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The private provision of public goods: tests of a provision point mechanism for funding green power programs

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Abstract

This paper utilizes laboratory and field experiments to test the use of a provision point mechanism to finance renewable energy programs. The mechanism solicits discrete contributions towards a provision threshold using a money-back guarantee for insufficient contributions and extended benefits for contributions in excess of the threshold. In the single shot, large group laboratory environment, contribution levels are found to be partially demand revealing as well as motivated by other-regarding behavior. In the field, relatively high participation is found. Furthermore, field participation is shown to be responsive to the provision point mechanism as well as program goals.

JEL classification: H41 public goods; C92 design of experiments, laboratory, group behavior; C93 design of experiments, field experiments; Q41 energy demand and supply; Q42 alternative energy sources

Keywords: Public goods; Provision point; Green pricing; Experiments; Altruism

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1. Introduction

Market research has uniformly predicted substantial customer interest in paying higher electric power rates to support renewable energy generation and environmental programs. However, experience with green pricing indicates that participation levels have fallen well short of predictions (Byrnes et al., 1995, 1999; Farhar and Houston, 1996).[1] Three explanations for this discrepancy seem possible. First, market research studies of predicted program support may have been upwardly biased due to their hypothetical nature. Second, most utility customers may have been unaware of such programs, in spite of attempts by electric utilities to inform them using bill inserts, mailed brochures and advertising. Carrying out market research necessarily informs customers of a potential green-pricing program, creating perfect awareness concerning the program in the sample population. As a result, forecasts derived from market research depend critically on assumptions about customer awareness, which in turn depend on the effectiveness of marketing. Lastly, because participation has commonly been structured as a charitable voluntary contribution, actual customer participation in green programs may have been lowered by free-riding, typical public good behavior which confounds private provision.

Over the last decade, provision point mechanisms have been shown to have desirable theoretical properties (Bagnoli and Lipman, 1989) and to substantially reduce free-riding in experimental tests when compared to the voluntary contribution mechanism (VCM) (Isaac et al., 1989; Suleiman and Rapoport, 1992; Dawes et al., 1986). There have even been anecdotal reports of provision points being used to successfully resolve actual free-riding problems (Bagnoli and McKee, 1991). In addition, innovations of the provision point mechanism, such as the money-back guarantee and rebate rules, have been found to increase contributions and provision frequency in experimental settings (Isaac et al., 1989; Rapoport and Eshed-Levy, 1989; Cadsby and Maynes, 1999; Marks and Croson, 1998).

Motivated in part by this literature, as well as by recent utility industry interest in voluntarily funded green power programs (see Holt and Associates' *Green Pricing* and *Green Power* newsletters), this paper analyzes a provision point mechanism using a paired laboratory and green pricing field application. The specific mechanism was implemented in the field in the Niagara Mohawk Power Corporation (NMPC) GreenChoice™ program. The parallel design of the two experiments allows us to investigate the demand revelation properties of the funding mechanism, as well as contributor characteristics and the role of the green-pricing mechanism features and program objectives. The laboratory experiment analyzes what participants do with their values, while the field experiment analyzes the factors underlying participant actions and values.

Both theoretical and experimental economists, not to mention financially constrained government agencies, have long hoped for a practical mechanism for the private funding of public goods (see for example, Groves and Ledyard, 1977; Smith, 1979). This research is designed to test whether attainment of this goal can be furthered with a provision point mechanism.

[1] See Baugh et al. (1995) for a detailed discussion of green pricing programs. This discrepancy between hypothetical and actual willingness to pay is frequently observed in the contingent valuation literature (Brown et al., 1996; Cummings et al., 1995, 1997; Loomis et al., 1996; Neill et al., 1994; Seip and Strand, 1992).

In Section 2 we provide the specifics of the NMPC GreenChoice™ program and the provision point mechanism used. The third section replicates the NMPC mechanism in a laboratory experiment, where in contrast to the field application, the real worth of the program to participants is known. The hypothesis that this provision point mechanism reduces free-riding is tested by comparing individual and group contributions relative to induced values.[2] A random utility model is used to predict the probability of individual participation as a function of induced value. We find that free-riding is not entirely eliminated. However, the probability of participation, at a fixed price, is positively correlated with induced value. This suggests that the mechanism is at least partially demand revealing. Also, what appears to be other-regarding behavior, such as altruism or warm-glow, offsets the negative provision consequences of free-riding.

In Section 4, we describe the field experiment and estimate a random utility model of actual program participation on the basis of individual respondent characteristics. Complete awareness is assured in the sample population by phoning customers, describing the GreenChoice™ program, and allowing them to sign-up or decline the offering while still on the phone. Hence, unawareness, a problem that plagues participation rates in actual programs, is eliminated as a reason for non-participation. Sign-up rates observed in the field experiment are much higher than those realized by previous green-pricing programs that solicit voluntary contributions. In addition, the funding mechanism features and program objectives are found to be important determinants of participation. Finally, Section 5 presents our conclusions and discusses some remaining issues concerning the use of provision points in the private provision of public goods.

2. The Niagara Mohawk Power Corporation GreenChoice™ program

NMPC, a public utility in New York state, sought to accelerate the development of renewable energy sources of electricity by offering its customers "green rates" as proposed by Moskovitz (1992, 1993). Moskovitz argued that customers would voluntarily sign-up and agree to pay higher electricity rates if the additional money collected were earmarked to support renewable energy projects or other environmental activities. Economists were quick to point out that the selection of such a rate by a customer would be a charitable contribution since the mechanism proposed by Moskovitz would allow free-riding (see Schulze, 1994).[3] NMPC in turn developed the GreenChoice™ program, which employs a modified contribution mechanism in an attempt to reduce free-riding incentives. The parameters of the GreenChoice™ program (i.e. the field experiment), as well as of the laboratory experiment, are summarized in Table 1. The laboratory experiment parameters will be discussed in Section 3.

[2] In a series of papers, Palfrey and Rosenthal (1984, 1988, 1991) develop theoretical models of contributions to public goods when individuals face the binary choice of contributing either a posted price or nothing. The complex environment under consideration in our experiment (a large group, heterogeneous valuations, and incomplete information about others preferences) precludes a direct test of this theory. In addition, Palfrey and Rosenthal analyze environments with homogeneous values, hence demand revelation is not considered.

[3] In designing this program, NMPC asked William Schulze to suggest mechanisms to reduce free-riding in green-pricing programs (Schulze, 1994).

Table 1
Field and laboratory experiment parameters

	Field experiment[a]	Laboratory experiment
Product	A landfill gas project that replaces fossil fuel generation of electricity for 1200 homes and plants 50,000 trees plus any extended benefits	The induced values of the entire group plus any extended benefits
Group size	1.2 million[b]	100
Provision point		
Number of participants needed to meet the provision point	12,000	40
Percentage of group	1%	40%
Dollar amount	$864,000	$300
Money-back guarantee	Full refund if provision point not met after a year	Full refund if provision point not met
Extended benefits	Additional renewable energy or trees in proportion to the additional funds collected	A total of $3 for the group ($0.03 × 100) for each additional contributor beyond the provision point
Cost of participation (per participant)	$6 per month	$3

[a] While signing-up customers, NMPC was to receive competitive bids on renewable energy projects. The field experiment product listed in the table—a landfill gas project and 50,000 trees—and the associated provision point and extended benefits were presented to participants as an example of the type of program that could be implemented.

[b] The group size reflects NMPC's entire household customer base and was the group size number presented to field experiment participants during their surveys. As noted in the text, the sample size for the field experiment was 206 households.

The mechanism adopted by NMPC employed three features that have been tested in the experimental literature. First, the mechanism contained a *provision point* of $864,000, which was to be raised through customer contributions. This minimum level of funding would provide for the construction of a renewable energy facility to serve 1200 homes and for the planting of 50,000 trees in the NMPC service area. The addition of a provision point adds multiple, efficient Nash equilibria at the threshold, and has been shown to increase individual pledges towards the provision of public goods. Unfortunately, unlike the VCM, if the threshold is not met, a provision point results in a complete loss of efficiency (Isaac et al., 1989). A provision point is a practical tool for stating the minimum requirements for supply of a good, giving a degree of accountability for provision, increasing a user's stake in provision, and decreasing free-riding expectations (Bagnoli and Lipman, 1989). Also, the provision point inherently provides greater product definition. Market researchers advocate product definition so participants clearly understand what they will receive in return for their contributions. [4]

[4] Macmillan et al. (1996) find a preference for environmental projects with greater certainty. A general affinity for more certain benefits is an essential element of Kahneman and Tversky's (1979) "prospect theory".

