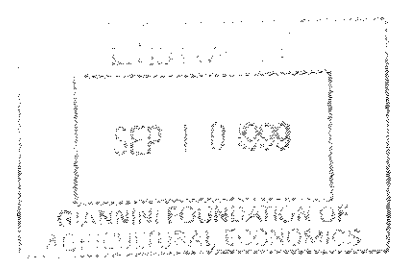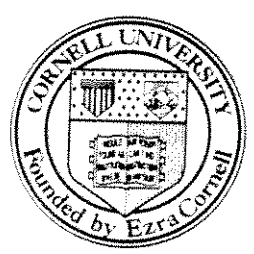*Working Paper Series in*

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Can Hypothetical Questions Predict Actual Participation in Public Programs? A Field Validity Test Using A Provision Point Mechanism

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Abstract

Niagara Mohawk Power Corporation utilized a demand revealing public good mechanism to implement a green electricity program for provision of renewable energy and planting trees. This GreenChoice™ program provided an opportunity to test the reliability of contingent valuation for predicting actual participation levels. In this study, participation levels predicted by hypothetical open-ended and dichotomous choice questions are compared to a reference level obtained from the actual GreenChoice™ program. This approach represents an important improvement over past public goods contingent valuation validity tests which have relied on voluntary contribution mechanisms to elicit actual willingness to pay, and thus are likely to overestimate hypothetical bias because of free riding. Yet, even with a demand revealing mechanism and controlling for awareness, hypothetical participation levels obtained from dichotomous choice responses are found to significantly exceed actual contributions. In contrast, open-ended responses predict actual contribution levels, in that hypothetical open-ended responses are not significantly different from actual responses. Calibration of hypothetical responses is also explored.

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1. INTRODUCTION

A critical issue in environmental economics and public policy is the ability of contingent valuation (CV) to measure "actual" willingness to pay (WTP) for environmental commodities (Arrow et al., 1993). Early validity field research compared hypothetical CV responses with values obtained from auctions and other actual market transactions for private (e.g. strawberries, Dickie et al., 1987) and quasi-public goods (e.g. hunting permits, Bishop and Heberlein, 1979), concluding that "the overwhelming weight from simulated market experiments favors the use of contingent valuation for estimating willingness to pay" (Bishop and Heberlein, 1990). More recent efforts have sought to extend the CV/actual market comparisons to less familiar public goods with large nonuse components: Duffield and Patterson (1992) conducted such comparisons for leasing water rights for threatened trout streams, Seip and Strand (1992) evaluated hypothetical and actual sign-ups for an environmental organization, Brown et al. (1996) compared hypothetical and real donations for the removal of roads on the north rim of the Grand Canyon, and Navrud and Veisten (1997) compared hypothetical and actual payments for old growth forest parcels. Together, these studies have suggested that there are considerable differences between hypothetical and actual contributions, which have largely been attributed to biases associated with the hypothetical nature of CV. For example, Brown et al. (1996, p. 164) argue that "Hypothetical questions, especially about donations to generally desirable environmental goods seem to engender overestimates of actual WTP." Such conclusions have lent

some support to efforts to discredit CV as a public policy decision tool. They have also led to efforts to "calibrate hypothetical CV responses to better approximate measures of actual WTP" (e.g. Champ *et al.*, 1995, 1997).

Using these past field comparisons as a justification for not using CV in public policy applications, or as a metric for calibrating CV values, is premature. Each of these comparisons relies on a voluntary market contributions mechanism (VCM) as a criterion for conducting the validity test. Theoretical developments following Samuelson (1954) and decades of experimental economics research indicate that these mechanisms are neither incentive compatible in theory nor demand revealing in practice (see Ledyard, 1995, for a comprehensive review of the literature): i.e. free riding is the expected norm. In VCM experiments involving real money, individuals typically contribute 40 to 60 percent of the Pareto optimum level. This failure of the VCM to elicit honest revelation of demand for public goods in the laboratory makes it an inappropriate market criterion to assess the validity of CV in field tests. Importantly, it casts serious doubts on the claim made by other researchers that CV suffers from hypothetical bias. Indeed, it is possible that the difference between hypothetical WTP and actual contributions found previously could largely be attributed to free riding rather than an expression of upward bias in hypothetical answers.[1]

In order to conduct more accurate field validity tests of the contingent valuation method, a demand revealing one-shot mechanism is needed to collect actual payments that more closely

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[1] To their credit, each of the aforementioned authors are apparently aware of the possible biases associated with using a VCM as a reference criterion for willingness to pay. For example, Seip and Strand (1992) note, "we may have significant free rider problems in voluntary payment" (p. 103). Brown *et al.* (1996) similarly note that a "voluntary payment towards a public good allows for free-riding...to the extent that free-riding occurs, it depresses actual payments" (p. 154).

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reflect true WTP. Here, demand revelation is defined in the purely empirical sense that individuals provide their true values through payments to a public fund. Importantly, the mechanism needs to be demand revealing in a single request for contributions so that it mirrors the context employed in actual CV.

To our knowledge, this paper presents the first field study to use such a demand revealing reference mechanism to test hypothetical bias and possible calibration alternatives in contingent valuation. This research is particularly timely because it focuses on green pricing, an approach increasingly being considered by public utilities to fund the development of renewable energy resources.

