Modeling and estimating WTP for reducing acid deposition injuries to cultural resources: using choice experiments in a group setting to estimate passive-use values*

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INTRODUCTION

Numerous elicitation methods have been employed to gather stated preference data for use in estimating the value of environmental goods. The most commonly used methods have been various forms of the contingent valuation method (CVM), for example payment cards, open-ended willingness-to-pay (WTP) questions, and referenda. More recently, choice experiments (CEs) have been used to gather valuation data for environmental goods for which the value of the good is primarily direct-use. This study uses pair-wise choice experiments to estimate the total value (direct- and passive-use) of an environmental good. The choice experiments were contained in a survey administered in-person in a group setting. This approach exploits many of the benefits of individual in-person interviews while maintaining a more consistent presentation of the information across respondents and lower implementation costs.

This study estimates the benefits of reducing acid deposition injuries to an important set of cultural resources: the 100 outdoor marble monuments in Washington, D.C. The reduction in injuries are presented as hypothetical preservation programs that mimic the likely range of injury reduction resulting from the reductions in sulfur dioxide (SO_2) emissions required by Title IV of the 1990 U.S. Clean Air Act Amendments.

Group interviews were conducted in the Philadelphia and Boston metopolitan areas. The results indicate that, on average, households in these areas are willing to make a one-time payment of $33 to $69, depending on the level of preservation, to slow down the rate of deterioration of the 100 outdoor marble monuments in Washington, D.C. The remainder of this paper is organized as follows. Section 2 introduces the elicitation method and the theoretical model. Section 3 discusses the collection of the choice experiment data and Section 4 presents the empirical results. Finally, Section 5 provides concluding remarks and suggestions for further research.

CHOICE EXPERIMENTS AND MODELING WTP

Valuing environmental goods with choice experiments

Choice experiments evolved from conjoint analysis, a method used extensively in marketing and transportation research (Louviere, 1988; Green and Srinvasan, 1990; Batsell and Louviere, 1991; and Louviere, 1992). Conjoint analysis requires respondents to rank or rate multiple alternatives where each alternative is characterized by multiple attributes (e.g., Johnson *et al*., 1995; and Roe *et al*., 1996). Typically, choice experiments require respondents to choose the most preferred alternative (a partial ranking) from multiple alternative goods–i.e., a choice set–where the alternatives within a choice set are differentiated by their attributes. When using choice experiments to value environmental goods a price, often a tax or a measure of travel costs, is included as one of the attributes of each alternative so that preferences towards the other attributes can be measured in terms of dollars, i.e., WTP or WTA.

Choice experiments have been used to estimate the value of public goods. For example, Magat *et al.*(1988) and Viscusi *et al.* (1991) estimated the value of reducing health risks; Adamowicz *et al.* (1994), Buchanan *et al*. (1998), and Adamowicz *et al.* (1997) estimated recreational site choice models for fishing, mountain biking, and moose hunting, respectively; Adamowicz *et al.* (1996) estimated the value of enhancing the population of a threatened species; and Layton and Brown (1998) estimated the value of mitigating forest loss resulting from global climate change.[1] Except for Adamowicz *et al*. (1996) and Layton and Brown (1998), each of these studies measured only direct-use values. In each of the studies, respondents were presented with multiple choice sets from which they chose their most preferred alternatives.

There are many desirable aspects of choice experiments, not least of which is the nature of the choice being made.[2] To choose the most preferred alternative from some set of alternatives is a very common decision experience, especially when one of the attributes of the alternatives is a price. One need only walk the isles of a grocery store to experience this type of decision environment. In a hypothetical market, multiple sets of alternative goods can be constructed with varying attribute levels for each alternative. The task of the respondent is to choose the most preferred alternative from each of these choice sets. In this respect, this type of choice experiment is markedly different from the CVM. Rather than being presented with one hypothetical state of the world and either voting for or against, or stating or choosing one's WTP for it, the choice experiment requires respondents to choose the good that is most preferred from multiple choice sets. One can argue that such a decision task encourages respondents to concentrate on the trade-offs between attributes rather than to take a position for or against an initiative or policy. This type of repeated decision process may also diffuse the strong emotions often associated with environmental goods thereby reducing the likelihood of "yea-saying."[3]

Like conjoint analysis, choice experiments allow for the construction of goods characterized by attribute levels that (currently) do not exist. This feature is particularly useful in marketing studies when the purpose is to estimate preferences for new products. Similarly, researchers estimating the value of environmental goods are often valuing a good or condition that does not currently exist. In this study, we estimate the value of changes in the future condition of a good–up to 300 years from now–which cannot be observed in goods currently available.