Second, NMPC's funding mechanism offered a money-back guarantee to customers, which assured them that all money collected would be refunded if contributions failed to reach the threshold. The money-back guarantee provided insurance to potential contributors against the risk of losing their contributions should the provision point not be met. The money-back guarantee creates numerous inefficient Nash equilibria below the provision threshold where, given the decisions of others, an individual decision is inconsequential and does not lead to provision. In experiments where subjects can contribute all or none of their endowment to a public good, the money-back guarantee has generated mixed results. Dawes et al. (1986) find that the money-back guarantee has no significant effect on the proportion of subjects contributing to the public good. However, Rapoport and Eshed-Levy (1989) report that the money-back guarantee results in greater frequency of provision and greater frequency of individual contribution. [5] In an environment where subjects can contribute any amount, Isaac et al. (1989) report that the guarantee significantly increases contributions; and more recently, Cadsby and Maynes (1999) find greater contributions and provision frequency in both binary and continuous contribution environments.

Third, the mechanism offered the possibility of extended benefits. Money collected in excess of the provision point would be used to extend benefits, or increase the production of the public good. Here, excess contributions were to be used to increase the number of homes served with renewable energy or to plant more trees. In theory, extending benefits beyond the provision point does not modify individual incentives, simply creating a VCM environment beyond the threshold (Marks and Croson, 1998). Marks and Croson refer to this use of excess contributions as a "utilization rebate" rule. Extended benefits in the form of a utilization rebate can create efficient outcomes where contributions exceed the provision point level. These outcomes may or may not be Nash equilibria. [6] In evaluating alternative rebate rules for provision point mechanisms, Marks and Croson find that offering extended benefits, via a utilization rebate rule, has the greatest positive effect upon average group contributions.

The one-shot or single-round nature of our experiments differs from the usual experimental analysis that utilizes multiple rounds. A few authors have examined one-shot mechanisms because they believe they are more accurate representations of actual public goods decisions (Alston and Nowell, 1996; Rondeau et al., 1999). However, in multiple round experiments, early round contributions have been shown to be significantly greater than contributions in later rounds. Some have attributed this phenomenon to strategic behavior and confusion due to a lack of experience (Isaac et al., 1985; Bagnoli and McKee, 1991; Palfrey and Prisbrey,

[5] In a single round experiment, Rapoport and Eshed-Levy find support for Dawes et al. (1986) finding. However, Dawes et al. data provides support for Rapoport and Eshed-Levy conclusion. Though Dawes et al. do not analyze frequency of provision, the values can be computed from their reported data. With a money-back guarantee, the public good was provided 100% and 57% of the time when provision required three and five contributors from seven subjects, respectively. Without the money-back guarantee, the public good was provided 70% and 40% of the time, respectively. Testing for the difference between sample proportions (Goldstein, 1964, pp. 100–101), the increased provision proportion with the money-back guarantee is significant with a provision point of three contributors ($x = 1.60 > 1.55 = x^*$ for a one-tail test at 6% from the standard normal distribution) but is not with a provision point of five contributors ($x = 0.69$).

[6] For a Pareto superior outcome when contributions exceed the provision point in the presence of extended benefits, an individual contribution must lead to group extended benefits in excess of the individual contribution amount. If the individual's share of the extended benefits from their contribution exceeds the individual contribution amount then the outcome is also a Nash equilibrium (Marks and Croson, 1998).

1997). Others have claimed that the observed deterioration over rounds is a special case where the incentive for achieving the efficient equilibrium (i.e. threshold) is low (Cadsby and Maynes, 1999).

One theoretically undesirable feature of NMPC's mechanism was that to legally qualify as a rate offering the program could only be offered at a posted price. Thus, customers could only make the binary decision of choosing to contribute a fixed amount of $6.00 per month or not to participate at all. A posted price is undesirable, because it does not allow households to self-select a monthly fee that better represents their preferences for the program. [7] Despite the posted price, the mechanism does not reduce to a referendum; only individuals who choose to participate pay.

Interestingly, the only other green-pricing programs to use a provision point mechanism that we are aware of were fully subscribed. Traverse City Light and Power in Michigan completed a windmill project using a funding mechanism similar to NMPC, except that it did not offer extended benefits. Instead, participation was curtailed after the program's provision point was successfully reached with 200 customers at an estimated residential premium of $7.58 per month (23% of the average residential bill) (Holt and Associates, 1996a). The City of Fort Collins in Colorado also used a series of provision points to solicit funds for up to three separate wind turbines (Holt and Associates, 1996b). By early 1997, enough customers had agreed to pay an average premium of $10 per month to exceed the minimum provision point established for funding two turbines (Clements-Grote, 1997; Holt and Associates, 1997).

In comparing these offerings with the GreenChoice™ program it is important to note that there are substantial differences in magnitude and scope. Both the Fort Collins and Traverse City programs were small, locally based programs able to focus on well-defined projects. Hence, broad awareness was easily achieved. In contrast, the GreenChoice™ program, which was to be offered to only the Buffalo area, for legal reasons had to be offered to NMPC's entire service area. NMPC's service area covers well over half the area of New York state. Consequently, marketing became a major impediment to the program. [8]

3. Laboratory experiment

3.1. Experimental design

The field experiment, which is discussed in the next section, yields information about (1) how the provision point mechanism adopted by NMPC might perform with respect to participation rate when full consumer awareness exists; and (2) whether or not there is consistency

[7] Cadsby and Maynes (1999), in a comparison of threshold experiments with continuous contributions and binary discrete contributions, find increased contributions and provision in the case of continuous contributions.

[8] Though the GreenChoice™ program was formally approved by the New York Public Service Commission, it was ultimately suspended before completion, because NMPC developed serious financial difficulties and was unable to promote customer awareness of the program. Most of the planned marketing campaign, including a substantial advertising budget and tree plantings at public schools throughout the service territory, was canceled. The program was only briefly mentioned in a bill insert and described in a brochure sent to about 3% of NMPC's customers. However, before the program was terminated we were able to conduct the field experiment with NMPC customers.

between individuals' stated preferences and program involvement. Nevertheless, without direct knowledge of individual valuations, we have no way of knowing if the mechanism is demand revealing or how successful the mechanism is in eliminating free-riding. A laboratory experiment was thus designed to test the mechanism in an environment where program values could be induced. If this mechanism fails to reduce free-riding in the laboratory, then we would expect it to fail to reduce free-riding in the field.

This section describes a classroom laboratory experiment specifically designed to evaluate the demand revelation properties of the NMPC mechanism. In addition to designing a laboratory mechanism paralleling the NMPC program, this experiment deviates from previous public goods research in three important ways. First, in contrast to most public goods experiments that have relied on "small groups" of less than 10 individuals, this experiment involved 100 participants. This "large group" approach was adopted to more closely reflect the NMPC field conditions. In addition, Isaac et al. (1994) have shown that individuals in groups of 40 and 100 contribute significantly more in a VCM public good experiment than do subjects in small groups ($n = 4$ and 10). And, Rondeau et al. (1999) have found that a provision point mechanism (using a proportional rebate) produces contribution levels consistent with aggregate demand revelation in a large group setting ($n = 45$), while the same mechanism results in under-revelation for small groups ($n = 6$).

A second manner in which the analysis of this experiment contrasts with previous public goods research is that it models individual contribution decisions with a random utility framework. Others have employed the random utility framework to explore various aspects of individual behavior with public goods, but none with respect to a provision point mechanism. [9]

Lastly, while this research does not test the effect of a rebate, to our knowledge, this laboratory experiment was the first to use a rebate with a provision point mechanism and money-back guarantee in a discrete contributions setting (see Marks and Croson, 1998, for an explicit evaluation of rebate effects in a continuous contributions setting).

The experiment was performed in an undergraduate economics principles class without the involvement of the instructor. The students had experience in market experiments but not in public goods experiments. An experiment "in decision-making" was introduced at the beginning of a regularly scheduled class, and printed instructions were distributed after students were seated. Students were instructed to copy the subject number written on their instructions onto a blank envelope they were provided. Students read their instructions (see sample in Appendix A), after which a brief oral summary was given. Questions were answered privately by monitors. Students were then allowed approximately 10 min to make a decision which shall be described shortly. They then sealed their instructions and decision responses in their envelopes. Follow-up questions were distributed immediately afterward, and subject numbers were copied from the envelopes to follow-up questionnaires. All materials were collected after the follow-up forms were completed. The sealed envelopes ensured that students could not alter their decisions after answering the follow-up questions. Students were not allowed to communicate during the experiment.

