VALUING ACCESS TO OUR PUBLIC LANDS: A UNIQUE PUBLIC GOOD PRICING EXPERIMENT

May 31, 2007

David Aadland
Bistra Anatchkova
Burke Grandjean
Jason F. Shogren
Benjamin Simon
Patricia A. Taylor [†]

Selected Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Portland, OR, July 29-August 1 2007

Abstract. We report the findings of a unique nation-wide experiment to price access to our public lands. In 2004, the U.S. Federal Lands Recreation Enhancement Act mandated the creation of a new annual pass to cover all federal recreation sites that charge an entrance or access fee. Our task was to assist federal policymakers in determining an appropriate price for this new pass. Toward that end, we administered a contingent valuation phone survey to over 3700 households to estimate households' willingness to pay (WTP) for the new pass at a variety of different prices. Our innovative experimental design allows us to estimate the degree of hypothetical bias in the sample and calibrate our WTP estimates to reflect actual purchasing decisions. In a sample of the general U.S. population – most of whom have little experience with similar federal passes – respondents tend to greatly exaggerate their WTP for the pass when contrasted with previous pass sales. A sample of recent pass purchasers, however, exhibits little bias. This confirms recent research showing that market experience can be an effective means to mitigate hypothetical bias.

[†]Author affiliations: Aadland is associate professor of economics at the University of Wyoming (aadland@uwyo.edu). Anatchkova is survey manager of the Wyoming Survey & Analysis Center (WYSAC) at the University of Wyoming. Grandjean is executive director of WYSAC and professor of statistics and sociology at the University of Wyoming. Shogren is the Stroock professor of economics at the University of Wyoming. Simon is the acting assistant director for the Office of Policy Analysis, U.S. Department of the Interior. Taylor is professor of sociology at the University of Wyoming. We thank Vic Adamowicz, Kerry Smith, Bruce Peacock and Kim Magraw for their valuable comments.

1. Introduction

This paper reports the findings of a unique nation-wide experiment to price access to our public lands. The Federal Lands Recreation Enhancement Act of 2004 mandated a new recreation pass (hereafter, the NRP) to replace the Golden Eagle Passport (GEP) and the National Parks Pass (NPP). The new pass, similar to the GEP, covers all federal lands that charge an entrance or access fee for recreational use. Our economic and survey research team undertook an economic analysis of the new pass program and submitted a price recommendation to federal land management agencies in the fall of 2006. The project was completed under the constraint that the NRP should "provide convenient access, at a fair price, to federal recreation sites that charge fees….and should at least allow the government to break even in the sense that, *on average*, the sale of the [NRP] does not result in a revenue loss relative to the revenue that would be received absent the ability to purchase an annual pass."[1] After receiving our analysis and price recommendation, in December 2006 the U.S. Departments of Agriculture and the Interior announced that the price for the annual NRP would be set at $80; the new pass went on sale in January 2007.

Herein we describe the methodological and economic issues associated with assisting federal land management agencies to determine an appropriate price for the new pass. We use contingent valuation (CV) methods to help determine an appropriate price for the NRP. CV and other stated preference valuation methods have made significant in-roads into public decision making over the last two decades. Federal decision makers use the value estimates to help guide their decision making for a range of topics like water quality protection, air quality improvements, watershed and ecosystem protection, and reduced human health risk (see for example Brown, Champ, and Boyle, 2004).

In the present application, an innovative experimental design allows us to contrast the hypothetical purchasing decisions of survey respondents with the actual purchasing decisions of households. As a result, we are less open to a major criticism of contingent valuation analysis—hypothetical bias.

---

[1] There are other possible policy objectives to consider (e.g., public education, congestion, pollution, and deterioration of infrastructure, etc.) that were outside the scope of our current study. Our goal was to provide information to help set the price of the new pass given the objective of maintaining revenue neutrality, rather than exploring the *optimal* price of the pass based on the full social costs.

Hypothetical bias exists when people overstate their actual willingness to pay (WTP) in a survey. In our analysis, we account for hypothetical decision-making because we are able to calibrate our new price estimates to actual, incentive-compatible purchasing decisions of households.

Unlike most other non-market valuation exercises, we have a real benchmark – the GEP. The GEP entitles households to basically identical access to public lands as the NRP and had been offered at $65 since 2000. Using past GEP sales figures and purchasing decisions for households within our sample, we are then able to estimate the degree of hypothetical bias (including awareness bias). The total degree of awareness and hypothetical bias in our sampling of the U.S. general population (a Random Digit Dialing sample) implies that NRP revenues taken directly from household survey responses are higher than the actual data by a factor of 16! The total bias using our sampling of recent pass purchasers (a sample obtained from the National Parks Foundation) is much lower and even slightly negative. This finding supports previous research in the area of non-market valuation, which shows that market experience is an important indicator of people's ability to accurately identify and state their true valuation for public and environmental goods (e.g., List and Shogren, 1998; Cherry et al., 2003; Cherry and Shogren, 2007; List and Gallet, 2001; Murphy et al., 2005).

2. Background

The Federal Lands Recreation Enhancement Act (Public Law 108-447, the FLREA), which was signed into law on December 8, 2004, approved the introduction of a new federal lands recreation pass to replace the existing GEP and NPP. The FLREA called for a pass to provide convenient and fairly priced access to federal recreation sites that charge fees; to provide opportunities for education on our federal lands; to provide support for public lands; and to develop partnerships with organizations that support recreation and stewardship on our public lands. This new recreation pass (NRP) covers the entrance fees for units administered by the National Park Service and the National Wildlife Refuge System, as well as standard amenity fees for developed areas administered by the Bureau of Land Management, the Bureau of Reclamation, and the U.S. Forest Service. Fee areas generally include visitor centers or other developments with certain standard amenities (e.g., designated parking, camping sites, etc.). Like the passes it is replacing, the new pass does not cover any expanded amenity fees for such things as reservation services or developed campgrounds and boat launches. When appropriate, pass holders will also continue to pay special recreation permit fees such as those for motorized recreational vehicle use, recreational events, and group activities.

The NRP is very similar to the earlier GEP. The GEP was introduced in 1965, at a price of $7 per year. By 1997 its price had risen to $50; by 2000 the price was $65. Like the NRP, the GEP provides entrance for the passholder (and other occupants of a private vehicle) to virtually all federal lands that charge a fee. One minor difference is that the NRP card can be signed by two adult passholders, either of whom may show the card to secure entrance, whereas the GEP card had space for only one signature. As a practical matter, however, this difference is inconsequential, because there was and is no mechanism in place to require the person showing the card to verify that the signature is his or hers.

The year 2000 also saw the introduction of the NPP, sold for $50 and providing entrance only to federal lands administered by the National Park Service. For an additional $15, a sticker could be purchased and affixed to the NPP to make it equivalent in all respects to the GEP (and therefore, essentially equivalent to the NRP). Throughout this paper, GEP refers to either the Golden Eagle Passport, per se, or the National Parks Pass plus sticker. Sales of the GEP and the NPP were discontinued in January of 2007 when the NRP was introduced.

3. Economic Analysis

Our economic analysis begins with the assumption that by stating their WTP for the NRP, households are revealing their optimal choice for expected number of visits to federal recreation sites. This assumption provides a convenient method for calculating expected NRP and gate revenues. All households with a maximum WTP above the price of the NRP will purchase the pass and contribute exclusively to pass revenues; all households with a maximum WTP that is below the price of the NRP will instead pay at the gate and contribute exclusively to gate revenues. We can then evaluate how various NRP prices will impact total pass and gate revenues, and whether the prices satisfy the "fairness and revenue neutrality" constraints mentioned in the *Introduction*.