> "Green pricing is a generic term for the offer of electricity generated from clean, environmentally preferred sources such as solar, wind, geothermal and some types of biomass and hydro energy sources. Consumers who choose to purchase this product pay a small premium for the green electricity. This idea has been getting significant attention since its conception in 1992 (Moskovitz, 1992). Seven utilities now have some form of green marketing program in operation, and some twenty others have been considering whether to offer green pricing, including conducting market research into consumer preferences." (Holt, 1997, p. 1)

Utility interest in this product has been motivated, in part, by national environmental opinion polls suggesting that majorities are willing to pay \$6 to \$25 more per month for green power (Farhar and Houston, 1996; Holt, 1997)[2]. Despite substantial evidence supporting public interest in green pricing programs, actual programs have been characterized by low participation

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[2] Market research conducted for individual utilities generally supports these attitudinal findings: a Sacramento Municipal Utility District (SMUD) study indicated that 43 percent of residential customers would pay 5 percent or more for their energy for SMUD to invest in renewable energy products; a Massachusetts Electric Company survey estimated that 48 percent of residential customers would probably or definitely sign up at a 5 percent premium; Niagara Mohawk Power Corporation research suggested that 60 percent of residential customers would sign up at a fixed rate of \$6 per month; and survey research for an unnamed western electric utility suggested that 82 percent of residential customers would be willing to pay rate premiums for renewable energy generation programs (Holt; 1997; Brynes *et al.*, 1995).

rates, usually less than 2 percent (Farhar and Houston, 1996).

Three explanations for this discrepancy seem likely. First, 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. Since market research must necessarily inform customers of a green pricing program, it inherently creates perfect awareness. Thus, forecasts derived from market research depend critically on assumptions about the effectiveness of marketing (Wood *et al.*, 1994). Second, free-riding may lower customer participation because participation has usually been structured as a charitable voluntary contribution.[3] Finally, the hypothetical questions used in market research studies may lead to upward bias. In this paper we control for the first two issues by using a phone survey to create 100 percent awareness and utilizing a demand revealing mechanism for the actual collection of funds in a GreenChoice™ program offered by Niagara Mohawk Power Corporation (NMPC). Thus we are able to isolate a direct test of hypothetical bias associated with different contingent valuation elicitation methods for this green pricing program.

The remainder of this paper is organized as follows. The next section provides a review

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[3] Interestingly, the other recent green pricing programs to use provision point mechanisms have met their (often fairly low) funding objectives, in contrast to early unsuccessful programs associated with voluntary contribution mechanisms. Traverse City Light and Power and Fort Collins Light and Power attempted and completed windmill projects using a first-come-first-served provision point mechanism. Participation in the Traverse City project was curtailed after the program's provision point was successfully reached with 263 customers, at an estimated 3.4 percent of targeted customers. At the time of this paper, Fort Collins had funded one of three windmills with no participation rates reported. Unfortunately, though the Niagara Mohawk Power Corporation (NMPC) 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. Before suspension, the program was briefly mentioned in a bill insert and described in a brochure sent to about 38,000 of NMPC's 1.2 million customers. Most of the planned marketing campaign, including a substantial advertising budget and tree plantings at public schools throughout the service territory, was canceled, and thus awareness was extremely low. Before the program was terminated, however, we were able to conduct the field experiment described in this paper with NMPC customers using a phone survey.

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of demand revealing public goods mechanisms and development of the mechanism used in this research. The third section describes the results of the validity test and the assessment of calibration tools for open-ended and dichotomous choice contingent valuation. Conclusions and implications are provided in the final section.

2. THE SEARCH FOR DEMAND REVEALING PUBLIC GOODS MECHANISMS

An important finding from decades of experimental economics research is that no public goods elicitation mechanism, even if it is theoretically incentive compatible, is perfectly demand revealing in practice (Smith, 1979, 1980; Harstad and Marrese, 1982). Some public goods mechanisms that increase incentives for honest revelation have been developed over the years (e.g. Groves-Ledyard, Tullock, Smith Auction, Clark), and have been shown to approach demand revelation in laboratory experiments. Public goods experiments are able to assess the degree of demand revelation because the true values of individuals are induced by, and thus known to, the researcher. Contributions to public goods in the laboratory can then be compared with individual and group induced values to assess the degree of demand revelation.

Extending these mechanisms to CV field research is, however, problematic. Mechanisms such as the Groves-Ledyard (Groves and Ledyard, 1977) often involve extremely complex incentive structures--greatly limiting their applicability and usefulness in situations outside of confined laboratory settings. Other mechanisms, such as the Smith Auction (Smith 1979, 1980; Coursey and Smith, 1984; Harstad and Marrese, 1982), require unanimity, which necessitates an interactive small-group situation. Moreover, these techniques require multiple rounds before

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they approximate group demand revelation, and, thus are not readily applicable in one-shot situations. Thus, it is understandable that prior CV public goods field validity studies (Duffield and Patterson, 1992; Seip and Strand, 1992; Brown *et al.*, 1996; Champ *et al.*, 1995, 1997; and Navrud and Veisten, 1997) have relied on voluntary contributions. However, as noted above, the voluntary contribution mechanism (VCM) is not theoretically incentive compatible and not empirically demand revealing.