[9] Random utility model applications in public goods experiments are becoming common. For example, Palfrey and Prisbrey (1997) and Spencer et al. (1998) analyze individual behavior using the random utility framework in VCM experiments and contingent choice experiments, respectively.

The nature of the decision was as follows. Each participant was given a starting balance of \$5 and the opportunity to join a group investment program for a one-time fixed fee of \$3. Before a participant decided whether or not to join, the group investment program and payoff calculations were described. The group investment program would yield a return only if 40% or more of the participants joined. Each participant was informed that they would receive their pre-specified "return" if this provision point was met or exceeded regardless of whether or not they had joined. Each subject was randomly assigned a return without replacement from a set of 100 values, consisting of 20 of each of the values in the set {\$0.50, \$1.75, \$3.00, \$4.25, \$5.50}. Hence, 20 subjects were assigned to each "return". Subjects were told their own return but were not made aware of the returns of other subjects, i.e. the distribution of values was not known. These returns were the induced values, designed to reflect the heterogeneous values NMPC customers hold for the GreenChoice^{TM} program.

If more than 40% joined, each participant also received a fixed "bonus payment" of \$0.03 for each participant that joined in excess of the provision point. If fewer than 40% joined, the group investment program was canceled and all contributions were refunded (see Table 1 for a summary of laboratory parameters).

The bonus payment was public information. Only the induced value was private information. Marks and Croson (1999) show that incomplete information about the distribution and the sum of the values for the public good does not undermine the provision point mechanism, providing equivalent levels of success with respect to provision, Nash equilibria played, and levels of contributions produced under complete information.

The fixed participation fee was selected in conjunction with the induced values to insure that (1) the average payoff would equal or slightly exceed the participation fee; and (2) the total group benefit would equal or exceed twice the total group cost if the provision point were met or exceeded.[10] Total benefits (TB) and costs (TC) for the entire group are portrayed in Fig. 1 for a group of 100 participants. As an example, suppose that 41 participants join. TB would equal \$303 and TC would equal \$123. TB would be the sum of all induced values, $20(\$0.50 + \$1.75 + \$3.00 + \$4.75 + \$5.50) = \$300$, plus extended benefits to all 100 participants from one additional joining participant, $\$0.03 \times 100 = \$3$. TC would be the 41 joining fees, $41 \times \$3 = \$123$.

The sample size of 100 was chosen to correspond with a large group setting, and to enable statistical analysis. The investment return values were chosen to be symmetric around the fixed fee and, based on pre-test results, to vary sufficiently to identify any relationship between induced value and participation for this sample size. The bonus mechanism was incorporated to reflect NMPC's offer of extended benefits financed by funds in excess of the provision point. The bonus amount of \$0.03 was chosen so as to equate the aggregate group marginal benefits and marginal costs, as shown in Fig. 1. Hence, excess contributions were symmetrically re-distributed to the entire group—contributors and non-contributors—such that there were no efficiency gains and no Nash equilibria above the provision threshold.[11] The instructions were worded so as to avoid intrinsic value associated with program

[10] In the laboratory setting, the provision equilibria, Pareto dominate the non-provision equilibria.

[11] Unlike a proportional rebate which re-distributes to contributors only. Both the laboratory experiment utilization rebate and the general proportional rebate are Pareto neutral.

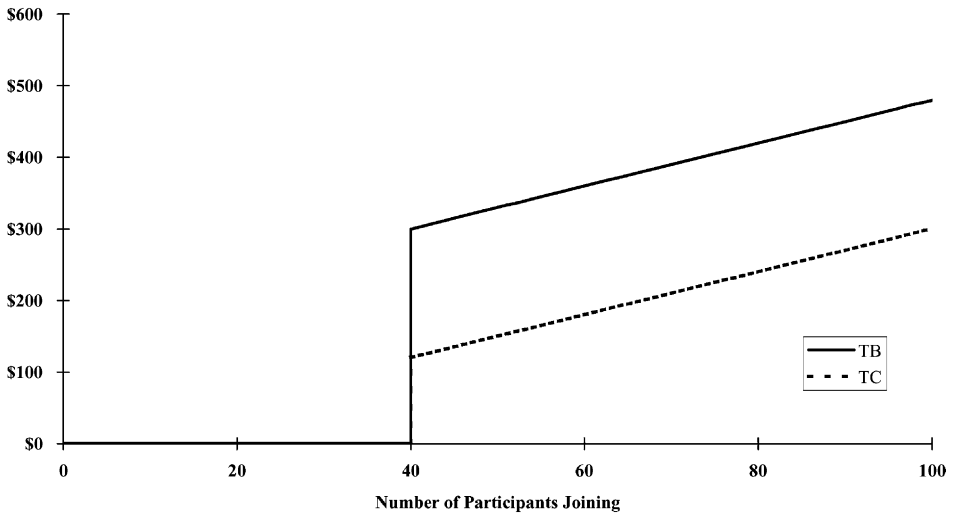

Fig. 1. Total benefits and costs.

context; we sought to isolate the effectiveness of the mechanism alone in reducing free-riding behavior. Though this removed an important aspect of realism associated with NMPC's GreenChoice^{TM} program, it allows for an unbiased evaluation of the program's financing mechanism. Lastly, follow-up questions were posed to collect additional information on the participation decision (see Appendix B). The questions attempted to measure expectations, as well as self-interest and altruistic or warm-glow factors that might exogenously enter into participation decisions.

In summary, this experiment was designed to test a "naïve" hypothesis: the NMPC provision point mechanism induces demand-revealing behavior under laboratory conditions. We test whether or not subjects with induced values above the posted price contribute and those with induced values below the posted price do not. If the mechanism is perfectly demand revealing, 50% of the 100 subjects should choose to participate in the program at a cost of $3. Given the distribution of induced values, the 40% with induced values less than $3 should not sign-up, the 40% with induced values exceeding $3 should sign-up, and the 20% with the $3 induced value should be indifferent between joining and not joining. Like the VCM, if this provision point mechanism fails to induce participation at levels approximating demand revelation, then we would expect the field experiment to underestimate "true" demand for the program.

3.2. Results and analysis

At the aggregate level, 47 subjects chose to join the program and pay the $3 fee. Accordingly, the public good was funded and the efficient equilibrium was realized. Clearly, this participation level closely approximates the 50% participation rate expected under our naïve

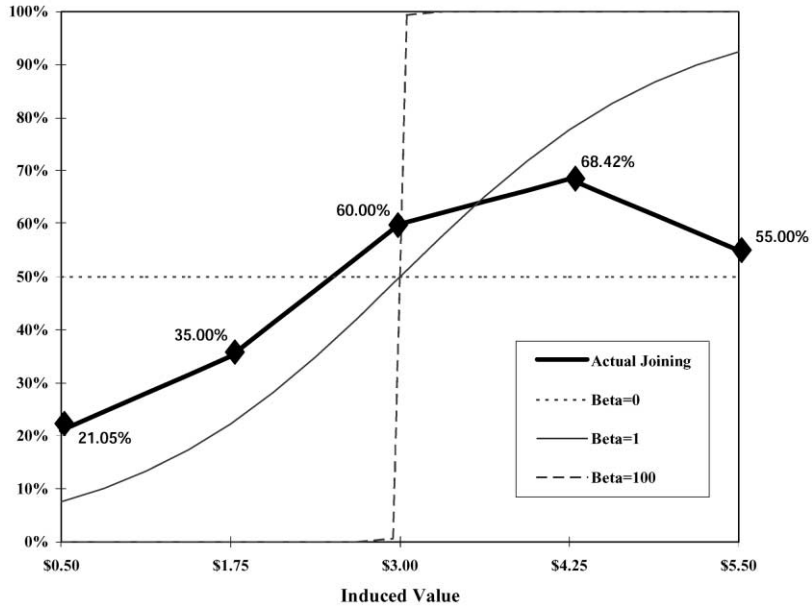

Fig. 2. Actual joining distribution and random utility model for various betas (by induced value).

hypothesis. Thus, given this sample design, the mechanism produces aggregate participation consistent with demand revelation. [12]

However, inspection of participation levels across induced values does not support the naïve hypothesis. As shown in Fig. 2, participation is generally responsive to increases in induced return but the response proportions do not exhibit a sharp step at $3. We find a combination of over- and under-revelation of induced demand. Some subjects with negative net values are contributing in violation of their dominant Nash strategy not to do so, and some subjects with positive net values are free-riding. An analysis of individual behavior can shed some light on what forces are motivating joining. [13]

[12] In reaching this conclusion, it is worth noting that, in the week following the provision point experiment, the same students exhibited typical, substantial free-riding behavior in the initial period of a standard computerized VCM experiment. Contributions in the first round of this multiple round experiment were 41% of the maximum possible *payoff* (where the payoff corresponds to the induced value in the provision point experiment). This proportion is consistent with 40–60% contribution levels observed by the VCM literature (Davis and Holt, 1993). This contribution figure is based on 84 valid VCM observations from the same 100 students. The 16 invalid observations were due to computer malfunction, student absence, or untraceable student information data. The experiment was developed by the Economic Science Laboratory at the University of Arizona and conducted (using monetary incentives) as part of the students' regular weekly sections held in the Laboratory for Experimental Economics and Decision Research at Cornell.