The value of the NRP is derived from both use and non-use sources. The NRP provides access to recreation at federal sites, without paying daily entrance or usage fees. We refer to this as *use value*, which can in turn be separated into *convenience* and *economic value*. Convenience refers to the reduced transaction costs associated with using the NRP rather than having to make separate payments for each entrance fee.[2] Economic value is derived from the expected cost in entrance fees, given the number of planned visits to recreation sites and the current entrance fee structure. The NRP may also provide agents with a sense of satisfaction in helping to fund the creation and maintenance of federal recreation sites that may be used by others. We refer to this non-use value as *stewardship value*.[3]

In deciding whether to purchase the NRP, households weigh all the benefits and costs. The benefits include convenience, economic value, possible stewardship motives and option values; the relevant cost is the price of the pass. The household's decision is straightforward – if the total benefits outweigh the private costs, purchase the pass; otherwise, pay the gate fees. To better understand this decision, we undertake a CV experiment designed to simulate the actual market environment and NRP purchasing decisions of households.

3.1 Hypothetical Bias

---

[2] We note that some may find an offsetting inconvenience in having to remember to bring the pass for each visit.

[3] Our discussion assumes households base their personal value of the pass exclusively on the expected number of recreation trips and the current gate fees, not the amount uncertainty associated with future trips. We recognize, however, that households might incorporate the option value of the pass into their decision making. Similar to a *real option*, the NRP can be thought of as an irreversible investment under uncertainty (Dixit and Pindyck, 1994). Imagine a household has already purchased the pass and has previously decided the expected benefits exceeded the cost of the pass. Once the NRP is purchased, the decision is final and irreversible because of legal restrictions on the resale of purchased passes. Now suppose a household receives an adverse shock (e.g., sudden loss in income, rising gasoline prices, family illness, etc.) and decides it must forgo a previously planned family vacation to a national park. The household may *ex post* regret the decision to purchase the NRP as it no longer passes the internal cost-benefit test. But it also seems reasonable that the household will, at least to some degree, anticipate this possibility *ex ante* and place a value on the option to delay the purchase. While we do not formally model the option value for the NRP, we recognize the household will likely incorporate the value of delaying purchase into its stated WTP for the pass.

A fundamental concern of any CV study is *hypothetical bias*. Respondents have a well-established tendency to state willingness to pay values that are significantly greater than those revealed in real-market interactions (e.g., Diamond and Hausman, 1994; Harrison and Rutström, 2006). While different methods have been proposed to obtain more accurate WTP values from non-market valuation surveys (Boyle, 2003), our study has a built-in mechanism to calibrate hypothetical WTP values with real choices. We take advantage of the fact that the NRP is nearly identical to the existing GEP, which has been previously sold in the marketplace. Our survey design (described in more detail below) uses revealed-preference data from the GEP market to estimate the degree of awareness and hypothetical bias within our survey sample. We use these estimated calibration factors to adjust WTP values from the survey so they are consistent with the actual, incentive-compatible purchasing decisions of households. The details of this calibration exercise are described in more detail below.

3.2 Calculating NRP and Gate Revenues

Initially, we assume households are motivated to purchase the NRP based solely on its economic value. That is, people purchase the pass if it reduces the total planned entrance expenses for visitation to federal recreation sites and do not place any value on convenience or stewardship. With this assumption, it is straightforward to use our estimated WTP values to project NRP and gate revenues associated with various NRP fee levels. *NRP revenue* is defined as the revenue generated directly from sales of the NRP. *Gate revenue* is the revenue generated from on-site entrance fees at federal recreation sites.

To further clarify, consider the case in which a household's maximum WTP for the NRP is greater than the price of the NRP. In this case, the household purchases the pass and contributes nothing to gate revenues. Conversely, if the household's maximum WTP is less than the cost of the NRP, the household will not purchase the pass and instead pay at the gate. If the household's WTP for the NRP is driven by economics, the most they would be willing to pay for the pass would be the exact amount they expect to spend at the gate. This produces a straightforward method for calculating NRP and gate revenues:

$$\text{NRP Revenues} = \sum_{\text{WTP} \geq \text{NRP Price}} \text{NRP Price} \quad (1.1)$$

$$\text{Gate Revenues} = \sum_{\text{WTP} < \text{NRP Price}} \text{NRP Price} \quad (1.2)$$

Total NRP revenues are calculated by multiplying NRP price by the total number of households with a maximum WTP greater than the price (i.e., all households that would purchase the pass). Total gate revenues are calculated by summing up maximum WTP for all households with WTP less than the NRP price (i.e., all households that would not purchase the pass and instead pay at the gate). This method for estimating total gate revenues assumes that (i) households do not systematically over- (or under-) estimate the number of trips to federal recreation sites, and (ii) they do not purchase the pass for convenience or stewardship purposes. The effect of relaxing these assumptions is discussed in more detail below.

4. Survey Design

Our goal with the valuation survey was to link the NRP valuation exercise to real choices and real outside options; respondents answered the new valuation question after thinking about the status quo and their familiarity with the NPP and GEP. Our intent was to keep the survey realistic, simple, and quick while still generating reasonable value estimates. When possible, we followed general guidelines established by recent research in this area and by the NOAA panel (Arrow *et al.*, 1993) on non-market valuation methods. Given time constraints and the scale of the project, however, the NOAA panel's recommended face-to-face survey was infeasible. Instead, we conducted a nationwide telephone survey between February and April of 2006, using computer-aided telephone interviewing. The survey methods were reviewed and approved by the U.S. Office of Management and Budget.

The survey sample consisted of two independent strata. The first stratum was sampled using a national Random Digit Dialing (RDD) draw of households with landline telephones. To enhance the precision of estimates from this part of the sample, it was pre-stratified by the 9 major geographic divisions defined by the U.S. Bureau of the Census, and post-stratified to reflect Census Bureau distributions by geographic division, household income, Hispanic origin, and racial identification. By design, this sample of 1799 responding RDD households represents all 110 million households in the U.S., except for about 30,000 that fall into the second stratum. The second stratum was randomly sampled from a population list of telephone numbers for households known to the National Parks Foundation (NPF) to have purchased a National Parks Pass (NPP) between April 2004 and March 2005 (i.e., from one to two years prior to the survey). This sample was also pre-stratified by geographic division, and the 1974 responding NPF households were post-stratified to reflect the geographic distribution of the NPF population list.

The total sample size across both strata was 3773 households. Within-household sampling was not undertaken, because the relevant unit of analysis is the household. The NRP (like the GEP and NPP) is not an individual pass; rather, it entitles the members of a household to access federal lands for recreation. Therefore, an adult respondent in each household included in the survey was asked to provide information on behalf of the household.

With total NPP sales of approximately half a million passes sold per year, the NPF population list of only 30,629 households covers only a small subset of NPP purchasers; obviously, it covers an even smaller fraction of all U.S. households. The NPF population, as well as the NPF sample drawn from that population, mainly represents households that purchased the pass on-line. The NPF sampling frame omits the much larger number of households that purchased the NPP in-person at a park, except for those that chose to provide their phone numbers by mailing a reply card to NPF, requesting a park “owner’s manual,” or sending the NPF a donation. It also omits the roughly 50,000 annual purchasers of the GEP. Results from the NPF sample are of interest because they reflect a small but noteworthy group of supporters of the national parks, while the RDD sample is designed to be representative of the full spectrum of the population of U.S. households.

