Embedding in Multiple-Referendum Contingent Valuation Experiment

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Abstract

KEYWORDS: Multiple-response nestd logit model, Component-sequence dependence, Closed-ended contingent valuation survey, Biological diversity

The embedding effect observed with contingent policy referendum of nonmarket goods is empirically examined. The investigation extends the application of contingent policy referendum data though the analysis is somewhat more complicated. Multiple-response nested logit model developed by Wu allows the estimation of marginal value of multiple-response data. In the empirical analysis, a manageable number of valuation sequences are chosen in such a way that each policy component (environmental attribute) appears in a different

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position in each particular sequence. A set of multiple referendum data is selected from a contingent valuation survey concerning proposed improvements in the environment of Big Darby Creek in central Ohio.

Statistical tests based on the estimated parameters are found to provide evidence that marginal value derived from multiple-referendum contingent valuation is dependent of the sequence. That is, the embedding effect exists in contingent policy referendum survey. This result is consistent wiht standard economic theory and with the phenomenon observed with private goods and public goods evaluated by open-ended contingent valuation survey explored by other research.

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I.Introduction

Contingent valuation has become widely used as a method for assigning a value to a resource or commodity when the relevant market does not exist, as is often the case for a public good, and in particular for the valuation of environmental resources. It is a survey method that individuals are asked hypothetical questions to elicit information about their willingness to pay for a specific proposed improvement in their resource allocation, or about the compensation that would induce them to accept a deterioration.

The contingent valuation technique considered here is the "contingent policy referendum" approach (also referred to as closed-ended valuation, discrete-choice valuation, take-it-or-leave-it approach). This approach, each individual is asked whether or not he would pay a specified price for the proposed improvement, has gained favor in recent years because of its methodological simplicity (an important consideration in mail surveys), and because it reduces

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certain biases inherent in alternative techniques (Hoehn and Randall, 1987).

Multidimensional policy analysis involves some package of potential changes (or components) that could be implemented separately or in various combinations. The welfare measure of a single change or a particular policy component depends upon which other components are present. How does the marginal valuation of a given policy component vary? Theoretically, it is expected that a component value is higher, the nearer that component is placed to the beginning of the valuation sequence (Boadway and Bruce, 1986; Hoehn and Randall, 1989; Wu, 1993b and 1995). That is, the incremental contribution of a particular component or change to the total value of the policy package will be smaller the later its position in sequence. This phenomenon has also popularized by Kahneman and Knetsch as "embedding" effect (Kahneman and Knetsch, 1992).

Tversky and Kahneman (1981) have conjectured that respondents may approach the task of formulating a contingent valuation method response by first setting a "mental account" or mental budget constraint, to limit the total amount that they would be willing to pay for whatever set of prospects the researcher may offer them. Then, they may "spend" almost all of that amount on the first item offered, leaving little to "spend" on subsequent items.

This kind of embedding effect observed with contingent valuation of nonmarket goods has been examined in its open-ended elicitation format and in market demand for private goods (Hoehn, 1991; Randall and Hoehn, 1996). This phenomenon for nonmarket goods evaluated by contingent policy referendum approach has not yet been investigated. The exploration will extend the application of contingent policy referendum data though the analysis is somewhat more complicated. The analysis will require an estimation model designed for the multiple-referendum contingent valuation data. Multiple-response nested logit model developed by Wu allows the estimation of marginal value of multiple-response data (Wu, 1993a).

The principal objective of this paper is, therefore, empirically to test whether the marginal value of a particular component of a policy package does in fact vary in contingent policy referendum format. In the empirical analysis, a manageable number of valuation sequences are chosen in such a way that each policy component (environmental attribute) appears in a different position in each particular sequence. A set of multiple referendum data is selected from a contingent valuation survey concerning proposed improvements in the environment of Big Darby Creek in central Ohio. Statistical tests based on the estimated parameters are found to provide evidence that marginal value derived from multiple-referendum contingent valuation is dependent of the sequence.