Choice Model

The choice experiment framework is consistent with the discrete choice random utility model, the same theoretical framework often used with CVM and travel cost data (McFadden, 1974; Ben-Akiva and Lerman, 1985; Mitchell and Carson, 1989). Within this framework, we assume that individuals have preferences over any pair of goods, for example, preservation alternatives. Individual *i* chooses the preservation alternative *j* that provides the greatest utility, U_{ij}, where alternative *j* is a member of the choice set of C possible alternatives. The probability that individual *i* will choose preservation alternative *j* over *k* is:[4]

$$\Pr_i\{j \text{ over } k\} = \Pr_i\{U_{ij} \geq U_{ik};\ j \neq k\} \qquad i = 1,2,...,I \text{ and } j,k = 1,2,...,23. \tag{1}$$

The utility individual *i* receives from choosing preservation alternative *j* is:

$$U_{ij} = V_{ij} + \varepsilon_{ij} \tag{2}$$

where V_{ij} is assumed deterministic from both the researcher's and the individual's perspective, and ε_{ij} is random from the researcher's perspective, but known by the individual. Equation (2) is the conditional indirect utility function and identifies maximum utility conditional on the choice of preservation alternative *j*. By substituting equation (2) into equation (1) and rearranging, the probability of choosing alternative *j* over alternative *k* becomes:

$$\Pr_i\{j \text{ over } k\} = \Pr_i\{V_{ij} - V_{ik} \geq \varepsilon_{ik} - \varepsilon_{ij};\ j \neq k\}. \tag{3}$$

It is assumed that each ε_{ij} is independently drawn from a univariate Type I Extreme Value Distribution (McFadden, 1974) with the cumulative distribution function:

$$F(\varepsilon_i) = \exp[-e^{-r_i(\varepsilon_i - \alpha)}] \tag{4}$$

where α is a location parameter set equal to zero and r_i is a positive scale parameter. This distribution has a mode of α, mean of $\alpha + \frac{\gamma}{r_i}$, where γ is Euler's constant (~ .57721), and variance $\sigma_\varepsilon^2 = \frac{\pi^2}{6r_i^2}$. We assume that the random components of the conditional indirect utility function, ε_{ij}, are independent and identically distributed across individuals and choice occasions; that is, $r_i = r \forall i$. Without loss of generality, *r* is set equal to 1. The probability that individual *i* will choose preservation alternative *j* over *k* becomes:

$$\Pr_i\{\text{j over k}\} = \frac{e^{V_{ij}}}{e^{V_{ij}} + e^{V_{ik}}} \quad \text{and} \quad \frac{\Pr_i\{\text{j over k}\}}{\Pr_i\{\text{k over j}\}} = \frac{e^{V_{ij}}}{e^{V_{ik}}}. \tag{5}$$

CHOICE EXPERIMENT DATA COLLECTION

Application

Society values cultural resources such as monuments, building facades, and outdoor sculpture for a variety of aesthetic, cultural, and historical reasons. Value may be derived from direct-use (e.g., visiting monuments), indirect-use (e.g., viewing pictures of monuments), and passive-use (e.g., knowing that monuments will teach current and future generations about historical events). Given the vast distribution of cultural resources, it is likely that their value to society is significant. Nevertheless, relatively little is known about how the public values these resources. Aside from what can be inferred from visitation data or maintenance and renovation expenditures, there are few quantitative estimates of the overall value of these resources. Even less is known about how the value of cultural resources may be affected by changes in the condition of these resources.

Some cultural resources that are made of carbonate stone, e.g. marble or limestone, or bronze are injured by exposure to air pollutants such as SO_2, which in the U.S. is being reduced by Title IV of the 1990 Clean Air Act Amendments. These injuries, which include surface erosion and soiling, alter the appearance of the resource to an extent that might diminish value.

For example, a bronze statue that has lost its original patina may no longer be aesthetically pleasing, or a marble monument that has lost its inscription may have less historical value. Society may derive benefits by avoiding such injuries or by slowing the rate at which they occur, which is one of the potential benefits of Title IV.

Survey instrument development

The survey instrument was developed after a scoping effort, which included a literature review, consultation with an expert review panel, and scoping interviews regarding preferences and attitudes toward monuments and their condition. Nine focus groups were then conducted to further develop and refine the presentation materials and the survey instrument.[5]

The goal of the study was to develop estimates of the value of expected reductions in injury to cultural resources as a result of the Title IV required reductions in SO_2 emissions. Because there are many types of materials and many different kinds of cultural resources that might benefit from reductions in SO_2 emissions, the first step in the study was to select a category of cultural resources on which to focus. We chose the set of outdoor marble monuments and historic buildings in the Washington D.C. area because these have national significance. For many types of building materials, the value of the damage caused by air pollution is adequately measured by the costs of replacement or repair, but this is likely not true for monuments and buildings with historic significance. We limited the material to marble to keep the description of the effects of air pollution manageable (it varies for different materials) and because marble is quite vulnerable to the effects of SO_2 and was a commonly used material for monuments and building facades between 1850 and 1940 in Washington D.C.

Although the Title IV requirements will result in substantial emission reductions throughout the eastern half of the United States (reducing SO_2 emissions by about 40% from

1980 levels), we limited this study to the potential effects on marble monuments and the marble facades of select historic buildings in the Washington D.C. area. Covering a larger area would be difficult because of the wide variation in the numbers and types of monuments in different locations. Limiting the study to a single monument would make the description of the monument easier, but would not reflect the regional nature of the impact of changes in air quality on the resource. Because Washington D.C. is the nation's capital and contains a large collection of nationally known monuments, we expect that the value of reducing the injury to these monuments will exceed the value of reducing the injury to monuments in other eastern U.S. cities, at least for non-residents.