[13] It is worth noting that none of the subjects viewed themselves as "critical" to provision. None of the subjects entered 39 in response to the follow-up question about how many people they believe joined, excluding themselves. However, one subject entered 40, believed the program was funded and joined. It is reasonable to believe that he/she may have thought himself/herself to be "critical". This overall lack of the perception of being critical supports the findings of Dawes et al. (1986) but contradicts the findings of Rapoport (1988).

Using the random utility framework first developed by McFadden (1976), it is possible to test the internal consistency of participation rates observed and the hypothesis that participation rates increase with induced value. In this framework, it is assumed that individuals know their own preferences with certainty, but that they may make errors in decision-making because of imperfect information or errors in optimization. In addition, some aspects of the individuals' preferences are not observable by the analyst, and treated as random. These limitations introduce a stochastic error component into the modeling of decisions (Maddala, 1983). Using such a model, we shall first specify the random utility equivalent of the naïve null hypothesis, in which a customer will sign-up for the program at posted price $\$C$ if the utility associated with having the program and paying $\$C$ is greater than the utility associated with not having the program. If we assume that indirect utility is additively separable, the probability of a "yes" response to a particular posted price is

$$\Pr\{\text{yes response}\} = \Pr\{V - C + \varepsilon > 0\} \tag{1}$$

where V is an individual's value or willingness to pay for the group program and ε is an error term. Assuming that the error is logistically distributed, Eq. (1) can be expressed as

$$\Pr\{\text{yes response}\} = \frac{1}{1 + \mathrm{e}^{-(\alpha+\beta(V-C))}} \tag{2}$$

where α and β, respectively, are location and slope parameters to be estimated. The null hypothesis H_0^1: $\alpha = 0$ corresponds to the hypothesis that, at $V = C$, there is a 50% participation level. A positive value for α would shift the entire distribution to the left in a manner consistent with over-revelation relative to induced values, while under-revelation would correspond to $\alpha < 0$. The null hypothesis for the slope parameter H_0^2: $\beta = 0$ has only a one-sided alternative $\beta > 0$. That is, we are testing the hypothesis that participation does not increase with induced value.

Note from Eq. (2) that, for $\beta > 0$, the relationship between induced value and participation becomes an "S" shaped function with the introduction of logistically distributed random errors. In addition, if $\alpha = 0$ when induced value equals cost ($V - C = 0$), participation is 50%; as $V - C$ becomes large, participation approaches 100%; and for small $V - C$, participation ultimately approaches 0%. The shape, or rather steepness, of the response function varies with the magnitude of β. If $\beta = 0$, the probability of participation is constant; if β is large, a step function is predicted. Fig. 2 illustrates this relationship for a range of β values.

Estimates of α and β using maximum likelihood techniques are found in the "base" column of Table 2.[14] Consistent with our hypotheses, α is not significantly different from zero, indicating that the hypothesis of 50% participation at $V - C = 0$ cannot be statistically rejected. In addition, the estimated coefficient on $V - C$, β, is positive and significant. This latter result supports the hypothesis that participation is positively correlated with induced

[14] Only 98 observations are reported in Table 2, due to the fact that two respondents had missing values for various parts of the questionnaire.

Table 2
Estimated logit models using induced values

Variable (coefficient)	Mean (S.D.) [range]	Base	Long
Constant (α_0)	1	−0.093 (0.211)	−2.26 (0.537)***
Group/self (α_1)	0.61 (0.44) [0.14, 2.50]		3.688 (0.836)***
Induced return (β)	0.01 (1.77) [−2.50, 2.50]	0.337 (0.123)***	0.301 (0.143)***
N		98	98
Likelihood ratio χ^2		8.02***	38.19***
Percent correctly predicted		60	72

*** Significance level of 1%.

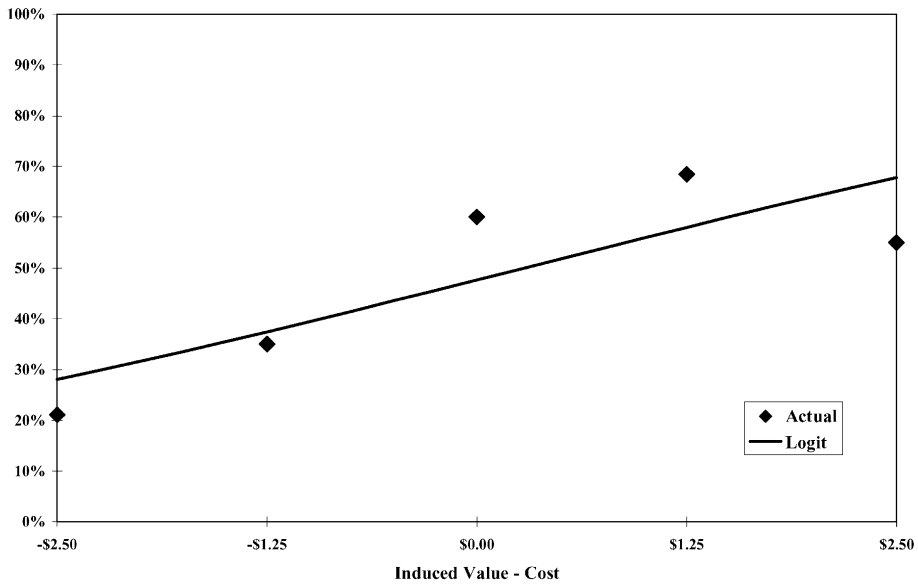

Fig. 3. Actual vs. logit estimated distribution (by induced value minus cost).

value. [15] In all, these results are consistent with the naïve hypothesis that the mechanism is demand revealing.

However, in spite of the significant estimation results reported in Table 2, closer examination of the data reveals that the model is not completely characterizing individual decisions. Recall Fig. 2, actual participation at lower values (e.g. $V = \$0.50$) exceeds the Nash equilibrium prediction of 0% participation. There is also a notable dip in actual participation at the induced value \$5.50. Fig. 3 shows the fit achieved by the base regression model. Fig. 3 is an alternative depiction of actual participation from Fig. 2, with induced value minus cost on the horizontal axis instead. Over- and under-provision are clearly not captured by the base

[15] This finding is consistent with those of Isaac et al. (1985) and Palfrey and Prisbrey (1997). In VCM environments, each found that average contributions and participation increase with greater relative induced value for the public good.

regression model. Hence, the remainder of this section is dedicated to an exploratory investigation of why these deviations occur, focusing on altruistic, warm-glow, and free-riding motives. [16]

An advantage of random utility modeling is that it allows other explanatory variables to be incorporated into the error based decision framework. In an effort to account for heterogeneous, exogenous motives, subjects were asked to indicate the importance they attached to maximizing their own earnings and to maximizing group earnings in making their decision, both a on seven-point scale (1: not important, 7: extremely important). These questions are provided in Appendix B.

The self-reported interest in maximizing "group" and "self" earnings are combined in a "group/self" ratio so as to normalize relative responses at the individual level. In other words, a response pattern group $= 5$, self $= 5$ is assigned a group/self ratio of 1, as is the response pattern group $= 2$, self $= 2$. In terms of Eq. (2), this ratio (group/self) is included by expanding α from a constant to a vector and treating the group/self ratio as a separate element of the vector. As such, argument α in Eq. (2) becomes $\alpha_{\text{Grand}} = \alpha_0 + \alpha_1$ (group/self). The expectation is that participation is positively related to group orientation, and thus α_1 should be positive with a corresponding null hypothesis H_0^3: $\alpha_1 = 0$. To account for this ratio, the null hypothesis H_0^1: $\alpha = 0$, must be restated as H_0^4: $\alpha_{\text{Grand}} = (\alpha_0 + \alpha_1\,(\text{group/self})) = 0$. As before, a positive value for α_{Grand} would shift the entire distribution to the left, indicating general "over-revelation". A negative α_{Grand} would shift the distribution to the right, providing evidence of general free-riding.