II. Multiple-Response Nested Logit Model

Let U_h (Q,D) be the utility level of individual h when he or she has disposable income D, and the state of his or her environment is given by the vector Q. This is a conditional indirect utility function, i.e., the utility attained by optimizing the expenditure of D over all other goods while holding Q fixed. Individual h is presented with a set of environmental packages Q_h^j (j=1,...,M), each with a price t_h^j. The environmental status quo is denoted Q_h^o. For each package, the individual is asked whether he or she is willing to pay the amount t_h^j. Denote the response by R_h^j as:

$$R_h^j = \begin{cases} 1 & \text{if willing to pay } t_h^j \\ 0 & \text{if not willing to pay} \end{cases} \quad (1)$$

Assuming a rational response in terms of utility maximization:

$$R_h^j = \begin{cases} 1 & \text{if } U_h(Q_h^j, D_h - t_h^j) > U_h(Q_h^0, D_h) \\ 0 & \text{otherwise} \end{cases} \quad (2)$$

where D_h is the individual's current disposable income.

As is commonly assumed, we suppose that U_h has the separable form:

$$U_h(Q_h^j, D_h) = V(Q_h^j, D_h, S_h) + \varepsilon_h^j \qquad (\ j=0,\ \ldots\ldots,M\ ) \quad (3)$$

where V is a parametric function of Q, D, and S, a vector of observed socioeconomic characteristics. The characteristics S_h can be viewed as proxies for unobservable parameters of the individual's utility function. The stochastic terms ε_h^j have mean zero, and represent the effects of unobserved variables, idiosyncratic tastes, etc.

The stochastic terms will be independent across individuals. For a given individual, however, the stochastic terms for different alternatives j will generally not be independent, because of individual-specific preferences common across alternatives as well as unobserved attributes shared between alternatives. Let the cumulative distribution function be:

$$F_\varepsilon(\eta_0,\ldots,\eta_M) \equiv \Pr\{\varepsilon_h^0 \le \eta_o,\ldots,\varepsilon_h^M \le \eta_M\} \tag{4}$$

Let Y_h be the set of alternatives with positive responses from individual h, and N_h be the set with negative responses, i.e.,

$$Y_h = \{ j | R_h^j = 1,\ 1 \le j \le M\} \tag{5}$$

$$N_h = \{ j | R_h^j = 0,\ 1 \le j \le M\} \tag{6}$$

Then the probability of the response vector $\mathbf{R_h}$ is:

$$\begin{aligned}\Pr\{R_h\} = \Pr\{ & U_h(Q_h^j, D_h - t_h^j) > U_h(Q_h^o, D_h),\ \text{all}\ j \in Y_h, \\ & \text{and}\ U_h(Q_h^j, D_h - t_h^j) \le U_h(Q_h^o, D_h),\ \text{all}\ j \in N_h\} \\ = \Pr\{ & \varepsilon_h^j > \varepsilon_h^j - \Delta V_h^j,\ \text{all}\ j \in Y_h,\ \textit{and}\ \varepsilon_h^j \le \varepsilon_h^o - \Delta V_h^j,\ \text{all}\ j \in N_h\}\end{aligned} \tag{7}$$

where ΔV_h^j stands for $\Delta V(Q_h^o, Q_h^j, D_h, t_h^j, S_h)$, the parametric part of the utility difference, defined by:

$$\Delta V(Q_h^o, Q_h^j, D_h, t_h^j, S_h) = V(Q_h^j, D_h - t_h^j, S_h) - V(Q_h^o, D_h, S_h) \qquad (8)$$

The function ΔV will usually be modelled as linear in parameters. The probability model of F_ε chosen for multiple-response nested logit model is a generalized extreme value distribution as follows:

$$F_\varepsilon(\eta_o, \ldots\ldots, \eta_M) = \exp\{-G(\exp[-\eta_0], \ldots\ldots, \exp[-\eta_m])\} \qquad (9)$$

where $G(y_0, \ldots, y_M)$ is a linearly homogeneous function of $\underline{y} \geq \underline{0}$, and satisfies a set of conditions (McFadden, 1978; 1981).