The approximately 100 outdoor marble monuments in Washington D.C. were listed for survey respondents along with a map showing their locations. A few photographs of selected monuments were also shown, including a few of the best known and a few of the less well known monuments. About 75% of the respondents said they had visited outdoor monuments in Washington D.C. Although people often commented on moving personal experiences when visiting certain monuments, the primary reason they offered for being willing to pay to preserve these monuments was so that the monuments would be available for other people to visit, both now and in the future.[6] Respondents stressed the importance of conveying the historical and inspirational messages of monuments to future generations; indeed, more than 70% of the respondents said that it mattered to them that these monuments still existed 100 years or more from now, which is long after their own expected lifetimes. Thus, passive-use values appeared to be a more important component of willingness to pay than direct-use values.

There were two key challenges to the development of the valuation scenario for this survey. The first was how to describe the change in the rate of injury to the monuments that would be achieved, and the second was finding a plausible hypothetical mechanism for achieving these changes with plausible alternative costs to individual households.

To develop the descriptions of the effects of SO_2 related pollutants on outdoor monuments we reviewed summaries of the scientific literature and consulted with researchers on this topic. SO_2 related pollutants have been linked to erosion and chemical alteration of marble. These processes lead to loss of surface detail and discoloration. Some erosion occurs with exposure to rain alone, but SO_2 related air pollutants accelerate this process and are responsible for certain types of discoloration. However, most of the quantitative analysis has focused on the chemistry and not on the impact of these processes on the overall appearance of the monument. We concluded that although the effects of SO_2 related air pollutants on marble monuments can be described, a specific quantitative estimate of the reduction in the rate of deterioration in the appearance of marble monuments as a result of Title IV emission reductions is not feasible at this time. However, a plausible range for these effects was defined based on consultation with experts in this area. We presented this to survey respondents as changes in the amount of time it would take before certain changes in appearance would occur, which were illustrated with computer generated photographs.

The second challenge was to develop a plausible hypothetical mechanism by which these changes in the rate of injury could be achieved. One option was to pose a change in air pollution emissions, but this caused several difficulties because there are so many joint benefits of reducing air pollution, including improvements in health and visibility. To focus the valuation questions on these 100 marble monuments, we posed three alternative treatment processes that would reduce the susceptibility of the marble to air pollution and weathering and slow the rate of deterioration in the appearance of the monuments. There are no such treatment processes available, but subjects in the focus groups seemed to readily accept the plausibility that such treatments exist. Using this hypothetical mechanism mimicked the expected effects on the monuments of reducing air pollution and allowed the valuation exercise to focus on just these 100 monuments.

Preceding the description of the preservation programs, the nature of the effects of pollution on marble were described with verbal descriptions and photographic illustrations. Of the roughly 100 outdoor marble monuments and historical buildings in Washington, D.C., almost all of them were erected between 1850 and 1940. These monuments and historic buildings were listed by name and their locations were shown on a map of the area. A few illustrative photographs of some well-known and not so well-known monuments were also shown.

Given the varying shapes of the monuments, the different types and quality of marble, the different weathering conditions, and the different ages of the monuments, the condition of the monuments is quite varied today. Two monuments were chosen to represent the average condition of the monuments today and the average expected future condition. The first is a statue of Benjamin Franklin in Washington, D.C. The second is a capital, or top, of a column, similar to those on the U.S. Capitol, the Supreme Court, and the Lincoln and Jefferson Memorials.

A photograph of each of these monuments was digitally altered to represent the average current condition of the group of monuments and the estimated average condition in 75 and 150 years from now if no preservation program is undertaken (that is, without the Title IV pollution reductions). These six images, included in the appendix and labeled Figure 5, were displayed on a timeline to illustrate how air polllution and weathering injuries are expected to affect the monuments' appearance over time. The baseline timeline spans 300 years, from 1850, the beginning of the monument installation period, to 2150, with the three pairs of pictures spaced along the timeline at 1996 (today), 2075 (about 75 years from now), and 2150 (about 150 years from now).[7]

The three preservation programs were described in terms of the extent to which they would proportionately alter the injury timeline. For Option A, which extends by 25% the amount of time it will take for the injuries in the picture series to occur, the second pair of pictures is shown at 94 years from now and the third pair at 188 years from now. Option B extends the amount of time by 50% to 113 years and 225 years, respectively; Option C extends the amount of time by 100%, or doubling the years to 150 and 300 from now, respectively.

Four large posters displayed the various timelines, the first poster showed the baseline timeline without any preservation program; the next three illustrated each preservation option in comparison to the baseline. Images of the latter three posters are included in the appendix, labeled Exhibits A, B, and C. In addition, each respondent had a large copy of the six-picture series to examine independently and at close range.

For our study, each set of choices consisted of two alternatives. Respondents were instructed to select the more preferred alternative from each pair. An alternative is a combination of one of the preservation options (Option A, Option B, Option C, or Status Quo) and a dollar value that the household would pay as a one-time payment for that option.[8] The dollar values were selected from the following: $0 (for status quo only), $0.25, $1, $3, $7, $10, $15, $25, and $50.[9]

To help respondents understand the choice task, the pair-wise choice section began with two example pairs. The example pairs were:

Example 1: No Preservation for $0 or Preservation Option C for $25 and

Example 2: Preservation Option B for $10 or Preservation Option C for $15

For each pair, the survey administrator provided reasons why people might select either option. These reasons were included to let participants know that there are good reasons for selecting either alternative in a pair.