However, in recent research, three important modifications to the VCM have been shown to reduce free-riding in public goods experiments: 1) A provision point (PP) is a minimum level of aggregate contributions below which the public good is not provided. Isaac, Schmidtz and Walker (1989), Suleiman and Rapoport (1992), and Dawes, *et al.* (1986) report that adding a PP significantly increases contributions in a variety of experimental environments. 2) A money-back guarantee (MBG) can be added to a provision point mechanism (PPM) so that individual contributions are refunded if the PP is not reached by the group. Isaac, Schmidtz and Walker (1989) report that contribution levels were substantially and significantly higher in treatments with the MBG compared to baseline PP experiments without a refund. 3) A rebate rule for disposing of contributions in excess of the provision point is a second form of assurance against the potential loss of contributions. Rebate rules can take various forms (see Marks and Crosson, 1996, for a study of alternative rebate rules). For example, in the proportional rebate (PR) rule, all excess contributions are returned to contributors. Each individual receives a share of the excess proportional to the weight of her contribution to the group fund. In an extended benefits (EB) rule, money collected in excess of the provision point would be used to extend benefits, or

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increase the production of the public good. Extending benefits beyond the provision point does not modify individual incentives in theory, but simply creates a VCM environment beyond the threshold. In evaluating alternative rebate rules for provision point mechanisms experimentally, Marks and Crosson (1996) found that offering extended benefits had the greatest positive effect upon group contributions.

In all, the PPM with MBG and PR or EB rebate rules have been shown to be successful at increasing contributions to public goods in experimental settings. There are also anecdotal reports of provision points being used to successfully resolve actual free-riding problems (e.g. Bagnoli and McKee, 1991). Yet these mechanisms typically fail to produce demand revelation. Rather, as shown theoretically by Bagnoli and Lipman (1989) and suggested in empirical applications by Bagnoli and McKee (1991), these mechanisms produce an infinite number of Nash equilibria where the sum of contributions exactly covers costs (PP). In these circumstances efficiency is achieved but demand is under revealed (with the exception of the case where cost equals willingness to pay). It should be noted, however, that all existing PPM experiments have been conducted in experimental settings that greatly depart from field conditions: in particular they involve small groups with multiple rounds. In an effort to create a closer parallel with single shot, large group situations relevant for CV field research, we conducted a series of provision point experiments which are briefly reviewed here and reported in detail in Rondeau *et al.* (1996, 1997) and Rose *et al.* (1996).

In a first set of experiments (reported in Rondeau *et al.* 1996, 1997) we explored the performance of the PP/MBG/PR mechanism as an alternative to the VCM in a setting where

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subjects could contribute any feasible amount. Experiments to test the properties of this mechanism were conducted with subjects drawn from undergraduate Cornell University classes. At the beginning of each experiment, subjects read instructions that can be summarized as follows. "Participants are part of a group. Each person in the group is given an initial balance of money and must decide how much of this balance to keep and how much to allocate to a group fund. The group fund yields a return only if a predetermined investment cost (the PP) is met or exceeded. If the sum of contributions is below the PP, contributions are fully refunded (the MBG). Alternatively, if the sum of contributions equals or exceeds the PP, individual earnings are the total of her initial balance minus her contribution, plus her personal refund from the group fund (the benefits from the public good), plus a rebate equal to her share of the contributions in excess of the PP." Subjects were aware of the number of participants in their group and that everyone had the same endowment, but were not told the level of the PP nor the private payoff to others from the public good. Three series of experiments were conducted using this mechanism, varying across experiments the group size, endowments, provision points, payoff functions, benefit cost ratios, and information about the provision point and the number of members in the group.

The first series of experiments began with a design similar to that used in previous provision point research, involving three "small groups" (n=6) of introductory economics students in a multiple round contributions experiment. Pooling the data from the first round of all three small group experiments we find that, in the aggregate, the ratio of revealed to induced demand is 67 percent. These results are far short of demand revelation but consistent with

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aggregate demand results found in previous PPM experiments (64 percent, Marks and Crosson, 1996; 61 percent, Cadsby and Maynes, 1996; 79 percent, Bagnoli and McKee, 1991). Using this experiment as a base, a second experiment was conducted with a much larger group of 50 students drawn from an environmental economics class in a single shot environment--an environment never before tested using a provision point in a laboratory economics experiment. In searching for a demand revealing mechanism we noted that Isaac, Walker, and Williams (1994) found that individuals in groups of 40 and 100 participants contributed significantly more to a VCM public good than did subjects in small groups. Since group size for CV commodities is always large, we hoped that a larger group size might similarly improve the performance of provision point mechanisms. We thus switched to a single round to make the cheap riding behavior observed in the multiple round small group experiments more risky as well as to test a more practical field mechanism.

In this second experiment, much to our surprise, groups approximately revealed demand in the aggregate for the public good. The ratio of aggregate revealed to induced demand was 107 percent. Because of the possible sensitivity of these experiments to subject type (Marwell and Ames, 1981; Isaac, McCue, and Plott, 1985; Cadsby and Maynes, 1996), a third set of experiments was conducted with three groups of 45 students from an introductory natural resources class. To address the possibility that individuals would strategically respond in a cost sharing manner as predicted by PP Nash equilibria (Bagnoli and Lipman, 1989; Bagnoli and McKee, 1991) information about the number of participants and the provision point was varied. These experiments supported the findings of the previous experiment, with aggregate demand

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revelation ranged from 96 to 112 percent across the varying information conditions.

