correlation in difference-in-differences estimation results in underestimates of the true standard errors. Here we follow their recommended solution by estimating standard errors based on block bootstraps, where we draw 200 bootstrap samples and also account for stratified sampling among nonparticipants, participants, and waitlisters. To see the effect of this correction, we report both the conventional and block bootstrap standard errors for all models. As expected, accounting for serial correlation generally increases the standard errors, yet the effect is not large enough to change our main conclusions with respect to hypothesis tests.

A potential concern with the Full Sample models relates to possible endogeneity of $GrnRate_{it}$. Because participation in the Green Rate program requires households to pay a premium on all of their electricity consumption, it is possible that electricity consumption

[17] All time invariant variables are dropped from the fixed effects model because their coefficients cannot be identified. The similarity of estimable parameters—especially $\hat{\alpha}$ and $\hat{\delta}$—suggest that the additional assumption about v_i in the random effects model is not restrictive. Moreover, a Hausman test of comparing both sets of estimates fails to reject the null hypothesis that the coefficients are the same in both models.

could affect $GrnRate_{it}$, whereby low consumption households are more likely to participate and thus face the price premium. We address this concern in two ways. First, we simply argue that endogeneity should not be a problem. Our reasoning is that the econometric model controls for observable characteristics that are thought to affect household electricity consumption, and we control for unobservable heterogeneity with v_i. Thus, endogeneity would only arise to the extent that participation decisions for the Green Rate program are based on a household's anticipated changes in electricity consumption. While this is possible, our opinion is that the effect of such anticipated changes is likely to be small or nonexistent.

The second way we address the concern about possible endogeneity is to estimate models using subsets of the observations and to compare the results with those for the Full Sample models. One specification is identical to equation (3), but includes only the participants and waitlisters; that is, nonparticipants are excluded from the estimation. As described previously, participants and waitlisters provide a natural experiment in which to test the effect of $GrnRate_{it}$. This follows because all households in both groups decided to participate, but actual participation was determined exogenously. With this subset of observations, we can identify all of the parameters with the exception of $SpcHeat$, which does not apply to any of the households. The results of the random effects estimator are reported as the Natural Experiment model in Table 3, and the results of the fixed effects estimator are reported in the Appendix.[18]

Another model that we estimate considers only time periods prior to establishment of the Green Rate program. This includes all observations between January 1994 and July 1996 for all three groups (participants, waitlisters, and nonparticipants). With this subset of data, we can ignore the Green Rate program entirely and focus on estimating the extent of voluntary restraint, albeit over a shorter duration of time. The general form of the specification is

$$kWhDay_{it} = \varphi EnvtOrg_i \; + \mathbf{X}_{it}\boldsymbol{\beta} + \lambda_t + \nu_i + \varepsilon_{it}, \tag{4}$$

which differs from equation (3) because $\alpha = \delta = 0$. The random effects and fixed effects

[18] As with the Full Sample models, we fail to reject the null hypothesis with a Hausman test, and the estimated coefficients on $GrnRate_{it}$ and $EnvtOrg_i \cdot GrnRate_{it}$ are very similar between the two models.

estimates of equation (4) are reported as the Before Program models, in Table 3 and the Appendix, respectively.[19]

5 Empirical Results

In this section we discuss the econometric results as they relate to the theoretical propositions. We focus on the random effects models because they allow identification of all parameters of interest and, when comparisons are possible, generate results that are very similar to those for the fixed effects models. The Full Sample, Natural Experiment, and Before Program models are referred to hereafter as the FS, NE, and BP models, respectively.

Voluntary Restraint. Proposition 1 predicts that conservationists will consume less *conventional* electricity than nonconservationists. The estimate of $\hat{\varphi}$ in the FS model supports this prediction; it is negative and statistically significant, indicating that households with membership in an environmental organization (conservationists) consume less conventional electricity. The magnitude of this difference is -1.591 kWh/day on average, which is a 9-percent reduction from the predicted level of average household consumption. With the FS model, therefore, we find evidence of substantial voluntary restraint: controlling for observed and unobserved heterogeneity, conservationists consume an average of 9 percent less conventional electricity than nonconservationists.