The choice task for each respondent then consisted of ten pair-wise choices. Twenty versions of the choice sets were used. The task of designing the choice sets was relatively straightforward because the alternatives are described in terms of only two attributes.[10] Preservation level takes one of four values and price takes one of nine values. All dominant pairs–pairs with more effective options for an equal or lower dollar amount (e.g., Option B at $3 and Option A at $7)–were excluded, leaving 108 pairs. Each of the 108 pairs appeared on at least one version. In addition, each survey had five pairs containing the status quo (No Preservation at $0) as an alternative.[11]

Survey administration

The survey data were collected during a series of group sessions. These sessions lasted an average of 1.5 hours and were attended by 7 to 31 respondents. The sessions were divided into two parts. During the first part, which lasted about 50 minutes, respondents alternated between listening to the administrator present information, reviewing the information in their response booklets, and providing written answers to survey questions. During the second part, respondents worked at their own pace reading survey questions and providing written answers. Information was provided verbally by the survey administrator, and reinforced with written summaries in the response booklets, and visually on large posters at the front of the room and in illustration booklets.[12]

This group survey approach exploits many of the advantages of in-person interviews: extensive use of visual aids; greater comprehension of complex hypothetical scenarios; and greater opportunity to motivate respondents to answer difficult questions.[13] Furthermore, the group sessions allow for greater consistency in presentation across individuals and allow more privacy for the respondent than individual surveying.[14] While the presentation of the information used in the group survey sessions was developed and tested in focus groups, the survey sessions were not conducted as focus groups. There were no discussions among participants and it was explained at the outset that survey responses would not be revealed during the session.

This survey required that an extensive amount of verbal and visual information be presented to respondents about the good, the injuries, and the hypothetical scenario. The amount of information in the survey and the need for extensive visual materials precluded the use of a telephone only survey (without accompanying materials). Since we were able to refine the presentation of the information during the focus groups, producing the materials and administering the group surveys was less costly than adapting the presentation to a combination mail-telephone survey. It may be feasible to adapt the materials for presentation in a mail survey, but this would require extensive testing to ensure its effectiveness in communicating the necessary information.

In each city we selected two survey areas to represent the city. In Boston, the areas were Dedham and Woburn; in Philadelphia, the areas were downtown and Ft. Washington. The sample was recruited from a list of randomly selected households who resided in these areas. Individuals at 908 households completed a telephone screening survey (several demographic questions) and were offered $50 to participate in a group survey on a national policy issue.[15] Of these, 409 (45%) agreed to attend; 272 (67%) actually attended a session and completed a survey. Because we did not specify the subject of the survey, contacts were not able to self-select based on their preferences for monument preservation. Four survey groups were conducted at each survey center in each area for a total of 8 groups per city and 16 overall. The size of the group ranged from 7 to 31, averaging 17 people per session.

That participants were required to attend a session and were compensated for doing so may compromise the degree to which our sample represents the population of Boston and Philadelphia.[16] Our sample somewhat under-represents younger (under 35 years) and older (over 64 years) individuals, and over-represents Caucasian and non-low-income individuals. Table 1 shows the demographic characteristics of our sample and the study population, metropolitan Philadelphia and Boston. Given the demographic differences of the sample and population, the sample mean WTP does not represent the population WTP unless it is weighted for these differences.

Table 1. Demographic Characteristics for Study Sample and Population

Demographic Characteristic		Sample		Population
Age (18 and older)	18 to 24	23	9%	16%
	25 to 34	37	14%	24%
	35 to 44	67	26%	18%
	45 to 64	106	41%	24%
	65+	26	10.%	18%
Ethnicity	Caucasian	197	76.%	70%
	Non-Caucasian	62	24%	30%
Income[17]	Less than $12,000	21	8%	20%
	More than $12,000	238	92%	80%

EMPIRICAL RESULTS

Estimation of conditional indirect utility function

We have data for I = 259 individuals, and choices of preservation alternatives for up to ten pairs of alternatives per individual, yeilding a total of 2,568 choices.[18] For each pair, *p*, an individual chooses alternative A or B. Given the binary logit model of pair-wise choices, the parameters in the conditional indirect utility function have been estimated by maximizing the following likelihood function using the Gauss programming language[19]:

$$L = \sum_{i=1}^{\mathrm{I}} \sum_{p=1}^{P_i} \left\{ \mathrm{y}_{ip} \ln\left(\frac{e^{\mathrm{V}_{iAp}}}{e^{\mathrm{V}_{iAp}} + e^{\mathrm{V}_{iBp}}} \right) + \left(1 - \mathrm{y}_{ip}\right) \ln\left(\frac{e^{\mathrm{V}_{iBp}}}{e^{\mathrm{V}_{iAp}} + e^{\mathrm{V}_{iBp}}} \right) \right\} \tag{6}$$

where y_{ip} equals one if individual i chooses alternative A from pair p and zero if alternative B is chosen.