Based on the promising nature of these results, a second research effort was undertaken to examine a mechanism that more closely corresponded to the actual NMPC collection mechanism (see Rose *et al.*, 1996). The specific PPM design we considered corresponds to that used by NMPC to accelerate the development of renewable energy sources of electricity. The mechanism adopted by NMPC employed three of the features discussed previously. First, it contained a provision point of $864,000 to be raised through customer contributions. This minimum level of funding would provide for the construction of a renewable energy facility to serve 1,200 homes, and for the planting of 50,000 trees in the NMPC service area. Second, NMPC's funding mechanism offered a money back guarantee to customers which assured them that, if contributions failed to reach the threshold, all money collected would be refunded. Third, the mechanism offered the possibility of extended benefits. Money collected in excess of the provision point would be used to increase the number of homes served with renewable energy or to plant more trees.

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 single posted price. Thus, customers could choose only to contribute a fixed amount of $6.00 per month or not 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. Note that, despite the posted price, the mechanism does not reduce to a referendum, because the only individuals to pay are those who choose to participate.

A laboratory experiment was designed to test the NMPC funding mechanism in a large group environment where program values could be induced. The experiment was performed in an undergraduate business-economics principles class using 100 students. This subject pool was specially chosen to give the mechanism a rigorous test because business and economics students contribute less in VCM experiments than other groups (Cadsby and Maynes, 1996). Each participant was given a starting value of $5 and the opportunity to join a group investment program for a one-time fixed fee of $3. The group investment program only yielded returns if 40 percent or more of the participants joined (the PP). Five groups of 20 subjects were assigned to one of five induced values {$0.50, $1.75, $3.00, $4.25, $5.50}. If more than 40 percent joined, each of the 100 participants received a "bonus payment" of 3¢ for each participant that joined in excess of the provision point (the EB). If fewer than 40 percent joined, the group investment program was canceled and all contributions were refunded (the MBG).

Given the $3 fee and the distribution of induced values, if subjects behave as if the NMPC mechanism is demand revealing, we would expect that 50 percent of the 100 subjects would choose to participate in the program. We would also expect that, under a random utility model that accounts for individual errors, the participation rate should increase with induced value. At the aggregate level, 47 percent of the subjects chose to participate, resulting in the funding of the public good. Ignoring the extended benefit, this participation level closely approximates the 50 percent participation rate expected from demand revelation. Thus, in aggregate terms, this mechanism appears to provide an approximately demand revealing outcome for this sample design. Furthermore, using a random utility based logistic model, the response

rate significantly increases with induced values and is not significantly different from 50 percent

participation at the point where induced value equals cost ($3).

3. THE NIAGARA MOHAWK POWER CORPORATION FIELD VALIDITY TEST

3.1. Experimental Design

Given that the NMPC mechanism appears to be approximately demand revealing in the

aggregate in laboratory experiments, it may well provide a substantially better baseline than the

VCM for a field validity test of contingent valuation. Thus participation in the GreenChoice™

program was solicited by telephone and compared with hypothetical responses in parallel

contingent valuation telephone surveys. As described previously, the program used a

PP/MBG/EB mechanism, with a single posted price of $6 per month. Contingent valuation

responses were collected using two telephone formats. The first was a dichotomous choice

version directly paralleling the actual solicitation. The second was an open-ended version asking

respondents the most they would be willing to pay for the program. These two survey formats

offer extremes on the continuum of continuous to discrete choice contingent valuation. Past

experimental economics and contingent valuation research have demonstrated that substantial

procedural variance exists between these formats (see summaries in Brown *et al.*, 1996, and

Schulze *et al.*, 1996). A critical question from a policy standpoint is which format most closely

approximates actual preferences. We will be examining this question in the case of a public good

offered at a single price.

All survey instruments followed the Dillman Total Design Method for telephone surveys

(Dillman, 1978). The method generally achieves a high overall response rate, emphasizing short, clear text blocks and engaging respondents with evenly spaced questions throughout the survey. Effort was made to make the program description correspond to the actual NMPC solicitation materials distributed to the public, despite the fact that these provided substantially less information than state of the art in contingent valuation research. Phone, rather than mail, surveys were employed in order to control for awareness.

Successive pretests of the survey were administered by phone to ensure that respondents clearly understood the instrument. The final phone survey was administered by Hagler Bailly Consulting, Inc., using a random sample of households in the Buffalo, New York area. Households in the sample were first sent a hand-signed cover letter on Cornell University stationery announcing the survey. They were informed 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. The study's sponsors were identified as the National Science Foundation and the Environmental Protection Agency, together with NMPC. A two dollar bill was enclosed as a token of appreciation for participation.

The telephone survey itself ran as follows. Both actual and hypothetical versions began by reaching the person in the household who usually paid the NMPC electric bill. Speaking to that person, the interviewer described the survey's purpose and sponsors. The individual was then asked to rate NMPC's service. Next, customer awareness of the program was obtained, and the goals of the program were described. Respondents were then asked about their interest in these objectives:

> 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?

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?

Depending on the version, 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 <u>of $6</u> 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 1,200 homes. However, if after one year, participation were insufficient to fund GreenChoice™ activities, Niagara Mohawk would cancel the program and refund all the money that was collected.

For the open-ended format, the underlined section was removed. The exact dollar amount of the provision point was hedged by NMPC so that the renewable energy project could be sent for competitive bid while the program was underway.