Both samples were screened, through questions early in the survey, to eliminate from our analysis those households in which anyone qualified for a Golden Age or Golden Access Passport. These lifetime passes, available only to senior citizens and the disabled, effectively remove a household from the market for an annual GEP, NPP, or NRP. Households who had not visited any federal recreation lands in the past two years were also screened out of the analysis, on the assumption they would not be part of the relevant market either. After screening, the RDD sample provided 529 cases for analysis and the NPF sample provided 1491 cases. Further details regarding survey design, sampling, and weighting can be found in Taylor et al. (2006).

In general, the survey questionnaire can be broken into five stages:

1) *Awareness of NPP or GEP*: The interview began with an introduction, some screening questions, and a short series of items about the household's recent recreational experiences on federal lands. The interviewer then asked whether the person was aware of the NPP or GEP. This question grounded the person in an outside option that is similar to the NRP. If YES, the person moved to Stage 2 (described below). If NO, the person moved to Stage 3.

2) *Status Quo*: The interviewer then asked whether the household has purchased a NPP or GEP. The person then moved to Stage 3.

3) *Purchase of the NRP*: After the interviewer provided a short description of the NRP (which has approximately the same attributes as the GEP; see footnote 2), we asked if the household would be willing to buy – binary choice, YES or NO – the NRP at a randomly selected bid value. For some respondents, the random bid value was the current GEP price. For these cases, the question allows us to compare hypothetical purchasing decisions to the real purchasing decisions in Stage 2. The experiment then continues to stage 4.

4) *Follow-up Valuation Question*: To more precisely pinpoint the valuation distribution, the interviewer then asks a follow-up valuation question. If a YES in Stage 3, we increase the price and ask YES or NO again; if a NO in Stage 3, we lower the price and ask again.

5) *Socio-Demographic Questions*: We end the survey with a series of socio-demographic questions including age, gender, income, education, race, etc.

Table 2 presents the full set of variables, with definitions and descriptive statistics. We turn now to the econometric analysis of the survey data.

5. Econometric Analysis

We break the econometric analysis into three sections. In section 5.1, we present the model to estimate overall WTP for the NRP. Section 5.2 defines the model used to estimate the degree of hypothetical bias in terms of increased probability that a stated-preference household will purchase the pass at $65. Finally, in section 5.3, we describe how to use the two models to translate the probability measure into a dollar-denominated measure of hypothetical bias. The hypothetical bias scaling factor can be used to calibrate the WTP estimates to the actual purchasing decisions of households.

5.1 Overall WTP Model

Our first econometric model estimates WTP for the NRP, which in turn can be used to forecast pass and gate revenue at various NRP fee levels. We use an interval regression model that follows directly from the double-bounded dichotomous-choice (DBDC) survey design described above (Hanneman et al., 1991; Herriges and Shogren, 1996). An interval regression is an ordered probit model with variable and known cut points (Woolridge, 2002).

Start by writing the empirical model in terms of a household's maximum WTP for the NRP, which is indirectly derived from the utility of visiting federal recreation sites:

$$WTP_i = \exp(X_i'\beta + \varepsilon_i), \qquad (3)$$

where WTP_i is the latent willingness to pay for the NRP; X_i is a vector of explanatory variables; β is a vector of coefficients; ε_i is a mean-zero Gaussian error term with variance σ^2; and $i = 1,..,N$ indexes households in a sample of size *N*. The exponential functional form guarantees the predicted WTP will be non-negative. Given expression (3), the probability of purchasing the pass is represented as

$$P_i = \Pr(y_i = 1) = \Pr(WTP_i \geq \ln(\$b_i)) = \Phi(\frac{1}{\sigma}(X_i'\beta - \ln(\$b_i))), \tag{4}$$

where Φ is the standard normal cumulative density function, $y_i = 1$ if the household purchased the pass, $y_i = 0$ if the household did not purchase the pass, and b_i is the proposed price of the NRP. The initial bids are chosen at random from the following bid vector:

$$\text{b} = (\$25, 45, 65, 85, 105, 125, 145, 165). \tag{5}$$

Table 3 shows the percent of the RDD and NPF samples that respond “YES” to the initial bids. As expected, the percent responding “YES” generally declines as the bids increase in value.

We selected the range of bids based on focus groups and comparisons to other recreation pass programs. As described in Section 4, we then ask a follow-up bid which is randomly selected from either b^H = (b+\$20, 2*b-\$5) if the respondent accepts the bid or b^L = (b-\$20, 0.5*(b+\$5)) if the respondent declines.[4] If a respondent answers “NO” to both bids, we ask a follow-up question with a bid equal to *zero*. The relevant probabilities of purchasing a pass within each possible range of prices are

$$P_{i1} = \Pr(-\infty < WTP_i < 0) = \Phi(\frac{1}{\sigma}(X_i'\beta)) \tag{6.1}$$

$$P_{i2} = \Pr(0 < WTP_i < b_i^L) = \Phi(\frac{1}{\sigma}(X_i'\beta - \ln(b_i^L))) - P_{1i} \tag{6.2}$$

$$P_{i3} = \Pr(b_i^L < WTP_i < b_i) = \Phi(\frac{1}{\sigma}(X_i'\beta - \ln(b_i))) - \Phi(\frac{1}{\sigma}(X_i'\beta - \ln(b_i^L))) \tag{6.3}$$

---

[4] In other words, if the initial bid price is accepted, the second price is (randomly) either \$20 higher, or else (with equal probability) it is approximately double the initial bid amount. If the initial price is declined, the second price is either \$20 lower, or else it is approximately half the initial amount. Adjustments of \$5 (when doubling or halving the initial amount) ensure that all bids are multiples of 5, to avoid any confounding that might arise if multiples of 10 have a different psychological resonance with respondents.

$$P_{i4} = \Pr(b_i < WTP_i < b_i^H) = \Phi(\frac{1}{\sigma}(X_i'\beta - \ln(b_i^H))) - \Phi(\frac{1}{\sigma}(X_i'\beta - \ln(b_i))) \quad (6.4)$$

$$P_{i5} = 1 - (P_{i1} + P_{i2} + P_{i3} + P_{i4}). \quad (6.5)$$

The log likelihood function is then given by

$$\ln L(\beta, \sigma) = \sum_{i=1}^{N} \sum_{j=1}^{5} w_{ij} \ln P_{ij}(\beta, \sigma), \quad (7)$$

where w_{ij} is a binary variable equal to one if household i chooses category j. We choose β and σ to maximize the likelihood function. With estimates of β and σ in hand, we form WTP estimates for every household in the sample, and in turn the NRP and gate revenue functions.

Table 4 presents the results from the DBDC model.[5] Protest households (i.e., those who refuse the pass for free) are excluded from the analysis, which is consistent with the original screening decision to exclude households that have not visited any federal lands recently and are unlikely to participate in the market for the NRP. As compared to the rest of the sample, protest households (N=67 for RDD; N=30 for NPF) tend to be older, less educated, lower income, less likely to be white, and more likely to reside in the northeast (PA, NY and NJ) and great plains (IA, KS, MN, MO, ND, NE and SD) states.

We incorporate heteroscedasticity into the econometric model because the WTP bid intervals vary across households. Recall that half of our follow-up bids are either half or twice the initial bid, so higher initial bids tend to be associated with larger WTP intervals. We use the initial bid to proxy for interval width and model the heteroscedasticity as

$$\sigma_i^2 = \exp(\alpha_0 + \alpha_1 b_i). \quad (8)$$

[5] Although not explicitly modeled here, a potential source of explanatory power is the distance to all nearby federal recreation sites. Measurement of this variable is difficult for various reasons: (i) many federal recreation sites have multiple points of entry (e.g., national forests), (ii) the definition of 'nearby' is arbitrary, (iii) not all recreation sites

As shown in Table 4, the likelihood-ratio statistic testing for the existence of heteroscedasticity is large and leads us to reject the null of homoscedastic errors in the NPF sample but not in the RDD sample.