The deterministic part of conditional indirect utility from equation (2), V_{ij}, is a function of the two attributites characterizing alternative j: the level of preservation alternative j, (Level_j) and the amount of money the individual has left to spend on all other goods after choosing preservation alternative j, (Income_i - Price_j); and other characteristics of individual i, S_i, such that:

$$\mathrm{V}_{ij} = \mathrm{V}(\mathrm{Level}_j, (\mathrm{Income}_i - \mathrm{Price}_j), \mathrm{S}_i) \qquad i = 1,2,\ldots,\mathrm{I} \text{ and } j = 1,2. \tag{7}$$

Level_j can take on one of four values: 0 for the status-quo, 0.25 for Option A, 0.50 for Option B, and 1.00 for Option C. Price_j, the dollar amount associated with preservation alternative j, can take on one of nine values: p = {0, 0.25, 1.00, 3, 7, 10, 15, 25, 50}. Income_i is the midpoint of the household income range specified by the respondent.[20]

Numerous non-linear relationships were tested for both (Income_i - Price_j) and Level_j. The specification of conditional indirect utility that best explains the choices made is:

$$\begin{aligned} \mathrm{V}_{ij} &= (b_1 + b_2 \text{ Gender}_i + b_3 \text{ Lowincome}_i)\,(\mathrm{Income}_i - \mathrm{Price}_j) \\ &+ (b_4 + b_5 \text{ Age}_i + b_6 \text{ Ethnicity}_i)\,\mathrm{Level}_j \\ &+ (b_7 + b_8 \text{ Age}_i + b_9 \text{ Ethnicity}_i)\,(\mathrm{Level}_j)^{.5}. \end{aligned} \tag{8}$$

Age_i is the respondent's age in years, and $Gender_i$, $Lowincome_i$, and $Ethnicity_i$, are dummy variables with the following assignments:

$Gender_i$: 0-Male, 1-Female

$Ethnicity_i$: 0-Caucasian, 1-Non-Caucasian

$Lowincome_i$: 0-Household annual income ≥ \$12,000; 1-Household annual income < \$12,000

The parameter estimates are reported in Table 2. Likelihood ratio tests indicate each variable adds significantly to the model's explanatory power.

Table 2. Maximum Likelihood Parameter Estimates for Conditional Indirect Utility Function

Parameters	Estimates	t-statistics
b_1	0.0521	12.056
b_2	-0.0241	-5.515
b_3	0.0346	3.311
b_4	-1.1652	-1.431
b_5	0.0387	2.234
b_6	-0.7507	-1.390
b_7	3.2849	3.792
b_8	-0.0122	-0.661
b_9	-0.9611	-1.730
Log of the likelihood function = -1,356.75		

The estimated model correctly predicted 75% of the choices. The model is better able to predict the choices of some respondents than others: the model predicts all of the choices of 55 respondents (21%) and predicts at least 70% of the choices of 192 respondents (74%). The model incorrectly predicts all choices for 3 respondents (1%). Another measure-of-goodness of fit is the ρ^2 index described by Ben-Akiva and Lerman (1985). For our model, the index, $\rho^2 = 1 - \frac{L(\hat{\beta})}{L(0)}$, equals 0.24.

The parameter $\beta_1 \equiv (b_1 + b_2 \text{ Gender}_i + b_3 \text{ Lowincome}_i)$ is the marginal utility of money. Given the estimates of these parameters, the marginal utility of money is positive and constant for each respondent, though it varies across respondents. The marginal utility of money is a step function of income; people with annual household income less than $12,000 have a greater marginal utiltiy of money than those with higher incomes. The marginal utility of money also varies by gender: women have a lower marginal utility of money than men.

The marginal utility of the level of preservation $(\beta_2 + .5\beta_3(Level_j)^{-0.5})$, where $\beta_2 \equiv (b_4 + b_5 \text{ Age}_i + b_6 \text{ Ethnicity}_i)$ and $\beta_3 \equiv (b_7 + b_8 \text{ Age}_i + b_9 \text{ Ethinicity}_i)$, is positive and declining for all respondents over the range of preservation levels considered (0 to 1), except for young, non-Caucasian respondents.[21] Marginal utility from preservation increases with age and is lower for non-Caucasians.

These differences among individuals are consistent with answers to the attitudinal survey questions. Repeatedly, female and Caucasian respondents expressed attitudes consistent with experiencing greater utility from monument preservation than their counterparts. Also, some non-Caucasian respondents, especially African-Americans, expressed some negative attitudes toward these monuments which they felt did not reflect their own history and culture.

Welfare estimates

To estimate the welfare changes, or willingness to pay, associated with changes in the rate of deterioration of the marble monuments in Washington, D.C., we estimate each individual's willingness to pay, WTP_i, for changes in the level of preservation.[22] Given that the marginal utility of money is a step function of income, that there is no choice over alternatives once the state is specified, and that the policies considered have small welfare effects, the WTP for a change from state 0 (the status quo) to Option *j* is:

$$\text{WTP}\{0j\} = \frac{1}{\beta_1}\left[U_{ij} - U_{i0}\right] \tag{9}$$

where $U_{ij} = V_{ij} + \varepsilon_{ij}$. Substituting the estimated conditional indirect utility function and simplifying: [23]

$$\text{WTP}\{0j\} = \frac{1}{\beta_1}\left[\beta_2(Level_j) + \beta_3(Level_j)^{1/2}\right] \tag{10}$$

We are interested in the WTP for changes from the status-quo, the level of preservation in the absence of the Title IV reductions in SO_2, to states of the world with one of the preservation options. The estimated WTP for Options A, B, and C for every individual in the sample is significantly different from zero. Table 3 reports the minimum, maximum, median and mean estimated WTP as a one-time payment and the confidence interval of the mean for the 259 respondents.