The survey then asked respondents whether the program's funding mechanism made them more or less interested in the program. After this, respondents in the actual version were faced with the participation question:

> So far I've described the GreenChoice™ program, as well as the $6 per month cost it would add to your household's electrical bill, if your were to join. You may need a moment to consider the next couple of questions. Given your household's income and expenses, I'd like you to think about whether or not you would be interested in the GreenChoice™ program. <u>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</u>

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> remain confidential. Does your household want to sign up for the program at a cost of $6.00 per month?

In the hypothetical dichotomous choice version, the underlined portions were replaced by:

"Would your household sign up for the program if it cost you $6 per month?"

> The hypothetical open-ended decision question was also worded in typical fashion:

> So far I've described the GreenChoice™ program. You may need a moment to consider the next couple of questions. Given your household's income and expenses, I'd like you to think about whether or not you would be interested in the GreenChoice™ program. What is the highest amount, if anything, that your household would pay each month and still sign up for the program?

All surveys ended with debriefing and socio-economic questions useful for modeling demand.

As it turned out, contributions in the actual version were never collected, because the GreenChoice™ program itself was canceled. NMPC developed severe financial difficulties, and, having failed to pay dividends to stockholders, was unable to advertise the GreenChoice™ program. Those who elected to participate as a result of our phone survey were sent a cancellation notice, and the funds contributed by all households who signed up were returned. It is, of course, possible that the customers that we signed up might have reneged by leaving the program during the 12 month payment period. However, there is early evidence that this is not a large issue. For example, 95 percent of the residents who signed up for the Traverse City Wind Power project are continuing to paying their committed level more than one year after the program started. With actual and hypothetical measures of participation identified, we turn next to the results of the surveys.

3.2 Results and Analysis

A random sample of 1250 households in the Buffalo, NY area, based on zip code delineation, was purchased from a marketing research firm. An adjusted sample of 985 households remained after removing bad addresses, unlisted numbers, non-NMPC customers, and three respondents who had previously heard of the GreenChoice™ program. Among these 985 households, 206 were in the actual mechanism sample, 393 were in the hypothetical open-ended sample, and 386 were in the hypothetical dichotomous choice sample.[4] Of the total adjusted sample, 177 refused to participate, yielding an overall response rate of 72.5 percent. None of the subsample response rates fell below 70 percent.

Of the actual mechanism sample of 206, 179 were reached by phone. Of these, 37 refused or did not complete the survey. Of the remaining 142 respondents, 29 signed up for the program, resulting in a participation rate of 20.4 percent. Participation would fall to 16.5 percent if we assume that the 37 people contacted who did not complete the survey would have declined the program. Note also, only three people from our entire sample recalled having heard about the program, reflecting NMPC's decision not to market the program. As such, these data indicate strong potential support for the GreenChoice™ program amongst NMPC customers, and suggest that the program could have been funded if marketing had been successful in increasing awareness.

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[4] A modified, shortened "Cheap Talk" warning (Cummings and Osborne, 1996) was used on a subsample of each of the hypothetical surveys in an effort to "push down" any hypothetical bias. No difference in responses was detected, consistent with those authors' findings. Thus, the versions with and without "Cheap Talk" warnings were pooled for the analysis in the text. When used, the following warning immediately preceded the decision question: "I have one caution though. For programs like this it's often the case that more people say they would sign up than actually do sign-up. Utilities in other parts of the country have found that eight times as many people say yes to similar programs as actually take part in them. With this in mind..."

The participation rate of 16-20 percent is also substantially higher than that observed in the majority of other green pricing programs reported in the literature (Baugh *et al.*, 1995; Brynes *et al.*, 1995; Holt, 1997; Farhar and Houston, 1996). There are, however, substantial differences between this and most previous programs. First, program awareness was controlled here at 100%. In previous programs, participation rates have typically been defined over the broader base of total customers or customers targeted with direct mailings. Yet, as our findings suggest, customer inserts and direct mailings do not guarantee even minimal awareness among customers. Secondly, as noted, previous participation programs have mostly relied upon voluntary contributions, rather than the provision point mechanism used here.

Thus, the 20.5 percent sign-up rate provides a benchmark for testing the hypothetical bias associated with open-ended and dichotomous choice CV questions among survey respondents. We do so using two methods of analysis. First we compare participation rates across actual and hypothetical versions using simple tests of proportions. Second, we model the participation decision and, controlling for socio-economic and other factors, test the hypothesis that response rates differ between actual and hypothetical treatments. To conduct the analysis, open-ended responses are converted to participation rates based on whether the values given exceed the $6 threshold.

As shown in Table 1, the estimated participation rate from the open-ended responses is 23.9 percent. The participation rate from the dichotomous choice responses is 30.5 percent. These results contrast with the NOAA panel recommendation that dichotomous choice values offer conservative, and thus preferable, estimates of value (Arrow *et al.*,1993). At the same time,

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they are consistent with previous comparisons in CV and laboratory experiments (see Brown *et al.*, 1996 and Schulze *et al.*, 1996 for recent reviews). A test of proportions rejects the hypothesis that actual and hypothetical open-ended participation levels differ at any standard level of significance (t=0.73). In contrast, the dichotomous choice sign-up rate of 30.5 percent is higher than the actual value of 20.5 percent at the 5 percent level of significance (t=2.12).

Following established dichotomous choice valuation techniques, we next assume a logistic distribution function to model an individual's participation decision as a function of covariates elicited in the questionnaire. Using actual responses as a base, we include binary variables to test whether each of the hypothetical patterns is significantly different from the actual response pattern.