The same result does not emerge in the NE model. While the estimate of $\hat{\varphi}$ is negative, it is not statistically different from zero. One reason for the difference may be the fact that electricity demand for participants and waitlisters is very close to the threshold (of 16 kWh/day) between the first and second block rates, whereas this is not the case for nonparticipants (see Table 1). This reduces the predicted level of average household consumption from approximately 17.8 kWh/day in the FS model to approximately 16.3 kWh/day in the NE model. In such cases—where demand is clustered at the threshold between block rates—we have shown previously that the theory does *not* predict differences in consumption between conserva-

[19] In this case, comparisons between the random and fixed effects estimators are limited because so few parameters can be identified with fixed effects. We nevertheless report both sets of results in the interest of completeness.

Table 3: Random effects models of household electricity consumption

	(FS) Full Sample		(NE) Natural Experiment		(BP) Before Program	
Variable	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
EnvtOrg ($\hat{\varphi}$)†	-1.591	(0.852)**	-0.236	(1.162)	-1.739	(0.971)**
		[0.715]**		[1.101]		[0.713]**
GrnRate ($\hat{\alpha}$)†	-0.701	(0.208)***	-1.541	(0.192)***	–	–
		[0.518]*		[0.549]***		–
EnvtOrg·GrnRate ($\hat{\delta}$)†	0.560	(0.293)**	0.623	(0.217)***	–	–
		[0.787]		[0.698]		–
Senior	-0.336	(0.337)	-0.427	(0.563)	-0.771	(1.168)
		[0.504]		[0.963]		[0.701]
WtrHeat	-0.764	(0.567)	5.288	(3.307)	0.197	(1.528)
		[2.201]		[2.340]**		[0.953]
SpcHeat	6.497	(0.429)***	–	–	5.510	(0.916)***
		[4.394]		–		[6.744]
Income	0.051	(0.012)***	0.034	(0.020)*	0.042	(0.014)***
		[0.014]***		[0.020]*		[0.016]***
FamSize	1.181	(0.173)***	2.037	(0.217)***	1.711	(0.310)***
		[0.564]**		[0.842]**		[0.513]***
Own	2.418	(1.541)	0.496	(3.612)	2.584	(1.864)
		[1.122]**		[3.268]		[1.358]*
AptCondo	-4.302	(1.342)***	-5.908	(2.148)***	-3.846	(1.569)**
		[0.957]***		[1.479]***		[1.064]***
MobHome	-1.909	(2.299)	5.132	(4.532)	-0.588	(2.611)
		[1.720]		[39.16]		[2.421]
Age	-0.019	(0.026)	0.062	(0.043)	0.022	(0.036)
		[0.032]		[0.083]		[0.024]
Gender	1.332	(0.709)*	-1.743	(1.255)	1.521	(0.808)*
		[0.564]**		[1.214]		[0.641]**
Education	0.154	(0.143)	0.186	(0.233)	0.148	(0.163)
		[0.117]		[0.212]		[0.114]
Month dummies	Yes		Yes		Yes	
Year dummies	Yes		Yes		Yes	
Observations	59,731		11,875		16,072	
Households	637		127		596	
Predicted $\overline{kWhDay_{it}}$	17.755		16.257		17.996	

Notes: The dependent variable is average daily electricity consumption by month, $kWhDay_{it}$. Conventional standard errors are in parentheses; block bootstrap standard errors are in brackets. *House* is the omitted category with respect to *AptCondo* and *MobHome*. Missing data for all survey variables other than *EnvtOrg* were filled with the means corresponding to the household's status as a participant, waitlister, or nonparticipant. The † indicates significance level based on a one-tailed test. One, two, or three asterisks indicate significance at the levels $p<0.10$, $p<0.05$, or $p<0.01$, respectively.

tionists and nonconservationists. Other possible reasons for the insignificance of voluntary restraint in the NE model include the facts that the number of observations is substantially lower, and that there is less variation in $EnvtOrg_i$ when nonparticipants are excluded. For all of these reasons, we argue that the NE model does not generate the most reliable estimate of voluntary restraint.