The results from including this ratio in the estimation are provided in the "long" column of Table 2. The estimated coefficient α_1 is positive and significant, i.e. the average participant exhibits other-regarding behavior. The addition of this variable makes a significant contribution to the explanatory power of the decision-making model. Notably, the inclusion of this variable does not have a significant effect on the slope coefficient, but does greatly increase the explanatory power of the estimated model, as demonstrated by the jump in the percentage of responses correctly predicted and the likelihood ratio chi-square value.

However, at the mean of the group/self ratio (0.61), α_{Grand} is not significantly different from zero for any standard level of significance: $\hat{\alpha}_{\text{Grand}} = -0.01$ (S.E. $= 0.25$). As such, the naïve null hypothesis H_0^4: $\alpha_{\text{Grand}} = 0$ still cannot be rejected for the average respondent in spite of the fact that the individual coefficients used in calculating α_{Grand} are each significantly different from zero. In other words, other-regarding behavior, as captured by the positive and significant α_1 estimate, is being canceled out by traditional free-riding behavior, as captured by the negative and significant α_0. [17]

Both other-regarding and free-riding behavior appear to be pervasive. First, a review of the average and median group/self ratios by induced value (Table 3), reveals a growing

[16] Altruism is the value received from increasing returns to the group. Warm-glow is the value received from the act of giving. Altruistic value increases as group benefits increase. Warm-glow value is constant, unaffected by group or private returns from the public good.

[17] A similar phenomenon is observed by Rondeau et al. (1999). It is interesting to note that α_{Grand} is significantly different from zero in the expected directions when the ratio group/self falls below 0.47 or exceeds 0.77. These results are consistent with previous research using split-sample designs to examine subject group effects in public good provision experiments, and provide additional evidence that participants bring different motives into experimental settings (Ledyard, 1995).

Table 3
Joining and group/self responses by induced value

Induced value	Number of observations	Number joined	Average group/self ratio	Median group/self ratio	Correlation (join, group/self)
$0.50	19	4	0.423	0.286	0.509
$1.75	20	7	0.588	0.429	0.643
$3.00	20	12	0.676	0.586	0.369
$4.25	19	13	0.760	0.714	0.635
$5.50	20	11	0.595	0.536	0.294

affinity for the group as induced value increases for all values but the highest value. Yet, there is no clear relationship between the self-proclaimed group motivation and joining: group motives are most strongly correlated with actual joining amongst the $1.75 and 4.25 induced value groups, while self-interested motives are strongest amongst the $0.50, $3.00, and $5.50 induced value groups. [18]

Second, we do not find evidence of behavioral differences between the less-than-$3 and the greater-than-$3 participants. [19] This is not surprising, since loss-aversion should be irrelevant in a donation setting, especially one with a money-back guarantee. In addition, our experimental design should not induce other-regarding or self-interested behavior. Instead, low- and high-induced value individuals are presented with different opportunities to exhibit behavior. For example, if we believe that V in Eq. (1) is the sum of induced, altruistic, and warm-glow values, and altruistic and warm-glow values are positive and constant regardless of a participants induced value, we should expect what is observed: joining rates that rise with induced value and are positive and rising for induced values below $3.

Our evidence of other-regarding behavior is consistent with Andreoni's (1995) arguments concerning the role of altruism in public goods experiments as well as the speculations of Van de Kragt et al. (1983), Rapoport (1988), Rapoport and Eshed-Levy (1989), and Palfrey and Rosenthal (1991) regarding the presence of altruism. Unfortunately, our parallel design precludes an attempt on our part to disentangle other-regarding behavior into altruism, warm-glow, and confusion. [20] And, to date, efforts in the literature have been limited to the VCM environment and have produced mixed results. [21]

[18] The $5.50 group seems to have falsely represented their joining decision. The relatively high self-reported average and median group/self ratio suggests other-regarding motives. However, the low correlation with joining implies that self-interested motives are actually behind their decisions to join or not to join.

[19] Additional models which include dummy variables and interaction terms for the greater-than-or-equal-to-$3 participants and then the greater-than-$3 participants confirm this result. In all cases, likelihood ratio tests do not support hypotheses of behavioral differences over the induced values.

[20] Separating altruism and warm-glow could be accomplished by varying the group return as in Palfrey and Prisbrey (1997).

[21] Palfrey and Prisbrey (1997) formally test for and find evidence of warm-glow and confusion but no trace of altruism. Conversely, Anderson et al. (1998) and Goeree et al. (1999) find only altruism and confusion. These findings are not directly transferable to our experimental setting, because in addition to the absence of a provision point and money-back guarantee, none of these experiments use the combination of private heterogeneous induced values, a single-shot decision, a discrete contribution, and a large group. Palfrey and Prisbrey use small groups of four. Anderson et al. use public homogeneous induced values, continuous contributions, and analyze only the last five rounds of the original ten round experiments. Goeree et al. use public homogeneous induced values, continuous contributions, and small groups of two and four.

Given the literature and our decision environment, we can only speculate that the other-regarding behavior observed in our laboratory experiment is a combination of altruism, warm-glow, and confusion. From the applied perspective of this paper, these results, in the "controlled environment" of the laboratory, further heighten the importance of identifying respondent characteristics and preferences that affect actual participation levels in field experiments.

4. Field experiment

The results from the laboratory show that participation elicited using a provision point mechanism will be sensitive to private value for the public good, as well as other motives which might include altruism, warm-glow, and confusion. The one-shot NMPC provision point mechanism appears to create an environment capable of increasing contributions and improving the probability of provision for whatever public good is offered. We now turn our attention to our field application of the mechanism, where we solicited actual contributions to GreenChoice^{TM}. The results of this effort allow us to evaluate the individual incentives of actual participation when private values are unknown. Below we investigate these incentives, analyzing the participation effects of the GreenChoice^{TM} program's green objectives and provision point financing features, as well as individual participant characteristics.

4.1. Experimental design

A telephone survey was utilized to contact a random sample of 206 households in the Buffalo area. [22] The telephone survey began by screening customers to identify the person in the household who usually pays the NMPC electric bill. Once that person was on the phone, the interviewer described the purpose of the survey and the sponsors of the study. The individual was then asked to rate NMPC's service. This allowed the small number of dissatisfied customers to vent frustration before answering the remaining questions. Customer awareness of the GreenChoice^{TM} program was obtained next, and then the goals of the program were described in turn. As the goals were described, the respondent was asked:

> *How interested are you in the goal of replacing fossil energy with renewable energy sources? On a scale from 1 to 10, where 1 is not at all interested and 10 is very interested, how interested are you?*

[22] The survey instrument followed Dillman total design method for telephone surveys (Dillman, 1978), which is designed to achieve a high overall response rate by keeping text blocks short and clear and by engaging the respondent with frequent questions throughout the survey. The response rate was just under 70%. The survey was pre-tested by administering successive draft versions by phone until respondents clearly understood the instrument. Hagler Bailly Consulting Inc. was contracted to administer the survey. Prior to telephone contact, potential respondents were sent a hand-signed cover letter on Cornell University stationery. The letter informed them that they had been selected as one of a small sample of customers to participate in the study of a new type of environmental program. It identified the study's sponsors as the National Science Foundation and the Environmental Protection Agency, together with NMPC, and enclosed a two dollar bill as a token of appreciation for participation. The two dollar bill has been found to be cost effective in increasing response rates.

and later:

How interested are you in the goal of planting trees on public lands in upstate New York? As before, on a scale from 1 to 10, where 1 is not at all interested and 10 is very interested, how interested are you?

The funding plan was then described as follows:

The GreenChoice™ program would be funded voluntarily. Customers who decide to join the program would pay an additional fixed fee of $6 per month on their NMPC bill. This fee would not be tax deductible. Customers could sign-up or cancel at any time. While customers sign-up, NMPC would ask for bids on renewable energy projects. Enough customers would have to become GreenChoice™ partners to pay for the program. For example, if 12,000 customers joined the first year, they would invest $864,000, which would allow Niagara Mohawk to plant 50,000 trees and fund a landfill gas project. The gas project could replace all fossil fuel electricity in 1200 homes. However, if after 1 year, participation was insufficient to fund GreenChoice™ activities, Niagara Mohawk would cancel the program and refund all the money that was collected.

The program description was taken, more or less, directly from the program brochure prepared by NMPC. NMPC was deliberately vague about the exact level of the provision point, because the renewable energy project was to be sent out for competitive bid. However, this type of information should be irrelevant, since changing the threshold level and even knowledge of the exact threshold level has been shown to be inconsequential in the presence of a money-back guarantee (Cadsby and Maynes, 1999; Rondeau et al., 1999).