Three categories of covariates are included when modeling participation. The first concerns respondents' support for the particular objectives of the program: replacing fossil fuels and planting trees in upstate New York. Interest in each goal was measured using a scale of one ("not at all interested") to 10 ("very interested"). Both scale responses are expected to be positively correlated with participation.[5]

The second category of covariates includes demographics, such as gender (male=1), age (in years), and education (college graduate or higher =1). Also included here are recent financial support of environmental groups (Yes=1), and impression of the overall service received from

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[5] Respondents were also asked immediately prior to the participation question how they viewed the program in comparison with other causes they might support, like the United Way, public television, or environmental groups, again using a scale of one (much less favorably) to 10 (much more favorably). This question was included to allow participants to consolidate their preferences and perceptions, as well as to remind them of possible substitutes for this program. Responses are not included in the econometric analysis because individual responses were endogenous functions of expressed interest in program characteristics and mechanism design.

NMPC on a 1 ("very poor") to 10 ("very good") scale. These types of variables are widely used

as explanatory covariates in the literature modeling environmental valuation.[6] From this literature

we expected age to be negatively correlated with participation, and education, impression of

NMPC service, and participation in environmental groups to be positively correlated with

participation.

The final category of covariates concerns respondents' views of the program's funding

mechanism. These variables are unconventional, in the sense that they do not proxy for the value

of the program itself. When told of the provision point and money back guarantee, respondents

were asked the following two questions:

> Does the fact that a minimum level of customer participation is required for
> GreenChoice™ 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™ of less interest to you, more interest, or does it not
> affect your interest in the program?

The provision point itself did not arouse greater interest in the program. Over 55 percent

responded that its inclusion did not affect their interest. Only 17 percent indicated that it

increased their interest. In contrast, the money back guarantee increased interest in the program

for 47 percent of respondents. Only 9 percent said that it reduced their interest. Both questions

were recoded as binary variables for estimation, assigned '1' for "more interest," and '0'

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6 The estimation procedure was motivated by a linear random utility difference model. Thus income is
not included in the estimation (Hanemann, 1984). Similarly, in contrast to standard dichotomous choice CV
models, price is not included as an explanatory variable of participation, because it is constant at $6 across all
participants.

otherwise. We expected their coefficients to be positive.

Joint and individually estimated logit models of program participation are reported in Table 2, together with sample means, standard deviations, and expected signs. The first column of coefficient estimates provides a joint model of participation with binary shifts for hypothetical open-ended and dichotomous choice responses. Actual contribution decisions serve as the baseline. The last three columns of the table provide separate estimation results for the actual, hypothetical open-ended, and hypothetical dichotomous choice participation decisions.

In general, the sign of the coefficients reflects prior expectations, and the overall models are highly significant. Favorable impressions of program characteristics tend to be positively correlated with program enrollment, although the coefficient on trees is not significant in any of the individual equations. Consistent with our expectations from the experimental provision point literature, the provision point and the money back guarantee are positively correlated with and each is a significant explanatory variable of participation, in both the joint and most individual models. The demographic characteristics are also largely consistent with prior environmental valuation research. Participation is negatively correlated with age and positively correlated with being male or a member of an environmental organization. Neither education nor rating of service is significant in any of the regressions. Overall, the significance of each of the equations and individual explanatory variables demonstrates that responses to the questions vary in a systematic fashion.

After accounting for these covariates, the binary variables for hypothetical responses in the joint model tell a tale similar to the simple tests of proportions. The coefficient for

hypothetical open-ended responses is small and not significantly different from zero. In contrast, the dichotomous choice responses are significantly different from actual decisions at the 10 percent level.[7] These results suggest that open-ended CV provides a more accurate prediction of participation than does dichotomous choice. This result is in keeping with Brown *et al.* (1996), who find, in comparing CV to VCM results, that dichotomous choice values exceeded open-ended values, which in turn exceeded actual contributions. Our results also suggest that free-riding may explain the difference between open-ended willingness to pay and actual contributions found in the Brown *et al.* study.

In assessing contingent valuation, Mitchell and Carson (1989) adapt the sociological concepts of criterion validity and construct validity. Criterion validity refers to the goodness of fit of CV estimates to benchmark values, such as market prices. Construct validity refers to whether CV estimates are related to explanatory variables as expected according to economic theory. Applying these measures here, open-ended responses appear to have a higher criterion validity than do dichotomous choice responses, where the reference criterion is the PP/MBG/EB mechanism used by NMPC. At the same time, the logistic analysis suggests that dichotomous choice responses perform better in terms of construct validity. That is, the dichotomous choice

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7 Letting LL denote the log likelihood, a likelihood ratio test LR= $-2(LL_{Resticted} - LL_{Unrestricted})$ was used to test the null hypothesis of equality of all coefficients across equations (with the exception of a binary shift variable for each equation). The test across all three survey versions is rejected at the 5 percent level of significance (LR=40.786 > 40.113 = $\chi^2(0.05, 27)$). The null hypothesis of equality between actual and open-ended responses (LR=12.133 < 14.684 = $\chi^2(0.05, 9)$) and actual and dichotomous choice responses (LR=12.133 < 14.684 = $\chi^2(0.05, 9)$) cannot, however, be rejected. As such, rejection of a joint model pooling all response functions appears to be driven by the inequality of open-ended and dichotomous choice response functions (LR=35.241 > 14,684 = $\chi^2(0.05, 9)$). Moving to paired actual-hypothetical pooled regressions, the significance of the binary shifters reflects the significance levels reported in Table 2. The coefficient on the hypothetical open ended responses was not significant at any level (t=0.73) while that on the hypothetical dichotomous choice responses was significant at the 10 percent level (t=1.82).