Mean and median WTP figures are presented at the bottom of Table 4. The mean and median WTP values for the RDD sample are approximately $42 and $35, indicating a WTP distribution that is slightly skewed toward higher WTP values. The mean and median WTP values for the NPF sample are substantially higher and are both approximately equal to $95.[6] Next, we turn to the measurement of hypothetical bias.

5.2 Hypothetical Bias Model

We now describe the econometric procedure to calibrate estimated WTP to be consistent with stated rates of GEP purchases from within our survey sample. We intentionally designed our valuation experiment to account for hypothetical bias by comparing hypothetical decisions to buy the NRP (at a bid equal to $65) with decisions to purchase the existing GEP, which has been sold for $65 in the marketplace. Assuming households are accurately stating whether or not they purchased the GEP within the previous year, this internal calibration should result in WTP and revenue estimates that reflect the actual purchasing behavior of households in the general U.S. population.

To estimate the potential degree of hypothetical bias in the survey data, we specify a probit model with a dummy variable to capture the difference between hypothetical and actual purchasing decisions.[7] We analyze the RDD and NPF samples separately. Within each of these samples, we pool data from two distinct subsamples—the *stated preference* and the *revealed preference* subsamples. The revealed preference subsample includes every household who knew of the $65 GEP. The stated preference

---

are equally attractive recreation areas, etc. For these reasons, we do not include this spatial variable in our empirical analysis but leave it as a possible avenue for future research.

[6] We also estimated a single-bounded dichotomous-choice (SBDC) WTP model. (The results are not shown here but are available upon request from the authors.) The predicted NPF WTP distributions and coefficient estimates from the SBDC model are very similar to the results from the DBDC model. For the RDD sample, the calibrated mean and median WTP from the SBDC model are approximately $7 lower than from the DBDC model, and the coefficient estimates are qualitatively similar.

subsample includes every household that received an initial bid of $65 and was unaware of the GEP.[8] Protest households (i.e., those that refuse the pass for free) are excluded from the analysis.

The underlying economic model is similar to (3) but modified to incorporate hypothetical bias

$$WTP_i = \exp(X_i'\beta + \delta \cdot SP_i + \varepsilon_i) = \exp(\delta \cdot SP_i)\exp(X_i'\beta + \varepsilon_i)\ , \tag{9}$$

where WTP_i is unobserved willingness to pay for either the GEP or the NRP, SP_i is a dummy variable equal to one for the stated preference subsample and zero for the revealed preference subsample, and δ is the hypothetical bias coefficient. We form the probability (P_i) that the i^{th} household purchases the pass at price of $65:

$$P_i = \Pr(WTP_i \geq \$65) = \Phi(\frac{1}{\sigma}(X_i'\beta + \delta \cdot SP_i - \ln(\$65)))\ . \tag{10}$$

Let $y_i = 1$ indicate the household purchased the pass (either hypothetical or real), and let $y_i = 0$ indicate they did not purchase the pass. This is a probit model with (log) likelihood function

$$\ln L(\beta, \delta \mid y, X) = \sum_{i=1}^{N} \left[y_i \ln(P_i) + (1 - y_i)\ln(1 - P_i) \right]. \tag{11}$$

The coefficients β and δ are only identifiable up to the scale factor $(1/\sigma)$. That is, because β and δ only show up in the likelihood function as a ratio with σ (i.e., (β/σ) and (δ/σ)) and the price is fixed at $65, it is impossible to disentangle the ratios and obtain individual estimates of β, δ and σ. However, the *marginal effects*, which measure the change in probability for a one unit change in the explanatory

[7] The design for estimating the degree of hypothetical bias follows Aadland and Caplan (2003).
[8] We also excluded 61 and 336 revealed-preference households in the RDD and NPF samples who were aware of the policy that allows receipts from recent entrance fees to federal recreation sites to be applied toward the cost of the

variables (*X* or *SP*), only depend on the identifiable ratios. For the average household, the marginal effect for hypothetical bias is

$$\begin{aligned}\Delta &= \Pr(y=1 \mid \overline{X}, SP=1) - \Pr(y=1 \mid \overline{X}, SP=0) \\ &= \Phi\left(\overline{X}'(\beta/\sigma) + (\delta/\sigma)\right) - \Phi\left(\overline{X}'(\beta/\sigma)\right).\end{aligned} \tag{12}$$

This coefficient is defined in terms of increased (or decreased) probability of pass purchase. In the next section, we describe how to translate Δ into a WTP scale factor using the baseline DBDC model.

5.3 Translating a Probability into a Dollar Measure of Hypothetical Bias

The coefficient of hypothetical bias Δ in expression (12) is measured in terms of probability the pass is purchased. Although this provides evidence of hypothetical bias, it does not allow household WTP and welfare measures to be directly adjusted to reflect revealed preferences. Furthermore, the probit model shown in expression (10) does not identify a dollar amount of hypothetical bias because the bids are not varied (i.e., the bid is fixed at $65). Fortunately, the DBDC model described in Section 5.1 uses the entire bid vector and allows us to identify household WTP.

We use the normal distribution along with estimates of β and σ to back out the WTP hypothetical bias scale factor consistent with Δ for the average household. This is accomplished by solving for δ (given estimates of β, σ, and Δ) from the following equation:

$$\Delta = \Pr(\overline{WTP}_{SP} > \$65) - \Pr(\overline{WTP}_{RP} > \$65) = \Phi(\frac{1}{\sigma}(\overline{X}'\beta + \delta - \ln(\$65))) - \Phi(\frac{1}{\sigma}(\overline{X}'\beta - \ln(\$65))), \tag{13}$$

where a *bar* over the variable represents its average value. Figure 1 illustrates the procedure for identifying exp(δ), the WTP scale factor for hypothetical bias. The procedure is straightforward. We

---

NPP or GEP. This was done to level the playing field because the “receipt policy” may alter the value of a pass and start with our estimate of hypothetical bias, Δ, which is measured in terms of the increased probability the NRP is purchased. This value is estimated using the method outlined in Section 5.2 and is represented by the etched area in Figure 1. We then calculate the value of $\exp(\delta)$ consistent with Δ assuming a normal distribution with standard deviation σ. Finally, we use the resulting WTP scale factor, $\exp(\delta)$, to form the *calibrated* WTP estimates [$WTP_i / \exp(\delta)$] that more accurately reflect actual purchasing decisions of households.

We now turn our attention to the estimation results from the hypothetical bias model outlined above. We estimate the hypothetical-bias model separately for the RDD and NPF samples. The first row of Table 5 presents the estimates of (δ/σ) under the coefficient heading and estimates of Δ under the marginal effect (ME) heading. In both samples, the hypothetical bias coefficients are positive and statistically significant. Furthermore, the ME estimates indicate that, all else equal, the average RDD and NPF stated-preference households are 13.6 and 12.6 percentage points more likely to purchase a $65 pass than similar revealed-preference households. The control variables include respondent and household demographics such as age, gender, education, race and region of residence.

As discussed above, the estimates of Δ need to be translated from a probability into a WTP scale factor (i.e., we need to map our estimates of Δ into estimates of $\exp(\delta)$) for the purpose of calibrating the WTP estimates for hypothetical bias. To accomplish this, we use the baseline DBDC estimates reported in Table 4. The estimated value for the hypothetical bias calibration factor, $\exp(\delta)$, is approximately 1.4 and 1.3 for the RDD and NPF samples. Table 6 reports the details for this calculation. Put differently, the RDD and NPF WTP values would need to be reduced by 40% and 30% to be consistent with the observation that stated-preference households are 13.6 and 12.6 percentage points more likely than revealed-preference households to purchase the pass at $65. The revenue functions reported below are scaled by $\exp(\delta)$ to more accurately reflect the actual purchasing decisions of households.