The survey then asked respondents whether the funding mechanism features of the program made them more or less interested in the program (see Section 4.2 for details). This was followed by the participation question. It was phrased as follows:

You may need a moment to consider the next couple of questions. Given your household's income and expenses, I would like you to think about whether or not you would be interested in the GreenChoice™ program. If you decide to sign-up, we will send your name to Niagara Mohawk, and get you enrolled in the program. All your other answers to this survey will remain confidential. Does your household want to sign-up for the program at a cost of $6 per month?

Participation was not hypothetical: participants were informed that their names were to be sent to NMPC for enrollment.[23] Although actual money were never collected because the program was suspended (see footnote No. 8), this sign-up now/pay later approach corresponds with the following stepwise process typically used in green-pricing programs: (1) potential projects are described; (2) subscriptions from customers are elicited through direct marketing, bill inserts and advertising; and (3) money is collected through regular billing. Experience from the Traverse City project suggests that the payment to intention

[23] In an analysis of Wisconsin and Colorado green-pricing programs, Byrnes et al. (1999) find that market simulations of this sort are better predictors of actual participation.

ratio is very high—in that case, Traverse City Light and Power found that approximately 5% of those who originally signed-up reneged.

The survey concluded with socio-economic questions useful for modeling demand. [24]

4.2. Results and analysis

Of the sample of 206 households, contact was made with 179. [25] Of these, 34 refused to participate and three could not complete the questionnaire. Thus, 142 respondents completed the survey, yielding a response rate of 69% of the base sample. Of the 142, 29 signed up for the program, resulting in a participation rate of 20.4%. If we assume that the 37 households who refused or could not complete the survey would also have refused the program, the participation rate would fall to 16.2%. Both these estimates stand in marked contrast to the actual sign-up rate of less than 3.3% observed by NMPC throughout the period GreenChoice™ was offered via bill inserts and brochures. [26] As discussed previously, low participation was likely due to minimal marketing and low customer awareness of the program. Indeed, none of the 142 randomly sampled respondents in our survey recalled having heard about the program. Participation rates of 16.2 and 20.4% are consistent with a preliminary market evaluation of the NMPC service area conducted by the Research Triangle Institute (RTI) (Wood et al., 1994). RTI estimated that, with full awareness, 17% would adopt a tree planting program at a $6 monthly premium. [27]

It is important to note that a participation rate of 16–20% is substantially higher than the 1% potentially needed to fund GreenChoice™ (12,000 of a total of 1.2 million NMPC customers), as well as the participation rates observed by the majority of actual green-pricing programs reported in the literature (Byrnes et al., 1995, 1999; Baugh et al., 1995; Holt and Associates, 1996a; Farhar and Houston, 1996). As suggested earlier, however, there are notable differences between our experiment and the majority of previous studies. Differences which might explain the discrepancy in participation rates. First, reported participation rates have generally not been adjusted to account for program awareness, which was controlled in our study at 100%. Instead, participation rates have typically been defined over the total customer base or over the base of customers targeted with direct mailings. Hence, rates are deflated. Actual programs have also (with the two exceptions noted previously) relied on voluntary contributions rather than the provision point mechanism used here. The findings of Byrnes et al. (1999) offer support to these two explanations. They provide complete program awareness while obtaining voluntary contributions. The resulting 5.6–10% participation rates are higher than most observed in implemented voluntary green-pricing programs but below those observed here.

[24] The field experiment was conducted as part of a larger National Science Foundation/Environmental Protection Agency research effort to investigate environmental values for public programs (Poe et al., 1997).

[25] Households were classified as "unable to contact" based on a minimum of eight attempts.

[26] NMPC had 0.1% of their 1.2 million customers sign-up. Before deciding to cancel the program, they sent bill inserts and brochures to 3% of their 1.2 million customers, i.e. 36,000 customers. Hence, 3.3% of the 36,000 customers signed-up for the program.

[27] However, RTI also estimated that 57% of customers not classified as "green" would adopt a renewable energy investment program at a $6 monthly premium, while 79% of "green" customers would adopt the same program. Approximately 30% of urban NMPC customers were classified as "green".

To investigate individual specific factors associated with participation decisions, we again turn to the random utility model (McFadden, 1976). The linear logistic distribution is assumed to characterize individual decisions

$$\Pr\{\text{yes response}\} = \frac{1}{1 + e^{-\alpha X}} \tag{3}$$

where X depicts a vector of covariates characterizing individuals and their perceptions of the program (including a constant term), and α is the corresponding set of coefficients to be estimated. A separate independent variable and corresponding coefficient for value cannot be included in the model since individual values are unobserved and cost is constant across all respondents.

Participation decisions are modeled as a function of three categories of covariates, which were elicited in the survey questionnaire. The first concerned the respondents' perceptions of the program's worth. As described earlier, respondents registered their interest in the twin goals of the GreenChoice^{TM} program—replacing fossil fuels and planting trees in upstate New York—using a scale of 1 ("not at all interested") to 10 ("very interested") for each goal.[28] These variables are expected to be positively correlated with the probability of joining the program.

The second category of covariates included gender (male = 1), age (years), education (college graduate or higher = 1), and recent financial support of environmental groups (yes = 1). Such characteristics are widely used as explanatory covariates in the environmental valuation literature. Based on this literature, it is expected that age will be negatively correlated with willingness-to-pay, while recent financial support for environmental groups will be positively correlated with joining the program. Gender and education have provided mixed results in the literature. In addition, individual perception of NMPC service, elicited using a 1 ("unfavorable") to 10 ("very favorable") scale, was included as a covariate.

The final category of covariates concerned respondents' perceptions of the provision point mechanism itself. After hearing about the funding provision point and money-back guarantee, respondents were asked the following two questions.

Does the fact that there is a minimum level of customer participation required for GreenChoice^{TM} to operate make the program of less interest to you, more interest, or does it not affect your interest?

Does the fact that Niagara Mohawk would refund all the money it collects—if support is insufficient—make GreenChoice^{TM} of less interest to you, more interest, or does it not affect your interest in the program?

These variables are admittedly ad hoc, in the sense that they do not proxy for the value of the program. However, they do provide information about perceptions regarding these specific components of the provision point mechanism. We found that over 55% responded

[28] Respondents were also asked how they viewed the program in comparison with other causes they might support "like the United Way, public television, or environmental groups", using a scale of 1 ("much less favorably") to 10 ("much more favorably") as a means of consolidating their preferences immediately prior to answering the participation question. Response to this question is not included here since it was found to be a statistically significant function of the type of project as well as the mechanism attributes.

Table 4
Estimated logit model of NMPC phone participants[a]

Variable [scale]	Mean	Expected sign	Estimated coefficients
Constant	1	n.a.	−4.386 (2.184)**
Replace fossil fuel [1–10]	6.27 (2.82)	+	0.233 (0.118)**
Plant trees [1–10]	8.35 (2.18)	+	0.216 (0.186)
Gender [male = 1]	0.46 (0.50)	?	0.954 (0.517)*
Age [numeric]	55.09 (15.70)	−	−0.0396 (0.0192)**
Give to environment [yes = 1]	0.19 (0.39)	+	0.666 (0.624)
College graduate [grad = 1]	0.45 (0.50)	+?	0.002 (0.546)
Rating of NMPC service [10 = very good]	8.49 (1.67)	+?	0.082 (0.644)
Minimum participation [more interested = 1]	0.17 (0.38)	+	1.416 (0.588)**
Money-back guarantee [more interested = 1]	0.47 (0.50)	+	−0.098 (0.550)
N	128		128
Likelihood ratio χ^2			31.03***
Percent correctly predicted			80

[a] Numbers in parentheses are standard errors.
* Significance level of 10%.
** Significance level of 5%.
*** Significance level of 1%.

that their interest was not affected by including a provision point and about 17 and 28% indicated that it increased and decreased, respectively, their interest in the program. In contrast, the money-back guarantee was widely favored: only 9% of respondents indicated that this attribute reduced their interest in the program, while 47% indicated that it increased their interest. For the purpose of modeling the participation decision, these response categories were re-coded as binary variables assigned '1' if the "more interest" option was selected, and zero otherwise. We expect their estimated coefficients to be positive.

The logit model of program participation is reported in Table 4, together with the sample means, standard deviations, and the expected signs of the estimated coefficients for all the explanatory variables described above. Given the single $6 threshold, the estimation results are fairly strong: 80% of the responses are correctly predicted and the overall likelihood greatly exceeds the critical value ($LR = 31.03 > 14.68 = \chi^2_{0.10}(9)$).