Table 3. Estimated Sample Household WTP: One-time payment

	Min	Max	Median	Mean	95% Confidence Interval of Mean[25]
WTP for Option A	\$8.91	\$60.62	\$30.86	\$38.16	\$31.67 - \$48.37
WTP for Option B	\$10.77	\$95.63	\$46.98	\$55.68	\$47.34 - \$69.27
WTP for Option C	\$11.59	\$155.04	\$73.31	\$82.24	\$71.33 - \$100.15

As suggested by the parameter estimates for the conditional indirect utility function, females, Caucasians, non-low-income people, and older people are willing to pay more than their counterparts. In general terms, the estimated WTP of non-low-income males is 53% that of non-low-income females, and the estimated WTP of low-income males is 72% that of low-income females. The estimated WTP of low-income males is 60% that of other males, and the estimated WTP of low-income females is 44% that of other females.[26] Depending on the age of the individual, a representative non-Caucasian's estimated WTP ranges from 34% to 60% of that of a Caucasian. For any 10-year increase in age, the estimated WTP for a Caucasian increases from 2% to 10%.

These mean WTP estimates can be adjusted to represent the urban populations of Boston and Philadelphia by weighting the WTP of sample respondents to correct for the fact that their demographic characteristics are, on average, somewhat different from those of the study population. Our sample underrepresents those under 35 years and those over 65 years, non-Caucasians, and those having low-income (see Table 1). Table 4 reports weighted estimates for the study population.[27]

Table 4. Weighted Estimated Household WTP: One-time payment

	Min	Max	Median	Mean	95% Confidence Interval of Mean
WTP for Option A	$10.85	$100.31	$25.18	$32.69	$27.27 – $41.32
WTP for Option B	$15.45	$156.65	$37.38	$47.14	$40.51 – $58.50
WTP for Option C	$20.52	$251.13	$56.63	$68.49	$60.28 – $83.27

For some policy analysis applications, such as comparing the benefits to annualized costs of air pollution control, it is useful to have estimates of annual WTP. The one-time household payment can be converted to equivalent perpetual annual payments by assuming some discount rate. Table 5 provides these calculations assuming a 7% real discount rate. It is uncertain what the correct discount rate is for this purpose, but 7% is used here to illustrate the calculation. A higher discount rate would give a higher annualized value, and a lower discount rate would give a lower annualized value.

Table 5. Annual Weighted Estimated Household WTP: Perpetual annual payment given a 7% discount rate

	Median Perpetual Annual Payment	Mean Perpetual Annual Payment
WTP for Option A	\$1.76	\$2.29
WTP for Option B	\$2.62	\$3.30
WTP for Option C	\$3.96	\$4.79

Comparison of welfare estimates

This section compares the WTP estimates derived here with WTP estimates generated from other studies which value reductions in pollution more generally. We also compare our choice experiment WTP estimates with the results of a payment card question included in our survey.

Comparison of estimates: estimates of benefits associated with reducing pollution

There have been a few studies that have estimated WTP for other types of benefits associated with reducing pollution. For example, McClelland *et al*. (1991) conducted a CVM study in Atlanta and Chicago to estimate the WTP of local residents for a reduction in air pollution comparable in magnitude to that expected in Eastern cities under Title IV. Respondents were asked their maximum annual household WTP for this reduction and then asked to allocate that amount among the various effects of air pollution that would be realized. They estimated a mean annual WTP of \$121 (1996 dollars). The average split among the various pollution effects was: \$26 for reduced soiling, materials, and vegetation effects, \$23 for visual air quality improvements, \$59 for reduced human health effects, and \$13 for other reduced effects. This study did not ask for WTP for air quality improvements in locations other than the city where the respondents lived. WTP for reducing air pollution injury to marble monuments in Washington, D.C. would therefore be in addition to WTP for local air quality improvements for most residents of the United States. Compared to a mean annual WTP for reducing local soiling, materials and vegetation injury of $26 per household, a mean annual WTP of $2.29 - $4.79 for reducing injury to marble monuments in Washington, D.C. is plausible.

Comparison of estimates: payment card data

Within our survey, valuation data were also gathered using a payment card question for the most effective preservation program, Option C. Respondents were asked to indicated their maximum WTP for Option C by circling one of 22 values ranging from $0 to $200, “More than $200” or “Don't know.”

The data were analzyed using an interval model assuming that the random component is distributed normally (Payment Card Model 1) and assuming that the random component is distributed log-normally (Payment Card Model 2). The models maximize the likelihood that each individual's E[WTP] lies between the amount circled on the payment card and the next highest amount. For Payment Card Model 1, the estimated E[WTP] function that best fits the data specifies E[WTP] as a function of ethnicity and a two step-income variable. For Payment Card Model 2, E[WTP] is a function of a step-age variable, gender, a step-income variable, and ethnicity. The results of both payment card models and the choice experiment model are shown in Table 6.