The BP model provides a better alternative to compare with the FS model. While the panels in the BP model are limited to observations prior to June 1996, there is greater cross-sectional variation, as participants, waitlisters, and nonparticipants are all included. The estimate of $\hat{\varphi}$ in the BP model is -1.739, and it is statistically different from zero, suggesting again that conservationists consume less conventional electricity than nonconservationists. The difference is an average of 1.739 kWh/day, which translates into a 9.6-percent reduction from the model's predicted level of average household consumption. This result is very similar to that for the FS model and thereby provides further evidence of substantial voluntary restraint.

Nonconservationists. The first part of Proposition 2 shows that nonconservationists will participate in the Green Rate program only if they derive a sufficiently large lump-sum benefit. The fact that many households without membership in an environmental organization actually participated is suggestive of this benefit. The second part of Proposition 2 enables a more sophisticated test, however. The prediction is that participating nonconservationists will reduce their electricity consumption, and the magnitude of their reduction will be as if there had been an increase in the price of conventional electricity equal to the green-electricity premium. The estimates of $\hat{\alpha}$ test this prediction. In both the FS and NE models, $\hat{\alpha}$ is negative and statistically significant, indicating that participating nonconservationists do in fact reduce their electricity consumption. The average magnitude of this reduction is 0.701 and 1.541 kWh/day, or 3.9 and 9.5 percent from the predicted means, for the FS and NE models, respectively.

But how do these estimates for reduced electricity consumption compare to what would have occurred with only an increase in the price of conventional electricity equal to the premium of 1.58¢/kWh? To answer this question, we derive price elasticities based on the voluntary premium and compare them to previously published estimates of the price elasticity for conventional electricity. We calculate the elasticities using the percentage change in the average price. This approach provides a straightforward way to account for the block-rate pricing and is consistent with much of the literature on estimating electricity demand.[20] Our estimates of the voluntary-price elasticity are -0.16 for the FS model and -0.38 for the NE model. The higher estimate for the NE model reflects the fact that participants and wait-listers consume less electricity on average, yet the estimate for $\hat{\alpha}$ is larger, thereby resulting in a larger percentage change in consumption.

It turns out that both estimates of the voluntary-price elasticity are well within the range of the price elasticities for conventional electricity that are reported in the literature, which generally fall between -0.1 and -0.7 (for reviews see Bohi and Zimmerman, 1984, and Berndt, 1991). We therefore cannot reject the hypothesis that participating nonconservationists respond as if there had only been an increase in the price of conventional electricity. Recall that, in the context of the theoretical model, this result implies that participation is motivated by a lump-sum benefit, due possibly to the social and psychological benefits described earlier.

Conservationists. What happens to the electricity consumption of participating conservationists? The first part of Proposition 3 identifies the possibility for an increase, a decrease, or no change in electricity consumption. Here the econometric results provide evidence of no change in consumption. The average change in consumption for a participating conservationist is given by the linear combination of $\alpha + \delta$ in specification (3). Estimates of this linear combination are -0.141 and -0.918 kWh/day for the FS and NE models, respectively. While both estimates of the linear combination are negative, neither is statistically different from zero.[21] Thus, conservationists—who were already exhibiting voluntary restraint—exhibit no statistically significant change in consumption after participating in the Green Rate program. In other words, participation has an insignificant effect on conservationists' demand for electricity. In the context of the theoretical model, this implies that the price premium

[20] See Bohi and Zimmerman (1984) for a discussion and literature review.

[21] A Wald test, using either set of standard errors, fails to reject the null hypothesis that $\hat{\alpha} + \hat{\delta} = 0$ in both the FS and NE models.

for green electricity is approximately equal to the subjective externality that conservationists were voluntarily internalizing with conventional electricity. The result may also reflect greater inelasticity of demand for conservationists, as they are already exhibiting voluntary restraint.