Considered jointly, the estimated coefficients for the two program goals—replacing fossil fuel and planting trees—are significant using a likelihood ratio test ($LR = 7.23 > 4.61 = \chi^2_{0.10}(2)$). Hence, we can conclude that there was a positive response to the objectives of the NMPC program. Comparison of the individual coefficient estimates suggests that, in spite of the observation that more people favored tree planting than fossil fuel replacement (means of 8.35 and 6.27, respectively), interest in fossil fuel replacement is a more significant predictor of participation decisions. The implication is that tree programs will have broad general support, but interest in fossil fuel replacement will be the significant explanatory factor in joining decisions. This finding is consistent with the NMPC market research (Wood et al., 1994).

A joint test of the null hypothesis that restricts all demographic coefficients to zero is rejected at the 10% level ($LR = 10.28 > 9.24 = \chi^2_{0.10}(5)$). The estimated coefficients on

respondent attributes vary in significance, consistent with other studies in the environmental valuation literature. Age is negatively correlated with participation (also a result in Byrnes et al., 1999), a factor that may be attributed to the life cycle hypothesis of value in which potential use values decline with age (Cropper and Sussman, 1990). This negative relation may also be associated with the fact that age is inversely correlated with income in our sample. [29] The finding that male respondents have a higher likelihood of participation contrasts with evidence suggesting that this variable is not substantially related to environmental concerns (Van Liere and Dunlap, 1980). The coefficients on the other socio-demographic covariates are not significantly different from zero.

From our perspective, despite their ad hoc nature, the funding mechanism variables are of considerable interest. Considered jointly, these variables are significant ($LR = 5.84 > 4.61 = \chi^2_{0.10}(2)$). In particular, interest in the provision point mechanism is a significant and positive explanatory variable in participation decisions. The minority of respondents with interest in that feature clearly had a higher participation rate, suggesting that the addition of this feature increases the likelihood of funding. In contrast, interest in the money-back guarantee is not a significant explanatory variable in the estimated model. While the money-back guarantee was popular in general, it was no more popular with participants who joined than with participants who did not join.

In summary, modeling of participation decisions indicates that the content and structural attributes of the NMPC mechanism are influential in participation decisions. The program goals of replacing fossil fuel energy and planting trees and the funding mechanism features of the provision point and the money-back guarantee are important to participants, particularly the replacement of fossil fuel energy and the provision point.

5. Discussion and conclusions

Green-pricing programs have been criticized substantially by the electric utility industry for their cost and poor customer participation. Our field experiment shows that customers, who face a binary decision within a provision point mechanism with money-back guarantee and extended benefits, participate at a relatively high rate when made fully aware of a green-pricing program (between 16 and 20%). Recall the two actual programs in which provision points were utilized. These programs succeeded in funding local projects with relatively high levels of participation.

Our parallel design of a laboratory and field experiment affords us the opportunity to evaluate the NMPC mechanism on two fronts: analyzing expressions of individual value for a public good and examining the composition of actual individual value. Despite the continued presence of free-riding, the laboratory results predict that joining responds to a combination of self-interested and other-regarding values, as well as decision error. Results are consistent with demand revelation at the aggregate level and partial demand revelation at the individual level, i.e. the probability of participation is positively correlated with induced value.

[29] In the linear random utility model used in this analysis, income cancels out of the equation (Hanemann, 1984) and is therefore not included here.

While the persistence of free-riding in the lab implies that the field experiment likely underestimates true demand, the field results suggest that subjects respond to the features of the provision point mechanism, increasing contributions and the likelihood of provision. Outperforming previous VCM field experiences, the NMPC mechanism appears to create a provision setting more conducive to contributing. This suggests that the disappointing sign-up rates of most green-pricing programs to date may be explained by the high levels of free-riding which tend to plague other mechanisms and by limited customer awareness.

Unfortunately, it is difficult, time consuming, and expensive to raise customer awareness for new programs, such as GreenChoice^{TM}. Economists should recognize the large impediment that consumer awareness plays for the private provision of public goods. The NMPC program may well have failed, even if implementation had been carried through, simply because the company was unable to expend sufficient resources to effectively market a statewide program. The successful provision point programs in Traverse City and Fort Collins funded local rather than statewide projects, greatly simplifying achievement of customer awareness. Nonetheless, employing a provision point mechanism is a relatively costless way to increase participation. This research found that, where large groups are involved in a single solicitation, provision point mechanisms may further the objective of privately funding public goods.

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Appendix A. Sample subject instructions for the laboratory experiment

Subject Number ___
PRINT your Name and Social Security Number so that we can pay you
Name _____
Social Security Number _____

A.1. Instructions

First, please write your subject number on the front of the envelope you have been given. You have been given the envelope to insure confidentiality.

This is an experiment in the economics of decision-making. If you follow the instructions closely and make decisions carefully, you can earn money. Please do not communicate with any other students during the experiment. If you have any questions please do not hesitate to raise your hand, so that someone can come over and answer your questions individually.

In this experiment all participants are given a starting balance of $5, which is yours to keep or use any way you like. At the end of these instructions, all of you will be asked if you want to join a group investment program for a one-time fee of $3. "The exact amount of money that you will earn in the experiment depends on your answer to this investment question, as well as on the answers of *all* the other participants in your group". At the end of the experiment, your earnings will be calculated and you will be paid in cash.

Once you understand the group investment program and how your earnings will be calculated, your task is to decide whether or not you want to join the group investment program for a fixed fee of $3.

The group investment program works as follows. You are a member of a group of 100 people in this class. The program will only be funded and implemented if at least 40 of the 100 participants in your group join the investment program. If enough participants join the investment program so that the program is implemented, the return on the investment will be "shared by all" participants in the experiment, "investors and non-investors alike". Specifically, "regardless of whether or not you have joined the group investment program", if enough people join, you will receive a return of $5.50. You will also receive a bonus payment of $0.03 for each participant that joins in excess of the minimum number of 40 necessary for the group program to be implemented. Furthermore, you keep your initial credit of $5 from which $3 will be deducted if you decide to join the investment program. Note that other participants may have a different return but do not have a different bonus.

If *not* enough participants join the investment program, the program will *not* be funded and will be canceled. In this case all the $3 fees collected will be refunded to those who joined. Thus, regardless of your decision to join the program or not, you would keep your $5 starting balance.

To Summarize

- You must decide whether or not to join a group investment program for a cost of $3.
- If fewer than 40 participants out of 100 join, the program will be canceled and all $3 fees will be refunded.
- If 40 or more participants join, the program will be implemented and you will receive a return of $5.50 plus a bonus of $0.03 for each household that joins above 40.
- Recall, that you do not need to join to receive your payment from the investment program if 40 or more other participants join.
- But if you do join, you must pay the $3 fee.

This is the end of the instructions. If you have any questions please raise your hand.

A.2. The question

Do you want to join the group investment program for a fixed fee of $3? (circle one only)

YES I wish to join
NO I do not wish to join

Please place this sheet in the envelope provided and seal it. When everyone has sealed their envelope, you will each be handed another sheet of questions. You must complete these additional questions in order to get paid.

Appendix B. Follow up questions for laboratory experiment

TO BE PAID, YOU MUST COMPLETE THESE QUESTIONS

Please enter your Subject Number from your envelope
PRINT your Name and Social Security Number as you did before
Name _____
Social Security Number _____

(1) Do you think that enough people joined to fund the group investment program? (Circle one answer)

YES NO

(1a) More precisely, how many people do you think joined--excluding yourself?

_____

(2) On a scale from 1 to 7, where 1 is not important and 7 is extremely important, how important were the following in your decision?

2a. I wanted to make as much money as I could for myself. (Circle one number)

1	2	3	4	5	6	7
Not Important						Extremely Important

2b. I wanted the group to make as much money as possible. (Circle one number)

1	2	3	4	5	6	7
Not Important						Extremely Important

References

Alston, R., Nowell, C., 1996. Implementing the voluntary contribution game: a field experiment. Journal of Economic Behavior and Organization 31, 357–368.

Anderson, S.P., Goeree, J.K., Holt, C.A., 1998. A theoretical analysis of altruism and decision error in public goods games. Journal of Public Economics 70, 297–323.

Andreoni, J., 1995. Cooperation in public-goods experiments: kindness or confusion? American Economic Review 85 (4), 891–904.