Table 6. Comparison of Estimated Sample Household WTP for Option C: One-time payment

	Median	Mean	95% Confidence Interval of Mean
Payment Card Model 1 (normal)	$68.06	$57.29	$49.26 - $64.93
Choice Experiment	$73.31	$82.24	$71.33 - $100.15
Payment Card Model 2 (log-normal)	$107.89	$96.95	$71.78 - $134.48

The choice experiment mean and median WTP estimates lie between the two payment card E[WTP] estimates; the choice experiment mean estimated WTP is significantly greater than the Payment Card Model 1 estimate, but is not significantly different than the Payment Card Model 2 estimate. Since the payment card question followed the pair-wise choices for all respondents, we are not able to test the extent to which this ordering affected the payment card responses. In addition, there may be systematic differences in how people answer choice experiment questions vesus payment card questions. Therefore, at best this comparison provides only a rough benchmark.

Discussion and Conclusion

This paper estimates the value of reducing the effects of air pollution on a set of important cultural resources. The valuation scenario used and the use of choice experiments allowed us to isolate an environmental change in a way that encouraged survey respondents to focus on one of the effects of air pollution while diffusing the strong emotions often associated with pollution reduction. We feel that the use of choice experiments is uniquely suited for such an analysis: it requires survey respondents to focus their attention on the various changes in attributes of an environmental good rather than requiring them to indicate the extent of their support for an environmental policy.

The welfare estimates presented are for the total value associated with slowing the rate of deterioration (or reducing the effects of pollution on) the outdoor marble monuments in Washington, D.C. We find that households in metropolitan Boston and Philadelphia are, on average, willing to pay a one time payment of $33 to $68 to slow the rate of injury to these monuments depending on the level of preservation (pollution reduction). This study finds that WTP is a function of gender, income group, age and ethnicity: female, non-low-income, older and Caucasian individuals are willing to pay more than their counterparts. Without further study, though, the extent to which these results can be generalized to a larger population is unknown. In particular, WTP may be a function of other demographic characteristics for which variation within our sample was limited. For example, WTP may depend upon region of residence or whether one lives in a rural or urban environment.

One of the motivations for this study is the requirement by the U.S. Congress that the costs and benefits of the Title IV program of the 1990 Clean Air Act Amendments be assessed as the program is implemented. Estimates of the expected benefits to human health (Ostro et al., 1999) and visibility aesthetics (Chestnut and Dennis, 1997) have been completed and will be updated as the actual emissions reductions are achieved. This study provides a step toward quantitative estimates of the expected benefits from slowed rates of injury to a set of nationally important monuments and historic buildings, although more information is needed before aggregate national estimates of the Title IV related benefits regarding this set of national monuments can be developed. More information in two areas is needed. First, the physical science needs to be better able to quantify the change in the rate of visible injury associated with the change in SO_2 emissions. Second, more must be learned about how values vary across the country for this set of monuments. Because of their national significance, we presume that their condition would have value to residents throughout the country, but this study only sampled urban and suburban residents in two eastern U.S. cities (both within a day's drive of Washington D.C.).

The valuation methodology and findings presented in this paper are of interest for several reasons. This is one of only a few studies where choice experiments have been used to estimate passive-use values and one of few studies to estimate the value of slowing the rate of deterioration of cultural resources. The welfare estimates we derive are significant and they are reasonable: they fall within the range of amounts estimated in studies of similar environmental goods and are supported by the follow-up payment card question within this study. These results add to the support for use of choice experiments in valuing environmental goods in general, and show the strengths of using this valuation technique for estimating passive-use values.

This study collected survey data in a group setting. This approach provides a low cost method of implementing in-person surveys requiring extensive and detailed information describing a hypothetical good and a valuation scenario. Finally, the marginal utility of money is modelled as a step function of income, an approach supported by the data and one which simplifies the derivation of welfare estimates. Each of these innovations contributes to the development of a methodology that can reliably estimate the value of non-market goods and, in particular, goods for which values are derived from passive-use.

Collecting multiple observations, in this case multiple choices, from each individual allows for the examination of differences across individuals. One possible extension of this study is to examine the extent of heterogeneity of preferences towards cultural resources. This can be done by relaxing our assumption that the scale parameter, r_i, is equal across all individuals and instead allow it to vary either by individual or type of individual. Relaxing this constraint would allow the parameter estimates to vary proportionally across individuals. Another approach is to employ a random parameters model whereby one or more of the taste parameters is randomly drawn from a known distribution yet the parameters for any specific individual are unknown. Given that 10 choices are observed for each individual, it may also be possible to allow complete heterogeneity of preferences by estimating a separate model for each respondent.

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NOTES

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[1]In contrast, several environmental valuation studies have used a rating technique, one in which survey respondents choose from among multiple choice sets by rating the degree to which they prefer one alternative over another. For example, Opaluch *et al*. (1993) and Kline and Wichelns (1996) use choice experiments to develop a utility index for the attributes associated with potential noxious facility sites and farm land preservation, respectively. Johnson and Desvousges (1997) estimate WTP for various electricity generation scenarios using a rating scale in which respondents indicate their strength of preference for one of two alternatives within each choice set.