Because G is linearly homogeneous, i.e.,

$$G_0(y_0, \ldots\ldots, y_M) \equiv \frac{\partial}{\partial y_0} G(y_0, \ldots\ldots, y_M) \qquad (10)$$

is homogenous of degree zero as $\underline{y} \geq \underline{0}$. Let $\sigma = \{\sigma(1), \ldots, \sigma(\nu)\}$ denote a subset of $\{1, \ldots, M\}$, with $0 \leq \nu \leq M$. Define

$$G^\sigma(y_0, y_{\sigma(1)}, \ldots\ldots, y_{\sigma(\nu)}) = G(y_0, y_1^*, \ldots\ldots, y_M^*) \qquad (11)$$

where

$$y_i^* = \begin{cases} y_i & \text{if } i \in \sigma \\ 0 & \text{otherwise} \end{cases} \qquad (12)$$

and let

$$G_0^{\sigma}(y_0, y_{\sigma(1)}, \ldots, y_{\sigma(v)}) = \frac{\partial}{\partial y_0} G^0(y_0, y_{\sigma(1)}, \ldots, y_{\sigma(v)}) \qquad (13)$$

Then the response probability can be expressed as:

$$\Pr(R_h) = \sum_{v=m}^{M} (-1)^{v-m} \sum_{\sigma \in (v,N)} \frac{G_0^{\sigma}(1, \exp[\Delta V_h^{\sigma(1)}], \ldots, \exp[\Delta V_h^{\sigma(v)}])}{G^{\sigma}(1, \exp[\Delta V_h^{\sigma(1)}], \ldots, \exp[\Delta V_h^{\sigma(v)}])} \qquad (14)$$

A. Response Probability for Cumulative Policies

When the alternatives are cumulative, i.e. $Q_h^{j+1} \geq Q_h^j$ (The inequality applies to each component of Q). In the case of a policy agenda with three components A, B, and C, each represents an improvement in environmental quality. Then one possible set of cumulative alternatives is: (0) the status quo, (1) A, (2) A+B, and (3) A+B+C, with alternatives (1)-(3) also involving a payment t_h. This suggests a tree structure like that in Figure 1. Node 5 represents unobserved ttributes of A that are common to alternatives 1, 2,and 3, all of which contain component A, while node 4 represents unobserved attributes of B that are common to alternatives 2 and 3, both of which contain component B.

In general, with M policy components, this tree structure can be represented by:

$$W(j) = \{j-1,\ 2M-j\} \qquad (j=M+1,\ldots,2M) \qquad (15)$$

with a numbering scheme like that in Figure 1; the total number of nodes is J=2M.

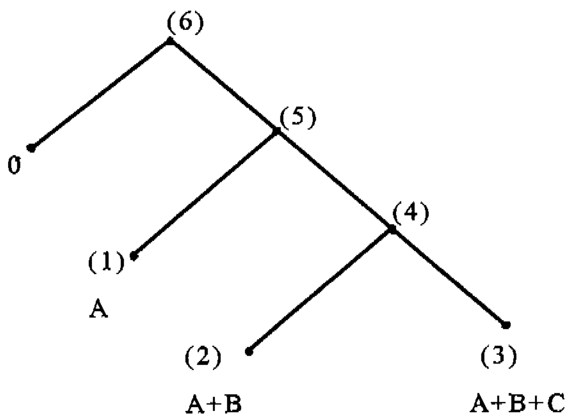

Figure 1. Tree Structure for Cumulative Alternatives

B. Nonnegativity Condition for Willingness to Pay

If the stochastic terms ε_h^i are continuous random variables with range $(-\infty,\infty)$ the stochastic utility model always has nonzero probability that preferences will be in the "wrong" order, i.e., an "improvement" in the environment Q leads to a decrease in utility U(Q,D) for some individuals, which in turn leads to a negative willingness to pay. This can happen even when a single item is evaluated: if F is the distribution function of $\varepsilon_h^1-\varepsilon_h^0$, then:

$$\Pr\{U_h(Q_h^1,D_h)<U_h(Q_h^0,D_h)\}=F[-\Delta V(Q_h^0,Q_h^1,D_h,O,S_h)] \quad (16)$$

which is always positive for commonly assumed distribution functions such as normal or logistic. Options for dealing with this problem include:

(i)As long as ΔV is reasonably large for most sample members, the probability (16) will be small, and can be ignored: it can be viewed as just one of many sources of model specification error. However, empirical estimates based on referendum data for environmental improvements sometimes yield non-negligible values of $F[-\Delta V(Q_h^0, Q_h^1, D_h, O, S_h)]$.

(ii) The preference reversal can be treated as a real effect, i.e., some small proportion of the population does in fact have an idiosyncratic aversion to the (free) improvement represented by Q_h^1.

(iii) The model can be modified so that preference reversals do not occur. One way of doing this is simply to truncate the utility distribution: start with the function U given by equation (3), and then define the actual utility U^* by:

$$U_h^*(Q_h^j, D_h) = \begin{cases} U_h(Q_h^j, D_h) & \text{if } U_h(Q_h^j, D_h) > U_h^*(Q_h^{j-1}, D_h) \\ U_h^*(Q_h^{j-1}, D_h) & \text{otherwise} \end{cases} \tag{17}$$

for $j = 1,2,\ldots,M$ with $U_h^*(Q_h^0, D_h) = U_h(Q_h^0, D_h)$. In other words, negative marginal utility for a free improvement is replaced by zero. In fact, it is not unreasonable to suppose that some proportion of the population is genuinely indifferent to a given environmental improvement Q_h^j.

In the case of a single improvement, this truncated model is sometimes implicitly used in computing aggregate benefit measures. The mean valuation for individuals of type S and income D is computed using:

$$E[WTP|D,S] = \int_0^\infty \{1 - F - \Delta V[(Q_h^0, Q_h^1, D_h, t_h, S_h)]\}\, dt \qquad (18)$$

i.e., the distribution of willingness-to-pay is truncated at zero, which is the same as truncating the distribution of $U_h^*(Q_h^1, D_h)$ at $U_h(Q_h^0, D_h)$. Because the threshold values th used in the survey are always positive, truncation does not affect the likelihood of the data for a single improvement. The parameter estimates are therefore unchanged, and the only difference between the original model and the truncated model is in the calculation of aggregate benefits via (18).

For multiple valuation data, the truncation (17) does affect the likelihood. For example, the "reversed" preference ordering:

$$U_h(A + B, D_h - t_h) < U_h(0, D_h) < U_h(B, D_h - t_h) \qquad (19)$$

(which gives the incompatible responses "yes" for improvement A and "no" for A+B at the same price) can occur in the original model but not in the truncated model. In the special case of equal thresholds (i.e., $t_h^j = t_h$, j = 1,...,M), the computation of the new probabilities is quite easy: reassign the probabilities of incompatible responses by changing each offending "no" to a "yes." For example,

$$\Pr\{Y^*(A,t), Y^*(A+B,t)\} = \Pr\{Y(A,t), Y(A+B,t)\} + \Pr\{Y(A,t), N(A+B,t)\} \qquad (20)$$

$$\Pr\{Y^*(A,t), N^*(A+B,t)\} = 0 \qquad (21)$$

where $Y^*(j, t)$ and $N^*(j, t)$ denote "yes" and "no" responses to package j at price t according to the utility function , while Y(j, t) and N(j, t) denote the responses according to the utility function U.