Bagnoli, M., Lipman, B., 1989. Provision of public goods: fully implementing the core through voluntary contributions. Review of Economic Studies 56, 583–601.
Bagnoli, M., McKee, M., 1991. Voluntary contributions games: efficient private provision of public goods. Economic Inquiry 29, 351–366.
Baugh, K., Brynes, B., Jones, C., Rahimzadeh, M., 1995. Green pricing: removing the guesswork. Public Utilities Fortnightly 8, 26–28.
Brown, T.C., Champ, P.A., Bishop, R.C., McCollum, D.W., 1996. Which response format reveals the truth about donations to a public good. Land Economics 72 (2), 152–166.
Byrnes, B., Rahimzadeh, M., Baugh, K., Jones, C., 1995. Caution renewable energy fog ahead. Shedding light on the marketability of renewables. Paper presented at NARUC-DOE Conference on Renewable and Sustainable Energy Strategies in a Competitive Market, Madison, WI, May 1995.
Byrnes, B., Jones, C., Goodman, S., 1999. Contingent valuation and real economic commitments: evidence from electric utility green pricing programmes. Journal of Environmental Planning and Management 42 (2), 149–166.
Cadsby, C.B., Maynes, E., 1999. Voluntary provision of threshold public goods with continuous contributions: experimental evidence. Journal of Public Economics 71, 53–73.
Clements-Grote, 1997. Wind Power Pilot Program Information Packet. City of Fort Collins Light and Power Utility, Fort Collins, CO.
Cropper, M.L., Sussman, F.G., 1990. Valuing future risks to life. Journal of Environmental Economics and Management 19, 160–174.
Cummings, R.G., Harrison, G.W., Rutström, E.E., 1995. Homegrown values and hypothetical surveys: is the dichotomous choice approach incentive-compatible? American Economic Review 85 (1), 260–266.
Cummings, R.G., Elliott, S., Harrison, G.W., Murphy, J., 1997. Are hypothetical referenda incentive compatible? Journal of Political Economy 105 (3), 609–621.
Davis, D.D., Holt, C.A., 1993. Experimental Economics. Princeton University Press, Princeton, pp. 325–333.
Dawes, R., Orbell, J., Simmons, R., van de Kragt, A., 1986. Organizing groups for collective action. American Political Science Review 8, 1171–1185.
Dillman, D.A., 1978. Mail and Telephone Surveys—The Total Design Method. Wiley, New York.
Farhar, B.C., Houston, A.H., 1996. Willingness to pay for electricity from renewable energy. Paper presented at the 1996 ACEEE Summer Study on Energy Efficiency in Buildings, Pacific Grove, CA, 25–31 August.
Goeree, J.K., Holt, C.A., Laury, S.K., 1999. Altruism and noisy behavior in one-shot public good experiments. Manuscript, Department of Economics, University of Virginia.
Goldstein, A., 1964. Biostatistics: An Introductory Text. Macmillan, New York.
Groves, T., Ledyard, J., 1977. Optimal allocation of public goods: a solution to the free rider problem. Econometrica 45, 783–809.
Hanemann, W.M., 1984. Welfare evaluations in contingent valuation experiments with discrete responses. American Journal of Agricultural Economics 66, 332–341.
Ed Holt and Associates, Inc. 1996a. Green pricing newsletter, No. 3, April. The Regulatory Assistance Project, Gardiner, ME.
Ed Holt and Associates, Inc. 1996b. Green pricing newsletter, No. 4, October. The Regulatory Assistance Project, Gardiner, ME.
Ed Holt and Associates, Inc. 1997. Green power newsletter, No. 5, May. The Regulatory Assistance Project, Gardiner, ME.
Ed Holt and Associates, Inc. 1998. Green power newsletter, No. 6, March. The Regulatory Assistance Project, Gardiner, ME.
Isaac, R.M., McCue, K.F., Plott, C.R., 1985. Public goods provision in an experimental environment. Journal of Public Economics 26, 51–74.
Isaac, R.M., Schmidtz, D., Walker, J.M., 1989. The assurance problem in a laboratory market. Public Choice 62, 217–236.
Isaac, R.M., Walker, J.M., Williams, A., 1994. Group size and voluntary provision of public goods: experimental evidence using large groups. Journal of Public Economics 54, 1–36.
Kahneman, D., Tversky, A., 1979. Prospect theory: an analysis of decision under risk. Econometrica 47 (2), 263–291.
Ledyard, J.O., 1995. Public goods: a survey of experimental research. In: Kagel, J.H., Roth, A.E. (Eds.), Handbook of Experimental Economics. Princeton University Press, Princeton, pp. 111–194.

Loomis, J., Brown, T., Lucero, B., Peterson, G., 1996. Improving validity experiments of contingent valuation methods: results of efforts to reduce the disparity of hypothetical and actual willingness to pay. Land Economics 72 (4), 450–461.

Macmillan, D., Hanley, N., Buckland, S., 1996. A contingent valuation study of uncertain environmental gains. Scottish Journal of Political Economy 43 (5), 519–533.

Maddala, G.S., 1983. Limited Dependent and Qualitative Variables in Econometrics. Cambridge University Press, New York.

Marks, M.B., Croson, R., 1998. Alternative rebate rules in the provision of a threshold public good: an experimental investigation. Journal of Public Economics 67, 195–220.

Marks, M.B., Croson, R., 1999. The effect of incomplete information in a threshold public good experiment. Public Choice 99, 103–118.

McFadden, D., 1976. Quantal choice analysis: a survey. Annals of Economic and Social Measurement 5, 363–390.

Moskovitz, D.H., 1992. Renewable energy: barriers and opportunities: walls and bridges. Report for the World Resources Institute.

Moskovitz, D.H., 1993. Green pricing: experience and lessons learned. The Regulatory Assistance Project, Gardiner, ME.

Neill, H.R., Cummings, R.G., Ganderton, P.T., Harrison, G.W., McGuckin, T., 1994. Hypothetical surveys and real economic commitments. Land Economics 70 (2), 145–154.

Palfrey, T., Rosenthal, H., 1984. Participation and the provision of discrete public goods: a strategic analysis. Journal of Public Economics 24, 171–193.

Palfrey, T., Rosenthal, H., 1988. Private incentives in social dilemmas: the effects of incomplete information and altruism. Journal of Public Economics 28, 309–332.

Palfrey, T., Rosenthal, H., 1991. Testing game-theoretic models of free riding: new evidence on probability bias and learning. In: Palfrey, T. (Ed.), Laboratory Research in Political Economy. University of Michigan Press, Ann Arbor, MI.

Palfrey, T.R., Prisbrey, J.E., 1997. Anomalous behavior in public goods experiments: how much and why? American Economic Review 87 (5), 829–846.

Poe, G.L., Clark, J., Schulze, W.D., 1997. Can hypothetical questions reveal true values? A field validity test using a provision point mechanism. Working paper series in Environmental and Resource Economics ERE 97-02 and WP 97-09, Cornell University.

Rapoport, A., 1988. Provision of step-level public goods: effects of inequality in resources. Journal of Personality and Social Psychology 54 (3), 432–440.

Rapoport, A., Eshed-Levy, D., 1989. Provision of step-level public goods: effects of greed and fear of being gypped. Organizational Behaviour and Human Decision Processes 44, 325–344.

Rondeau, D., Schulze, W.D., Poe, G.L., 1999. Voluntary revelation of the demand for public goods using a provision point mechanism. Journal of Public Economics 72, 455–470.

Schulze, W., 1994. Green pricing: solutions for the potential free-rider problem. Paper prepared for Niagara Mohawk Power Corporation, Cornell University.

Seip, K., Strand, J., 1992. Willingness to pay for environmental goods in Norway: a contingent valuation study with real payments. Environmental and Resource Economics 2 (1), 91–106.

Smith, V.L., 1979. Experiments with a decentralized mechanism for public goods decisions. American Economic Review 70, 584–599.

Spencer, M.A., Swallow, S.K., Miller, C.J., 1998. Valuing water quality monitoring: a contingent valuation experiment involving hypothetical and real payments. Agricultural and Resource Economics Review 4, 28–42.

Suleiman, R., Rapoport, A., 1992. Provision of step-level public goods with discontinuous contribution. Journal of Behavioral Decision Making 5, 133–153.

Van Liere, K.D., Dunlap, R.E., 1980. The social bases of environmental concerns: a review of hypotheses, explanations and empirical evidence. Public Opinion Quarterly 44, 181–197.

Van de Kragt, A.J., Orbell, J.M., Dawes, R.M., 1983. The minimal contributing set as a solution to public goods problems. The American Political Science Review 77, 112–122.

Wood, L.L., Desvousges, W.H., Kenyon, A.E., Bala, M.V., Johnson, F.R., Iachan, R., Fries, E.E., 1994. Evaluating the market for green products: WTP results and market penetration forecasts. Working paper #4, Center for Economics Research, Research Triangle Institute, Research Triangle Park, NC.