Conservationists versus nonconservationists. Proposition 4 makes two predictions about the relationship between conservationists and nonconservationists. The first prediction is that participating conservationists will reduce their electricity consumption by (weakly) less than participating nonconservationists. This prediction implies a positive coefficient $\hat{\delta}$ on the interaction term *EnvtOrg·GrnRate*. In both the FS and NE models, the coefficient is positive and approximately equal to 0.6. While both estimates are statistically significant with the conventional standard errors, accounting for serial correlation with the block bootstrap standard errors renders them both statistically insignificant.

The second prediction of Proposition 4 is that, after controlling for other factors, conservationists and nonconservationists who participate in the Green Rate program will consume the same amount of green electricity. We test this prediction with the hypothesis that $\hat{\varphi} + \hat{\delta} = 0$. Estimates of this linear combination are -1.031 and 0.387 kWh/day for FS and NE models, yet Wald tests reveal that neither estimate is statistically different from zero. Thus, the two types of households are indistinguishable with respect to green-electricity consumption. According to the theoretical model, this similarity occurs because conservationists have no reason to voluntarily restrain their consumption of green electricity, as it generates no pollution.

Other determinants of electricity consumption. The remaining coefficients in Table 3 provide information about other factors that influence electricity consumption. Among the adjustments to the basic-rate schedule, there is evidence that electric heating affects consumption in the expected way. Based on the FS and BP models, the coefficient on *SpcHeat* is positive, indicating that households use more electricity in the months when heating is required. This effect is not statistically significant, however, after accounting for serial correlation. Households with higher income consume significantly more electricity, and the implied income elasticities are 0.16, 0.13, and 0.13 in the FS, NE, and BP models.[22] The number of family members living in the household has a positive and significant effect on electricity consumption. Electricity consumption is significantly lower in apartments and condominiums compared to houses; whereas, mobile homes are not significantly different from houses. Home ownership does not have a significant effect on electricity consumption, nor do the sociodemographic characteristics of age and education. Gender does have a significant effect in the FS and BP models, and the positive coefficient indicates that a female name on billing statements is associated with lower electricity consumption. Although not reported, the year dummies exhibit no general trend, while the month dummies indicate more electricity consumption during the winter months. This latter result is to be expected in places like Traverse City, where the number of daylight hours is substantially lower in the winter, and air-conditioning is not common in the summer.

6 Summary and Conclusion

This paper investigates the way in which concern for the environment translates into predictable patterns of household behavior. Three questions provide the focus of analysis: Do preferences for environmental quality result in the voluntary restraint of consumption? What explains willingness to pay a premium for environmentally friendly goods and services? And what is the relationship between such voluntary restraint and voluntary price premiums? To answer these questions, we develop a theoretical model of conservation behavior and test its predictions in an empirical study of household electricity consumption with introduction of a voluntary green-electricity program.

The theoretical model starts with the distinction between conservationists and nonconservationists. Only conservationists care about environmental quality in a way that promotes concern about the effects of their consumption decisions on the environment. This concern—motivated perhaps by guilt alone—translates into the voluntary restraint of consumption; that is, conservationists consume lower quantities of pollution-generating goods and ser-

[22] These elasticity estimates are well within the range of income elasticities reported in the literature for electricity demand (for reviews see Bohi and Zimmerman, 1984, and Berndt, 1991).

vices, such as conventional electricity. While voluntary restraint is conservation based on the choice of quantities, the model also considers conservation based on the choice of prices. When the opportunities are available, the desire to avoid generating pollution may translate into payment of a voluntary premium for substitute goods and services that are more environmentally friendly, such as green electricity.

An additional feature of the model is that willingness to pay a voluntary price premium is motivated by more than just the desire to reduce pollution. Social and psychological benefits also play a role. These benefits may be related to social approval, prestige, and warm glow—the same motives that have been shown to motivate private provision of public goods. For both conservationists and nonconservationists, these potential motives are captured with a lump-sum benefit that arises from paying a voluntary price premium. According to the model, therefore, both conservationists and nonconservationists may be willing to pay a voluntary price premium, whereas only conservationists exhibit voluntary restraint.

The empirical portion of the paper analyzes household electricity demand before and after introduction of a green-electricity program. The analysis takes advantage of original survey data and utility data to estimate differences in electricity consumption between conservationists and nonconservationists, before and after participation in the green-electricity program. Furthermore, the empirical setting provides a unique natural experiment in which program participants are compared to a control group of households on the program's waiting list.