[2] The authors of the choice experiment studies mentioned above make note of these and other advantages of using choice experiments to gather stated preference data.

[3] Adamowicz *et al.* (1996) discuss this possible effect and also suggest that respondents are less able to behave strategically when responding to choice experiments.

[4] Morey (1999) provides a thorough description and derivation of the multinomial logit model.

[5] A more complete description of the survey development process and a copy of the survey are available at http://spot.colorado.edu/~morey/monument/index.html.

[6] Although focus group participants and, later, survey respondents expressed strong feelings about the importance of these monuments, they rated the importance of the condition of the monuments significantly lower than other issues such as crime, public education and health care.

[7] The original condition of the monuments is not portrayed in the timeline.

[8] More complex alternatives are common, e.g., the goods in Adamowicz *et al*. (1996) have seven attributes. However, the simplicity of our bundles avoids a potential criticism of more complex alternatives. This criticism suggests that respondents might make their choices based on simplifying decision rules that ignore some attributes (Tversky *et al*., 1989).

[9] These amounts were chosen based on information about WTP provided by focus group respondents.

[10] When each alternative is characterized by more than two attributes, the efficient selection of choice sets is more complex. See Adamowicz *et al.* (1997).

[11] Across the 272 surveys, the correlation coefficient for the change in price and the change in level of preservation is .2590.

[12] A copy of the survey is available at http://spot.colorado.edu/~morey/monument/index.html.

[13] The advantages of in-person interviews for stated preference surveys have been described by many, including Mitchell and Carson (1989), Arrow *et al*. (1993), and Mitchell and Carson (1995).

[14] This benefit, discussed by Weinberg (1983), suggests that respondents will be more comfortable not revealing their answers about personal issues (e.g., drug use) to an interviewer. It may also be that respondents answer more truthfully in response to questions about environmental or other social issues when they are not required to reveal their answer to an interviewer.

[15] Given the political climate at the time (August, 1996), it was necessary to say that the subject of the survey was not related to any election issues or candidates, nor health care.

[16] Most of the research on monetary incentives has focused on the degree to which such incentives–usually small payments of $5 or less–increase response rates for mail surveys (e.g. Mizes *et al*.,1984; Hopkins and Gullickson, 1992; Robertson and Bellenger, 1978; Church, 1993) and in-person interviews (Willmack *et al*., 1995 and Goyder, 1994). Some studies have also tested for significant differences in the demographic characteristics and responses of those paid an incentive and a control group (e.g. Robertson and Bellenger, 1978; Willmack *et al*., 1995; Jobber *et al*., 1988; Finlay and Thistlethwaite, 1992; Lorenzi *et al*., 1988; James and Bolstein, 1992; and Trice, 1984). In most of these studies, no response bias or demographic differences were found. Trice (1984) and James and Bolstein (1992) find some evidence of response effects due to incentive payments, though no response bias per se.

[17] This is for annual household income of less than $12,500 for the study population.

[18] Thirteen of the 272 respondents did not provide all of the demographic data used in the model. Of the remaining 259 respondents, some did not make a choice for each of the ten pairs.

[19] Since $r_i = 1 \forall i$ it is omitted here.

[20] The dollar amount of $120,000 was assigned to the variable $Income_i$ for respondents who indicated that their household income is greater than $100,000. The results of the model are not sensitive to this choice.

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[21] Non-Caucasian respondents under age 24 have an estimated negative marginal utility of preservation for levels greater than 0.8.

[22] Typically, one is constrained to estimate the expected value of the individual's WTP, E[WTP], rather than the WTP_i. This is because the individual's WTP is a function of his or her epsilon draw. However, this is not the case when the policy is a change in states and there is no choice in either state – our case. The epsilon is the same on both sides of the equality that defines WTP, so WTP is not a function of the epsilons, and one estimates it rather than its expectation. See Morey and Rossmann (2000).

[23] Note that equations (9) and (10) contain additional terms if paying the WTP associated with a policy is of sufficient magnitude to cause an individual to change income categories (e.g. become poor). See Morey and Rossmann (2000) for details. Given the magnitude of the WTP estimates in this application, it is unlikely that any individuals are so effected.

[25] This confidence interval is calculated using an order statistic on 2000 Monte Carlo simulations of the mean WTP for the sample. This Monte Carlo sampling experiment uses a random number generator to draw independent observations of the estimated parameters from a normal distribution with a mean equal to the parameter estimates and variance equal to the estimated parameter covariance matrix. This is repeated 20,000 times for each of the 259 respondents.

[26] The differences by gender complicate the interpretation of these estimates as household WTP estimates. For households in which there is a man and a woman, the household WTP is likely to depend on the roles of the man and woman in the household expenditure decision making process. A conservative approach would be to use the estimate of the decision maker with the lower WTP, in this case males.

[27] We have data on the distribution of the population by age, income and ethnicity categories but do not know the extent to which age, income and ethnicity are correlated. Therefore we must weight WTP as though these characteristics are not correlated. As a result, our weighted estimates are likely to be conservative estimates for the population since income and ethnicity are likely to be positively correlated; the assumption that they are not will overweight the WTP of non-Caucasians and low-income households.