---

was not described to our survey respondents.

6. Estimated Revenue Functions

In this section, we describe the calibration processes and present the estimated NRP and gate revenue functions. We calculate both parametric and non-parametric estimates of the revenue functions. The *parametric* estimates of the revenue functions are based on the DBDC model and methods outlined in Section 5. The *non-parametric* estimates of the revenue functions are based on the Turnbull distribution-free estimator. These estimates are a direct reflection of households' "YES" or "NO" responses to the various bids presented in the CV analysis (see Haab and McConnell, 2002). For simplicity, we focus on the non-parametric estimates and make the parametric estimates available upon request.[9]

6.1 Calibration

All the revenue functions are calibrated for awareness and hypothetical bias. Begin by considering the adjustment for "pass awareness". Approximately 50% of the RDD sample and 4% of the NPF sample were unaware of both the NPP and GEP.[10] Assuming the NRP is marketed in a similar manner, we expect similar fractions of the respective populations will not purchase the NRP because they do not learn of its existence. To account for this in our population revenue projections, we calculate NRP revenues in the sample by summing NRP revenues only for those who were aware of either the NPP or the GEP and have a maximum WTP that is higher than the proposed NRP price. We then scale that amount up to the appropriate populations. Estimated gate revenues, include households who were unaware of either the NPP or GEP, under the assumption such households will continue to visit federal recreation sites and pay gate fees.

---

[9] The primary difference between the estimates is that the non-parametric model has more success predicting the smaller number of households that place themselves at the tails of the WTP distributions (see Greene (2003), page 685). Although the revenue functions tend to have a similar shape, the peak revenue occurs at a significantly lower price for the parametric estimates.

[10] The NPF sample consisted of telephone numbers that had belonged to households purchasing the NPP from one to two years before the survey was conducted. Some of those telephone numbers may no longer have belonged to the households that bought the pass, and respondents reached at those numbers might have been unaware of both the NPP and the GEP.

There are two types of calibration for hypothetical bias: internal and external. The internal calibration procedure uses the sample RDD and NPF survey data and is outlined in Sections 5.2 and 5.3. The external calibration procedure uses outside information on recent GEP revenues to project future GEP revenues and then matches them to projected NRP revenues. As a consequence, the external calibration process adjusts for any remaining hypothetical bias not addressed by the awareness or internal hypothetical bias adjustments. Based on NPP and GEP revenue figures for 2005, we project that at a price equal to \$65, NRP revenues should be approximately \$30 million and \$1 million for the RDD and NPF populations. After adjustments to WTP for awareness bias and internal hypothetical bias, we then scale the corresponding NRP revenues to match these figures. Because gate revenues are calculated from NRP revenues, they are automatically calibrated in a similar fashion.

Table 7 presents the magnitudes of all three types of calibration factors. Panel A presents the projected NRP revenues based on various assumptions about awareness and hypothetical bias in the relevant populations. Panel B presents total scaling factors and their decomposition into awareness bias, internal hypothetical bias and external hypothetical bias. In calculating the total bias, the decomposed terms are multiplied together, rather than added, to be consistent with the multiplicative hypothetical bias term in equation (9). By decomposing the total bias in a multiplicative fashion, each individual bias term maintains the interpretation of a 'scaling factor'.

The scaling factors in Panel B are calculated in a sequential fashion using the revenue projections in Panel A. First, the scaling factors for awareness bias are calculated by taking the ratio of predicted NRP revenues at \$65 (assuming all households in the population will be made aware of the NRP) to the predicted NRP revenues at \$65 (assuming that households in the population will be aware of the NRP at the same rate as our sample was aware of the GEP). Second, maintaining the correction for awareness bias, the internal hypothetical bias scaling factor is calculated by taking the ratio of predicted NRP revenues at \$65 (without a correction for internal hypothetical bias) to predicted NRP revenues at \$65 (after scaling WTP by $\exp(\delta)$). Finally, the external bias factor is calculated by taking the ratio of projected revenues at $65 (with adjustments for awareness and internal hypothetical bias) to the benchmark revenues ($30 million and $1 million for the RDD and NPF populations).

Panel B of Table 9 shows the total degree of awareness and hypothetical bias using the RDD sample and the non-parametric forecasts implies that NRP revenues are approximately 16 times higher than the unadjusted data suggest. The total bias using the NPF sample is much lower and even slightly negative in the non-parametric case. This suggests the overall hypothetical bias for the general public RDD sample is greater than the bias for the more pass-experienced NPF sample. The result also confirms previous empirical and meta-analysis research that market experience helps mitigate valuation biases (e.g., List and Shogren, 1998; Cherry et al., 2003; Cherry and Shogren, 2007; List and Gallet, 2001; Murphy et al., 2005).

6.2 Projected Revenue Functions

In Table 8, we present non-parametric, calibrated estimates for NRP and gate revenues from the RDD and NPF samples.

6.2.1 NRP Revenue

As shown in Table 8, the NRP revenue functions reach maximums at approximately $25 and $45 for the RDD and NPF samples.[11] For the RDD sample, NRP revenues drop sharply at $45 and then level off up to $105, after which pass revenues again begin to fall more rapidly. In the NPF sample, the decline in pass revenues after the peak is steady out to $275. The degree of sensitivity of NRP revenues to price reflects the elasticity of the underlying demand curve for the NRP. Recall, all these revenue functions are calibrated for awareness, hypothetical and external bias as described in Section 6.1.

6.2.2 Gate Revenue

[11] We calculate the non-parametric revenue functions by assuming the household's true WTP is at the midpoint of the chosen bid interval. Households that answer "YES" to both bids are assigned a WTP equal to $10 plus the high bid. Households that answer "NO" to both bids, but "YES" when asked if they would accept the new pass for free, are assigned a WTP equal to half the lower bid. Those that reject both bids, and also say they would not accept the

Table 8 also shows gate revenues. As discussed in Section 3.2, we project the level of gate revenues based on households' maximum WTP for the NRP (i.e., the most households should be willing to pay for the NRP is the amount they expect to spend at the gate). At low NRP prices, gate revenues are relatively low and consist primarily of households that are unaware of the pass program and thus pay at the gate.[12] As the NRP price goes up, gate revenues increase as households with a maximum WTP less than the pass price choose instead to pay at the gate. Gate revenues flatten out at their maximum level once the NRP price reaches about $150 for the RDD sample and about $200 for the NPF sample. At these higher-end prices, there are few predicted NRP purchasers remaining.

6.2.3 Revenue Neutrality

Recall from the *Introduction* that the selected NRP price must be "fair and revenue neutral". Revenue neutrality implies that the price of the NRP should not result in substantial revenue losses relative to the revenue that would be received absent the ability to purchase an annual pass. The revenue losses from pricing the NRP are straightforward to calculate. The revenues absent the pass are given by the gate revenues at the bottom of the table (i.e., at a sufficiently high price that no households purchase the pass). The $252 and $2.8 million revenues for the RDD and NPF samples can then be compared to the total NRP plus gate revenues at lower NRP prices. The results in Table 8 suggest that the price may need to be set well above the recent GEP price of $65 to avoid sacrificing substantial revenues. As the NRP price increases, we approach "revenue neutrality" near a price of about $150 for the RDD sample and $200 for the NPF sample. We note $125 is the cost of an annual pass for California's state parks and $140 is the approximate price (in U.S. dollars) of an annual pass for Parks Canada.