The econometric results are consistent with the theoretical predictions. There is evidence of substantial voluntary restraint, as conservationists consume almost 10 percent less conventional electricity than nonconservationists. Conservationists are also more likely to participate in the green-electricity program. Other results are based on changes in electricity consumption after paying the voluntary price premium for green electricity. Nonconservationists are found to reduce their consumption after participating in the program. In particular, they reduce consumption as if there had been an increase in the price of conventional electricity equal to the premium for green electricity. In the context of the model, this result is consistent with the existence of social and psychological benefits of the green-electricity program that are unrelated to electricity consumption. In contrast, conservationists, who were already exhibiting voluntary restraint, do not reduce their electricity consumption after paying the price premium for green electricity. This result is consistent with the price premium for green electricity being approximately equal to the subjective externality that conservationists were voluntarily internalizing with conventional electricity. Finally, there is evidence that conservationists and nonconservationists are indistinguishable with respect to consumption of green electricity. The theory underlying this result is that voluntary restraint does not apply to environmentally friendly goods and services.

To conclude, the theoretical analysis provides new insight into the economics of voluntary conservation. While the primary focus of environmental economics has been the design of policy instruments to induce internalization of environmental externalities, this paper examines the extent to which consumers internalize their externalities voluntarily. Understanding behavior of this type is important, as it opens the door to consideration of the potential ways in which voluntary conservation can serve as a complement or substitute for more centralized forms of energy and environmental policy. The theoretical model generates a series of novel predictions about the relationship between voluntary restraint and voluntary price premiums. We find empirical support for all of the theoretical predictions. Future research should investigate whether these findings are robust to consumption of different goods and services. Opportunities for such research are increasingly available, as markets for environmentally friendly goods and services continue to expand.

Appendix Table: Fixed effects models of household electricity consumption

	(FS) Full Sample		(NE) Natural Experiment		(BP) Before Program	
Variable	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
EnvtOrg ($\hat{\varphi}$)†	–	–	–	–	–	–
		–		–		–
GrnRate ($\hat{\alpha}$)†	-0.610	(0.210)***	-1.519	(0.193)***	–	–
		[0.518]		[0.615]**		–
EnvtOrg·GrnRate ($\hat{\delta}$)†	0.494	(0.296)**	0.609	(0.218)***	–	–
		[0.750]		[0.785]		–
Senior	-0.286	(0.356)	-0.693	(0.587)	–	–
		[0.515]		[0.927]		–
WtrHeat	-1.024	(0.620)*	–	–	–	–
		[2.814]		–		–
SpcHeat	6.369	(0.430)***	–	–	5.264	(0.927)***
		[4.530]		–		[7.048]
Income	–	–	–	–	–	–
		–		–		–
FamSize	0.768	(0.207)***	1.947	(0.233)***	1.781	(0.623)***
		[0.659]		[0.963]**		[1.356]
Own	–	–	–	–	–	–
		–		–		–
AptCondo	–	–	–	–	–	–
		–		–		–
MobHome	–	–	–	–	–	–
		–		–		–
Age	0.057	(0.120)	0.045	(0.138)	-0.174	(0.678)
		[0.293]		[0.517]		[0.530]
Gender	–	–	–	–	–	–
		–		–		–
Education	–	–	–	–	–	–
		–		–		–
Month dummies	Yes		Yes		Yes	
Year dummies	Yes		Yes		Yes	
Observations	597,31		11,875		16,072	
Households	637		127		596	

Notes: The dependent variable is average daily electricity consumption by month, $kWhDay_{it}$. Conventional standard errors are in parentheses; block bootstrap standard errors are in brackets. *House* is the omitted category with respect to *AptCondo* and *MobHome*. Missing data for all survey variables other than *EnvtOrg* were filled with the means corresponding to the household's status as a participant, waitlister, or nonparticipant. The † indicates significance level based on a one-tailed test. One, two, or three asterisks indicate significance at the levels $p<0.10$, $p<0.05$, or $p<0.01$, respectively.

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