III.Contingent Evaluation of Environmental Improvements to Big Darby Creek

In this empirical study, the test of component-sequence dependence is applied to the benefit evaluation of environmental improvements to Central Ohio's Big Darby Creek, one of the most biologically diverse creeks in the mainland United States. A variety of plant and animal species can be found in the creek, including eighty-six kinds of fish, and forty bivalve species and freshwater mollusks. Water quality in Darby Creek is generally "good". However, there has been a fairly rapid decline in water quality during the last few years (Ohio Environmental Protection Agency, 1983). The decline of water quality of the creek is due to point and nonpoint sources of pollution, which include organic and inorganic chemicals and silt and sediment runoff from nearby waste water treatment plants, agricultural land, limited urban areas, and roadways. Aquatic biologists estimate that up to 25 percent of the species found here may be eliminated from the river in the near future if the current rate of pollution continues. With the hopes of controlling these pollutants and benefitting the aquatic ecosystem, efforts have been made to protect this natural preserve from uses that might destroy its natural and aesthetic conditions (The Nature Conservancy, 1989).

In addition to the unique biological diversity of the creek, Big

Darby Creek is also an important recreational resource. Near the intersection of Big and Little Darby Creeks is the Battelle-Darby Creek Metropolitan Park, which provides recreational opportunities and outdoor enjoyment for local residents. Given the proximity of Battelle-Darby Creek Metropolitan Park, a potential recreational corridor for outdoor pursuits could be expanded along the creek. Preservation of the creek and improvements of the park are among regulatory and management proposals presently under consideration.

Data for the empirical analysis came from a contingent valuation experiment (Cummings, Brookshire, and Schulze, 1986; Davis, 1963; Randall, Ives, and Eastman, 1974; and Mitchell and Carson, 1989). The part of the sample used here was selected from known visitors, termed "recreationists," and was designed to be representative of the various users of Battelle-Darby Metropolitan Park. A total of 686 households were selected during fifteen trips, chosen to represent weekdays, weekends, and holidays, which were made to the park from July through October of 1989. The contingent valuation data were collected through mail surveys.The mailing administration followed guidelines to enhance the response rate suggested by Dillman (1978).

Respondents in the sample were asked to value a sequence of proposed projects to enhance and to preserve the environment of Big Darby Creek.Three environmental attributes (policy components) were identified to represent the impacts of these projects: Index of Biotic Integrity (IBI), streambed visibility (SBV), and mileage of hiking trails (HT).

The IBI is an indicator of biological diversity, used by the Ohio Environmental Protection Agency and other agencies to capture the impact of water pollution on fish species (Karr, 1981, and Karr et al., 1986). The scale of the IBI ranges from 12, meaning poor water quality, to 60, which represents excellent water quality. To help make things easier for the survey respondents, we arithmetically converted the IBI scale so that it ranged from 0 to 100, and named it the Species Variety Scale (SVS). The SVS readings in Big Darby Creek and its tributaries are in the process of falling from around 80, a "very good" condition, to 65, a "good" condition, because of pollution. ithout control of nonpoint source pollution, a SVS reading at 65 is set as the base condition. To maintain the SVS reading at 80, measures to modestly reduce the water pollution, such as the creation of a forested buffer along stream sides, need to be employed.

Streambed visibility, the second component of the complex policy, is defined as the percentage of days in a year when the bed of Big Darby Creek is visible. Because of soil erosion, streambeds are rarely visible in Big Darby Creek, or, for that matter, in other streams in central Ohio. With nonpoint source pollution controls, stream bottoms would be visible 20 percent of the year. The third dimension of the delivered environmental goods is the development of the hiking trails mileage. With the development of the park, the current five miles of hiking trails in the park will increase to eight miles.