---

pass for free (67 households in the RDD sample and 30 in the NPF sample), are treated as protest bidders and are omitted from the analysis.

[12] Projected gate revenues are based on the assumption that the fraction of unaware households in the population does not vary with the NRP price. We recognize that this assumption is questionable at low NRP prices (i.e., word is likely to spread fast if the NRP price is set at or near zero). These low prices, however, are also likely to be outside the practical range for public policy, and little or no attention need be given to the extremes of any of the revenue functions.

In all of our results so far, we assume that households are motivated to purchase the NRP based on its *economic value*. That is, people purchase the NRP pass because doing so results in a savings in expected at-the-gate expenses for visiting federal recreation sites. This assumption has some empirical support: 83% of the RDD sample (and more than 90% of the NPF sample) state that "the number of times the household expects to visit federal lands" and "the price of the pass compared to the cost of entrance fees" are important reasons to purchase the pass. But there are other reasons a household may purchase the pass. First, the household may receive *convenience value*, which refers to the reduced transaction costs associated with using the NRP rather than having to make separate payments for each entrance fee. A smaller but still substantial fraction of the RDD sample (76%) states that "the convenience of one annual pass" is important. That figure is even higher in the NPF sample (94%). There may also be *stewardship value*, if the household views the NRP as a method for contributing to the maintenance and improvement of federal lands and facilities. And households may systematically *over-estimate* the number of expected trips to federal recreation sites or the associated entry fees. Any of these factors (and perhaps others) might encourage households to purchase the NRP at a greater rate than the basic "economic" assumption would imply. Consequently, our estimates to this point represent a lower bound on the demand for the NRP pass based on economic considerations.

We believe the economic rationale for purchasing the pass is reasonable. However, the open-ended survey questions reveal a few households do express stewardship concerns. Furthermore, in the parametric model the coefficient for ALL REVENUE, which could be considered a weak proxy for stewardship, is a positive and statistically significant predictor of WTP. In addition, the average expected number of trips within the next year (3.58 and 5.98 for RDD and NPF) are slightly higher than the average number of typical trips (3.09 and 5.89), which might indicate some over-estimation of upcoming trips.[13]

[13] For both samples, the estimated and actual average numbers of trips are not statistically different from one another at a 10% significance level.

To explore these possibilities, we allow 40% of the WTP for the NRP to be derived from convenience, stewardship concerns, trip over-estimation, and/or other "non-economic" factors. Note this percentage is strictly illustrative—we are unable to estimate directly the non-economic component of WTP. In this case, rather than being a *revenue loser*, the NRP program could actually become a *revenue generator* for NRP prices greater than $60 – but only if nearly 40% of the value of the NRP is due to stewardship or other non-economic factors.[14] This seems unlikely given our survey shows limited evidence of stewardship purchasers and little systematic over-estimation of visitation to federal recreation sites.

7. Concluding remarks

Stated preference valuation methods have made significant in-roads into public decision making over the last two decades. Federal decision makers use the value estimates to help guide their decision making for a range of topics like water quality protection, air quality improvements, watershed and ecosystem protection, and reduced human health risk (see for example Brown, Champ, and Boyle, 2004). Herein we describe our use of contingent valuation to assist U.S. federal land management agencies to determine an appropriate price for a new recreation pass providing access to all federal lands. The project was spurred by the U.S. Federal Lands Recreation Enhancement Act of 2004, which authorized a new recreation pass (NRP) to replace the existing Golden Eagle Passport and the National Parks Pass. The open question we addressed was evaluating how much to charge for the new recreation pass given the preferences of the general public and the revenue neutral constraints of the federal agencies. We designed and administered a contingent valuation survey to over 3700 households to estimate households' willingness to pay for the new pass at a variety of different prices.

Our experimental design allows us to estimate the degree of hypothetical bias in the sample and calibrate our WTP estimates to reflect actual purchasing decisions. We find the general U.S. population – most of whom have little experience with similar federal passes – tend to greatly exaggerate their WTP

[14] The estimation results are omitted to conserve space but are available from the authors upon request.

for the pass when contrasted with previous pass sales. A sample of recent pass purchasers, however, exhibits little hypothetical bias; supporting the idea that market experience can help mitigate the bias. After accounting for the hypothetical bias, our results suggest that to maintain the “revenue neutrality” target desired by the federal agencies, the NRP price would have to be around $150 for the general population sample and $200 for recent pass purchasers.   In December 2006, the federal government announced the price of the new recreation pass—*America the Beautiful Pass*—would be set at $80. According to our estimates, the now current $80 price implies an approximate $10 million loss in revenues, or 4% of total pass and gate revenues, when considering the general U.S. population.

References

Aadland, D. and A.J. Caplan. 2003. "Willingness to pay for curbside recycling with detection and mitigation of hypothetical bias." *American Journal of Agricultural Economics*, 85(2), 492–502.

Arrow, K., R. Solow, P.R. Portney, E.E. Leamer, R. Radner, and H. Schuman. 1993. "Report of the NOAA Panel on contingent valuation." *Federal Register*, 58(10): 4601-14.

Bateman, I.J. and K.G. Willis. 1999 (eds). *Valuing environmental preferences: theory and practice of the contingent valuation method in the US, EU, and developing countries*. Oxford University Press, Oxford.

Boyle, K. 2003. "Contingent valuation in practice," in P. Champ, K. Boyle and Tom Brown (editors), *A Primer on Nonmarket Valuation*. Kluwer Academic Publishers.

Brown, T., P. Champ, and K. Boyle. Eds. 2003. *A Primer on Nonmarket Valuation*. Kluwer Academic Publishers.

Cameron, T.A. and M.D. James. 1987. "Efficient estimation methods for 'close-ended' contingent valuation surveys." *Review of Economics and Statistics*, 69, 269-276.

Carson, R.T., T.Groves and M.J. Machina. 2000. Incentive and Informational Properties of Preference Questions. Unpublished manuscript.

Cherry, T.L., T. Crocker, and J.F. Shogren. 2003. "Rationality Spillovers" *Journal of Environmental Economics and Management* 45, 63-84.

Cherry, T.L. and J.F Shogren. 2007. "Rationality Crossovers." *Journal of Economics Psychology* 28, 261-277.

Combs, J., R. Kirkpatrick, J. Shogren, and J. Herriges. 1993. "Matching grants and public goods: A closed-ended contingent valuation experiment," *Public Finance Quarterly* 21, 178-195.

Cummings, R.G., S. Elliot, G.W. Harrison, and J. Murphy. 1997. "Are Hypothetical Referenda Incentive Compatible?" *Journal of Political Economy* 105(3), 609-621.

Cummings, R.G., G.W. Harrison, and E.E. Rutström. 1995. "Homegrown Values and Hypothetical Surveys: Is the Dichotomous Choice Approach Incentive Compatible?" *American Economic Review* 85(1), 260-266.

Diamond, P.A., and J.A. Hausman. 1994. "Contingent valuation: Is some number better than none?" *Journal of Economic Perspectives* 8(4), 45-64.

Dixit, A.K., and R.S. Pindyck. 1994. *Investment under Uncertainty*, Princeton University Press, Princeton, NJ.

Greene, W.H. 2003. *Econometric Analysis*. 5th Edition. New Jersey, Prentice Hall.

Haab, T.C. and K.E. McConnell. 2002. *Valuing Environmental and Natural Resources: The Econometrics of Non-Market Valuation*. Cheltenham, UK, Edward Elgar.

Hanemann, W. 1984. “Welfare evaluations in contingent valuation experiments with discrete responses.” *American Journal of Agricultural Economics*, 66 (3), 332-341.