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regression exhibits a substantially better fit (as measured by the likelihood ratio) than the open-ended response function. This suggests that open-ended responses do not vary as systematically with socio-economic characteristics as do dichotomous choice responses. However, given the relatively close correspondence of hypothetical open-ended responses with actual participation levels, these results challenge the usefulness of construct validity as a dominant criterion for evaluating CV elicitation techniques.

4. CALIBRATION OF HYPOTHETICAL RESPONSES

As indicated in the previous section, some upward hypothetical bias remains even when a demand revealing mechanism is used to provide a reference for actual willingness to pay. Two different methods have been recently suggested in the CV literature to calibrate or adjust hypothetical values obtained from open-ended or dichotomous choice responses to more closely reflect actual values. Such calibration is widely used in market research to adjust survey responses to predict actual demand. Here, we examine the accuracy of these two methods.

With respect to open-ended responses, Schulze *et al.* (1997) argue that a "disembedding" question following the open-ended question may reduce hypothetical bias by reminding respondents to only state values for the specific good in question rather than including other "embedded" values such as moral satisfaction. In the NMPC survey, this calibration was accomplished as follows. First, individuals were asked to answer an open-ended willingness to pay question as previously described. The following issue is then raised:

Some people say that it's hard to think about the amount you would pay for a specific program like GreenChoice™, rather than for environmental programs or other good causes

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in general...

and individuals are asked if their bid on the open-ended question was just for the GreenChoice™ program or if the stated WTP included values for a wider range of environmental or public causes. If the respondent indicates that, "Yes, my stated value included other causes," then they are asked to estimate the proportion of their stated value that was for the GreenChoice™ program. This "disembedded" portion is then multiplied by the original open-ended value to isolate the value for the program.

Several studies have used this approach, with self-reported embedding ranging from 20 percent (clean up local groundwater, McClelland *et al.*, 1992) to 50 percent (medium size oil spills, Rowe *et al.*, 1991). In addition to the notion that individuals are embedding their specific values within a broader stated value, two other interpretations of these self-reported adjustments have been offered. First, experimental economists have found that in repeated rounds, values tend to fall after the first bid. In other words values tend to be overstated on the first round and tend to approach induced or actual values in subsequent rounds (Davis and Holt, 1993). The disembedding question thus allows individuals to act as if they are in a more experienced, second round situation. Second, the disembedding question might act as a reminder that individuals may want to spend their money in other ways, thus providing an additional opportunity to consider budget constraints and substitutes. The need for emphasizing these constraints in the contingent valuation question was highlighted in Arrow *et al.* (1993).

Champ *et al.* (1995, 1997) have suggested an alternative debriefing method appropriate to dichotomous choice contingent valuation. Building on evidence that individual respondents have

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some uncertainty in their WTP values (Gregory *et al.,* 1995; Ready *et al.,* 1995; Poe and Welsh, 1996), this approach asks those who responded "Yes" to the dichotomous choice question the following debriefing question:

> So you think that you would sign up. I'd like to know how sure you are of that. On a scale from 1 to 10, where "1" is "very uncertain" and "10" is "very certain," how sure are you that you would sign up and pay the extra $6 a month?

Using similar wording, a CV field validity study of WTP for road removal on the north rim of the Grand Canyon (Champ *et al.,* 1995) found that estimating a model, in which only the "yes" respondents who had a certainty level of '10' were coded as yes responses, was not significantly different from actual contributions. It should be noted again that the Champ *et al.* reference for actual contributions was obtained using a voluntary contribution mechanism, which may lead to excessive adjustment.

The results of these calibration approaches are reported in Table 3. On average, the open-ended respondents reported that 23 percent of their values were embedded (i.e. that their value for the program was 77 percent of their original open-ended response). This lowered the entire open-ended WTP distribution, and reduced the estimated percentage who would have said yes to $6 to 16.4 percent. Although this is lower than the actual contribution level of 20.5 percent, it (as well as the original unembedded open-ended proportion) is not significantly different from this reference value ($t=0.89$). However, these results are suggestive in the sense that they demonstrate that overcompensation using this approach is possible. Over-correction is predicted in the psychological literature on self-correction when the subjects are given additional information on sources of error, as was done with this case in the embedding question (Wegener

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and Petty, 1997; Wilson and Brekke, 1994).

Dichotomous choice respondents reported a wide range of certainty levels. Only a small percent reported that they had a certainty level of '10', with the mode being at '7'. Sign-up proportions accounting for different certainty level thresholds are provided in Table 3. Proportions associated with treating yes responses with subsequent certainty levels of "greater than or equal to '6'" to "greater than or equal to '8'" as "true" yes responses, are not significantly different from the actual sign-up rate. However, a certainty level of greater than or equal to '7' most closely corresponds to the actual sign up rate. These calibration results differ somewhat from the Champ *et al.* (1995, 1997) findings. In addition to the aforementioned mechanism effects, these differences between the two studies may be attributed to the good itself, or to phone versus mail formats.