Hanemann, W., J. Loomis and B. Kanninen. 1991. Statistical Efficiency of double bounded dichotomous choice contingent valuation, *American Journal of Agricultural Economics*, 73(4), 1255-1263.

Harrison G.W. and E.E. Rutström. 2006 “Experimental Evidence on the Existence of Hypothetical Bias in Value Elicitation Methods, in *Handbook of Results in Experimental Economics*, eds. C. Plott and V.L. Smith. New York, Elsevier Science.

Herriges J. and J. Shogren. 1996. Starting point bias in dichotomous choice valuation with follow-up questioning. Journal *of Environmental Economics and Management*, 30, 112-131.

List, J.A. and J.F. Shogren 1998. “Calibration of the Differences between Actual and Hypothetical Valuations in a Field Experiment." *Journal of Economic Behavior & Organization*, 37, 193-205.

List J.A. and C.A. Gallet. 2001. “What Experimental Protocol Influence Disparities Between Actual and Hypothetical Stated Values? Evidence from a Meta-Analysis.” *Environmental and Resource Economics* 20, 241-254.

Mitchell, R.C. and R.T. Carson. 1989. *Using Surveys to Value Public Goods: The Contingent Valuation Method*. Washington D.C.: Resources for the Future.

Murphy, J.J., P.G. Allen, T.H. Stevens, and D. Weatherhead. (2005). "A Meta-Analysis of Hypothetical Bias in Contingent Valuation." *Environmental and Resource Economics*. 30(3):313-325.

Navrud, S. and E.D. Mungatana. 1994. “Environmental valuation in developing countries: The recreational value of wildlife viewing.” *Ecological Economics*, 11, 135-151.

Phaneuf, D.J. and V.K. Smith, 2003. “Recreation demand models.” Chapter 7 in Karl-Göran Mäler and J. Vincent (eds), *Handbook of Environmental Economics*, North-Holland, Volume 2.

Simon, B. 2005. *Passing go: Recreation fees and the use of passes to cover entry fees* ..Washington DC: National Park Service.

Taylor, P. A., B. Grandjean and B. Anatchkova. 2006. “Analysis to Assist with Pricing the New Recreation Pass: Task 5, The Survey.” WYSAC Technical Report No. SRC-615, 219 pages. Also posted on the website of the U.S. Department of the Interior.

Woolridge, J.M. 2002. *Econometric Analysis of Cross Section and Panel Data*. MIT Press, Cambridge, MA.

Table 1. Acronyms used in the Text

Acronym	Full Expression
WTP	Willingness to Pay
NRP	New Recreation Pass
NPP	National Park Pass
GEP	Golden Eagle Pass
NPF	National Park Foundation
RDD	Random Digit Dialing
DBDC	Double-Bounded Dichotomous Choice
SBDC	Single-Bounded Dichotomous Choice
CV	Contingent Valuation
ME	Marginal Effect

Table 2. Variable Definitions and Sample Means

Variables	Definitions	Means	
		RDD Sample (N = 462)	NPF Sample (N = 1461)
Initial Bid	First bid chosen randomly from {$25,$45,$65,$85,$105,$125,$145,$165}	93.615	96.691
All Revenue	1 if household is more likely to purchase pass if all money was used for services and facilities on federal recreation sites; 0 otherwise	0.628	0.636
Low Visits	1 if number of visits last year to Federal recreation sites ≤ 3, 0 otherwise	0.803	0.453
Young	1 if 17 < Age < 30; 0 otherwise	0.149	0.138
Old	1 if 50 < Age < 60; 0 otherwise	0.242	0.300
Male	1 if Male; 0 otherwise	0.433	0.477
BS degree	1 if BS degree or some graduate school; 0 otherwise	0.357	0.394
Professional degree	1 if Graduate or professional degree; 0 otherwise	0.236	0.353
Low Income	1 if Household income is less than $50K; 0 otherwise	0.321	0.255
Hispanic	1 if Hispanic; 0 otherwise	0.056	0.027
White	1 if White; 0 otherwise	0.846	0.876
Asian	1 if Asian; 0 otherwise	0.011	0.026
African American	1 if African American; 0 otherwise	0.024	0.003
NE	1 if states (CT, MA, ME, NH, RI, VT); NE = 0 otherwise	0.048	0.079
ENC	1 if states (PA, NY, NJ); ENC = 0 otherwise	0.113	0.117
WNC	1 if states (WI, OH, MI, IN, IL); WNC = 0 otherwise	0.160	0.155
GP	1 if states (IA, KS, MN, MO, ND, NE, SD); GP = 0 otherwise	0.071	0.082
SE	1 if states (DC, DE, FL, GA, MD, NC, SC, VA, WV); SE = 0 otherwise	0.165	0.177
WSC	1 if states (AL, KY, MS, TN); WSC = 0 otherwise	0.065	0.025
SW	1 if states (AR, LA, OK, TX); SW = 0 otherwise	0.067	0.071
RM	1 if states (AZ, CO, ID, MT, NM, NV, UT, WY); RM = 0 otherwise	0.097	0.109
PC	1 if states (AK, CA, HI, OR, WA); PC = 0 otherwise	0.214	0.185

Table 3. Percent Responding "YES" to Initial Referendum

RDD Sample (N = 462)		NPF Sample (N = 1461)	
Price	Percent Responding "YES"	Price	Percent Responding "YES"
25	55.5%	25	89.4%
45	38.3%	45	79.0%
65	22.4%	65	60.2%
85	22.0%	85	45.4%
105	19.4%	105	33.9%
125	10.5%	125	22.8%
145	12.7%	145	22.3%
165	13.5%	165	13.6%

Notes. Protest households (67 in RDD sample and 30 in NPF sample) have been omitted.

Table 4. DBDC WTP Estimates for the NRP

Explanatory Variables†	RDD Sample		NPF Sample	
	Coefficient	P-Value	Coefficient	P –Value
All Revenue	0.52***	0.00	0.12***	0.00
Low Visits	-0.40***	0.01	-0.11***	0.00
Young	0.12	0.27	-0.09*	0.06
Old	-0.01	0.47	-0.04**	0.04
Male	-0.09	0.24	-0.08**	0.02
BS degree	0.17	0.15	0.05	0.14
Professional degree	0.08	0.33	0.09**	0.04
Low Income	-0.10	0.27	-0.19***	0.00
White	0.06	0.43	-0.02	0.39
Hispanic	0.77**	0.02	0.07	0.31
Asian	0.62	0.12	-0.16	0.12
African American	-0.66*	0.09	0.32	0.14
NE	-0.24	0.22	0.02	0.38
ENC	-0.23	0.17	-0.03	0.34
WNC	-0.40**	0.04	-0.04	0.27
GP	-0.18	0.26	-0.12*	0.09
SE	-0.07	0.38	-0.02	0.34
WSC	-0.40*	0.10	-0.06	0.31
SW	0.02	0.47	0.04	0.30
RM	0.21	0.19	0.05	0.21
Heteroscedasticity (H^d) Results				
Constant	-0.22	0.22	-0.57***	0.00
Initial Bid	0.003	0.19	-0.01***	0.00
H^d Likelihood Ratio	0.76	0.38	14.34***	0.00
Summary Statistics				
Sample Size	462		1461	
Likelihood Ratio Statistic	45.97***		65.07***	
Pseudo-R^2	0.056		0.024	
Mean WTP	$42.28		$94.52	
Median WTP	$34.93		$95.63	

Notes. (***), (**), and (*) refer to statistical significance at the 1, 5 and 10 percent levels. The estimation was carried out using the Constrained Maximum Likelihood (CML 2.0) package in Gauss version 3.5. The nonlinear optimization routine was Newton-Raphson with a convergence criterion of 1×10^{-5} for the gradient of the coefficients. The estimates for "don't know" and "missing" dummy variables are not shown. †Although not explicitly listed as an explanatory variable, we control for BID in creating the probabilities that enter the likelihood function. See Cameron and James [1987] for further details. Protest households are defined as those who refused the NRP for free and are excluded from the analysis.

Table 5. Hypothetical Bias Probit Model

Explanatory Variables	RDD Sample				NPF Sample			
	Mean	Coefficient	P –Value	ME	Mean	Coefficient	P –Value	ME
Hypothetical	0.082	1.362***	0.001	0.136	0.039	0.348**	0.034	0.126
All Revenue	0.628	-0.177	0.395	-0.007	0.636	0.030	0.376	0.012
Low Visits	0.803	-1.329***	0.002	-0.131	0.453	-0.409***	0.000	-0.157
Young	0.149	0.580	0.163	0.038	0.138	-0.055	0.346	-0.021
Old	0.242	-0.400	0.206	-0.014	0.300	0.177**	0.043	0.067
Male	0.433	-0.517	0.106	-0.022	0.477	0.062	0.252	0.024
BS degree	0.357	0.537	0.140	0.026	0.394	0.093	0.210	0.036
Professional degree	0.236	0.068	0.452	0.003	0.353	0.129	0.144	0.049
Low Income	0.312	-0.400	0.204	-0.019	0.255	0.054	0.361	0.020
White	0.846	-0.577	0.156	-0.038	0.877	0.224*	0.080	0.087
NE	0.048	0.168	0.438	0.008	0.079	-0.475***	0.008	-0.187
ENC	0.113	0.178	0.383	0.008	0.117	-0.297**	0.038	-0.117
WNC	0.160	0.117	0.427	0.005	0.155	-0.375**	0.012	-0.147
GP	0.071	0.122	0.433	0.005	0.082	-0.730***	0.000	-0.285
SE	0.165	-0.187	0.383	-0.007	0.177	-0.307**	0.018	-0.120
WSC	0.065	-3.832	0.461	-0.032	0.025	-0.471**	0.046	-0.186
SW	0.067	-1.256	0.084	-0.020	0.071	-0.353**	0.039	-0.139
RM	0.097	-1.114	0.133	-0.022	0.109	-0.171	0.147	-0.067
Constant	1.000	-0.639	0.235	--	1.000	0.435**	0.037	--
Sample Size	180				830			
Hypothetical Bias Scaling Factor (e^{δ})	1.43				1.30			

Notes. (***), (**), and (*) refer to statistical significance at the 1, 5 and 10 percent levels. The estimation was carried out using the Constrained Maximum Likelihood (CML 2.0) package in Gauss version 3.5. The nonlinear optimization routine was Newton-Raphson with a convergence criterion of 1×10^{-5} for the gradient of the coefficients. The estimates for "don't know" and "missing" dummy variables are not shown. ME = Marginal Effect. 26 and 17 protest households (those that would not be interested in the NRP even if it were offered free of charge) were removed from the RDD and NPF samples.

Table 6. Information Used in Solving for the Internal Hypothetical Bias Factor from Equation (13)

Estimate	RDD Sample	NPF Sample
Δ	0.136	0.126
σ	1.014	0.561
$\bar{X}'\beta$	3.748	4.536
Equation (13): $\Delta = \Phi(\frac{1}{\sigma}(\bar{X}'\beta + \delta - \ln(\$65))) - \Phi(\frac{1}{\sigma}(\bar{X}'\beta - \ln(\$65)))$		
δ	0.357	0.261
$\exp(\delta)$	1.430	1.298

Notes. $\Phi \equiv$ standard normal cumulative distribution function.

Table 7. Awareness, Internal Hypothetical Bias and External Hypothetical Bias Calibration Factors

Panel A. NRP Revenue Predictions

Revenue Type	Predicted NRP Revenue ($65 × Millions of Households Purchasing NRP)			
	RDD Sample		NPF Sample	
	Non-Parametric	Parametric	Non-Parametric	Parametric
w/out Awareness Correction	491.14	254.63	0.88	1.40
w/ Awareness Correction	187.63	102.75	0.85	1.35
w/ Awareness & IHB Correction	143.48	22.34	0.54	1.03
w/ EHB Correction	30.00	30.00	1.00	1.00

Panel B. Scaling Factors

Calibration Type	Scaling Factor: "NRP Revenues are Divided by a Factor of __"			
	RDD Sample		NPF Sample	
	Non-Parametric	Parametric	Non-Parametric	Parametric
Awareness Bias	2.62	2.48	1.04	1.04
Internal Hypothetical Bias	1.31	4.60	1.57	1.31
External Hypothetical Bias	4.78	0.74	0.54	1.03
Total Bias	16.41	8.44	0.88	1.40

Notes. IHB = Internal Hypothetical Bias; EHB = External Hypothetical Bias.

Table 8. Predicted Revenue and Number of Pass Holders (Non-Parametric Estimates)

	RDD Sample			NPF Sample		
Price	Predicted Number of Pass Holders (in thousands)	NRP Revenue (millions of $)	Gate Revenue (millions of $)	Predicted Number of Pass Holders (in thousands)	NRP Revenue (millions of $)	Gate Revenue (millions of $)
15	2,698.2	40.5	137.9	41,414	0.62	0.11
25	1,828.4	45.7	155.2	39,609	0.99	0.15
35	1,207.1	42.2	173.8	35,133	1.23	0.28
45	603.6	27.2	198.0	27,610	1.24	0.59
55	497.0	27.3	203.8	20,989	1.15	0.92
65	461.5	30.0	205.8	15,385	1.00	1.25
75	319.5	24.0	216.1	12,940	0.97	1.42
85	284.0	24.1	218.8	9,667	0.82	1.68
95	248.5	23.6	222.1	7,335	0.70	1.89
105	213.0	22.4	225.7	4,965	0.52	2.13
115	88.8	10.2	239.6	3,987	0.46	2.23
125	71.0	8.9	241.8	2,972	0.37	2.36
135	53.3	7.2	244.2	2,520	0.34	2.42
145	17.8	2.6	249.3	1,881	0.27	2.51
155	17.8	2.8	249.3	1,241	0.19	2.60
165	0	0	252.1	1,091	0.18	2.63
175	0	0	252.1	828	0.14	2.67
185	0	0	252.1	715	0.13	2.69
195	0	0	252.1	489	0.10	2.73
205	0	0	252.1	226	0.05	2.79
215	0	0	252.1	226	0.05	2.79
225	0	0	252.1	113	0.03	2.81
235	0	0	252.1	113	0.03	2.81
245	0	0	252.1	113	0.03	2.81
255	0	0	252.1	75	0.02	2.82
265	0	0	252.1	75	0.02	2.82
275	0	0	252.1	0	0	2.84

Notes. For simplicity, price points at the extremes of the bid range are excluded. RDD survey data have been calibrated to reflect $30 million in NRP revenue at $65, based on current annual pass sales. NPF survey data have been calibrated to reflect $1 million in NRP revenue at $65, based on estimated NPP and GEP sales to former purchasers through NPF. Revenue and pass holder figures are calculated using the midpoint of the WTP interval. Households that state “YES” to both bids are assigned a WTP equal to $10 plus the highest bid. For the RDD sample, 67 protest households have been omitted, leaving a sample size of N = 462. For the NPF sample, 30 protest households have been omitted, leaving a sample size of N = 1461.

Figure 1. Illustration of the Procedure to Identify a Dollar-Valued Hypothetical Bias Estimate