A third calibration approach generally attributed to the NOAA proposed regulations (1994) suggests that WTP values be divided by two in order to correct for hypothetical bias. Using this 50 percent calibration rule on the open-ended values resulted in an estimated participation rate of 7 percent at $6, which substantially overcorrects hypothetical responses with respect to the actual. If instead, the percent of participants at $6 of the dichotomous choice hypothetical values was used, then the estimated percent approximates 15 percent, which is below, but not significantly different than the actual participation rate (t=1.25). Some caution should be taken, however, in assuming a direct correspondence between correcting DC percent and a shift in WTP. In other words, halving the percent at $6 may not directly correspond to halving the estimated WTP, due to non-linearities in underlying WTP distributions.

5. CONCLUSIONS

Three principal conclusions emerge from the research presented here.

First, contingent valuation can provide reasonable estimates of actual public good program participation--when free riding is addressed in the mechanism utilized to actually provide the good. Our laboratory and field experiments suggest that prior field experiments may have shown biased results because of their reliance on the voluntary contributions mechanism.

Second, the elicitation method used in contingent valuation matters for the reliability of the method in predicting actual participation. In particular, dichotomous choice substantially overestimates actual participation, by about fifty percent, while open-ended willingness to pay overestimates by seventeen percent. Calibration methods have been proposed for both methods that can provide conservative estimates of participation and, potentially, of value.

Third, a comparison of the results of this field study with economics laboratory experiments that have examined hypothetical bias shows substantial parallelism. A recent survey of this literature (Schulze *et al.*, 1996) argues that, for open ended willingness to pay questions, "...one has to conclude that some upward bias is likely to be present." In contrast, the experimental evidence concerning dichotomous choice shows that values from dichotomous choice uniformly exceed actual values (Balistreri *et al.*, 1996; Cummings *et al.*, 1995) and also exceed those obtained using open-ended willingness to pay (Schulze *et al.*, 1996). This apparent parallelism could be a powerful tool in advancing contingent valuation techniques using laboratory experimental methods.

Table 1: Proportion of Actual and Hypothetical Sign-Ups by Response Type

Response Type	Percent Participation (observations)
Actual Dichotomous Choice	20.4 (n = 142)
Hypothetical Open Ended (OE Hypo)	23.9 (n = 284)
Hypothetical Dichotomous Choice (DC Hypo)	30.5 (n = 259)

Table 2: Estimated Logit Models by Response Category

Variable (Description)	Exp. Sign	Mean (s.d.)	Estimated Coefficients (s.e.)			
			Joint	Actual	OE Hypo	DC Hypo
Constant			-4.024 (0.856)***	-4.386 (2.184)**	-2.471 (1.167)**	-5.143 (1.602)***
D-DC Hypo (DC Hypo=1)		0.38 (0.49)	0.574 (0.299)*			
D-OE Hypo (OE Hypo=1)		0.41 (0.49)	0.142 (0.298)			
Renewables (1 to 10 scale)	+	6.38 (2.71)	0.150 (0.047)***	0.233 (0.118)**	0.119 (0.099)	0.297 (0.085)***
Trees (1 to 10 scale)	+	8.44 (2.23)	0.116 (0.065)*	0.216 (0.186)	-0.012 (0.073)	0.154 (0.116)
D-Prov. Pt. (Interest=1)	+	0.17 (0.38)	1.353 (0.259)***	1.416 (0.588)**	0.925 (0.411)**	1.868 (0.479)***
D-MBGuar (Interest=1)	+	0.48 (0.50)	0.626 (0.220)***	-0.098 (0.550)	0.734 (0.329)**	0.758 (0.425)*
Age (Years)	-	51.9 (16.3)	-0.023 (0.007)***	-0.040 (0.019)**	-0.039 (0.011)***	-0.003 (0.013)
D-Gender (Male=1)	?	0.46 (0.50)	0.463 (0.213)**	0.954 (0.517)*	0.432 (0.323)	0.224 (0.388)
D-Cgrad (Cgrad=1)	?	0.36 (0.48)	0.181 (0.223)	0.002 (0.997)	0.300 (0.321)	0.275 (0.450)
D-Enviro (Contribute =1)	+	0.24 (0.43)	1.108 (0.233)***	0.666 (0.624)	0.461 (0.346)	2.474 (0.451)***
Rate Service (1 to 10 scale)	+	8.45 (1.65)	0.074 (0.069)	0.082 (0.178)	0.154 (0.102)	-0.087 (0.134)
Chi Sq			148.93	31.10	35.99	117.11
n		620	620	128	255	237

*,**, and *** indicate 10, 5 and 1 percent significance, respectively.

Table 3: Actual Sign-ups and Calibrated Hypothetical Sign Ups

Response Type	Percent Participation (observations)
Actual Dichotomous Choice	20.4 (n=142)
Hypothetical Open Ended, Revised for Embedding	16.4 (n=280)
Hypothetical Dichotomous Choice (DC Hypo), Revised for Certainty	
All or Unrestricted	30.5** (n=259)
Certainty ≥ 5	29.0* (n=259)
Certainty ≥ 6	24.7 (n=259)
Certainty ≥ 7	20.9 (n=259)
Certainty ≥ 8	13.9 (n=259)
Certainty ≥ 9	8.5*** (n=259)
Certainty = 10	6.6*** (n=259)

*,**, and *** indicate that the proportions are significantly different from the "actual" value at the 10, 5, and 1 percent levels, respectively.

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