Having been given the description of the policy impacts, survey respondents were asked to evaluate various policy packages. Referendum vote questions were designed for survey respondents to answer "yes" or "no" to a pre-assigned fixed payment level for each package (Bishop and Heberlein, 1979; Hanemann, 1984; and Hoehn and Randall, 1987). A permanent increase of annual local or state taxes collected to finance resource management projects in and around the Darby Creek area was the payment vehicle used. The threshold payment levels were selected so as to reflect the general pattern of the responses from a pretest, in which valuations were found to be concentrated more at the low end. The fixed annual payments used in the questionnaire were $10, $20, $30, $75, and $150.

The questionnaire also contained questions regarding respondents' attitudes toward general environmental issues. Questions regarding respondent's personal information, such as income, education, and other sociodemographic characteristics, were placed at the end of the questionnaire.

With three environmental attributes, species variety scale (SVS), streambed visibility (SBV), and mileage of hiking trail (HT), there are six possible cumulative policy sequences. For example, one version of the questionnaire contains contingent referenda on the policies SVS, SVS+SBV, and SVS+SBV+HT. In the empirical analysis, a manageable number of valuation sequence, denoted as sequences I, II, and III are chosen in such a way that each policy component appears in a different position in each particular sequence, as shown in Table 1.

Table 1. Sequences of Delivered Policy Components

Policy	Sequence I	Sequence II	Sequence III
1	SVS	SBV	HT
2	SVS+SBV	SBV+HT	HT+SVS
3	SVS+SBV+HT	SBV+HT+SVS	HT+SVS+SBV

IV.Estimation of the Multiple-Response Model with Cumulative Alternatives

Since individuals provided only "yes" or "no" responses to any of the proposed policy packages, the marginal value of a specific policy component can not be obtained directly. The effect of a component can be derived from the responses to packages with and without that specific component. In the case at hand, for example, the marginal value of component SVS in the presence of SBV+HT can be derived from the responses to packages SBV+HT+SVS and SBV+HT in sequence II. The relevant alternatives are then: (0) the status quo, (1) SBV+HT, and (2) SBV+HT+SVS. In the present survey data, the respondent faced the same level of payment t for both packages (1) and (2). Under these circumstances, the choice alternatives can be represented by a two-level tree structure like that in Figure 2. We describe the estimation and test procedures for the component SVS. The same procedures, with suitably changed notation, apply also to the other two components, SBV and HT.

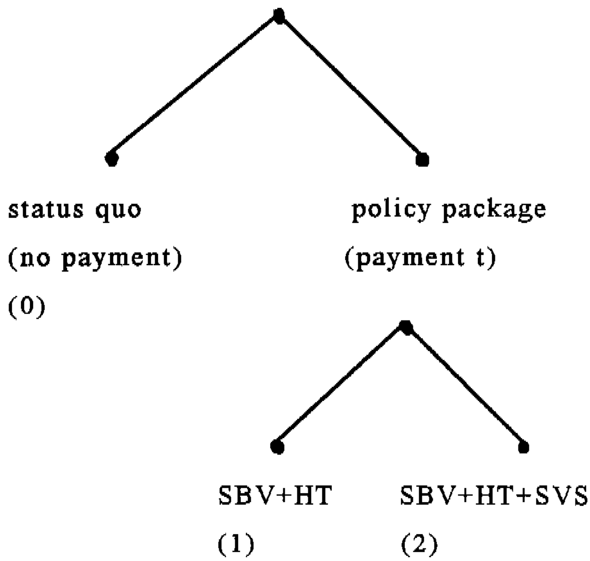

Figure 2.　Two-Level Tree Structure for a Multiple-Response Model with Cumulative Alternatives

Incremental values of each component are estimated under status quo and two other evaluation sequences. For component SVS as an example, its incremental values are estimated under the status quo (sequence I), and under the difference between policy 3 and 2 of sequence II and the difference between policy 2 and 1 of sequence III. The relevant policy packages are indexed by (s, j), where s is the policy sequence (I, II, or III), and j is the cumulative policy in that sequence (1, 2, or 3), as defined in Table 1. For example, (II, 2) is the package SBV+HT. Let $\Delta V(s, j) \equiv \Delta V(Q_h^0, Q_h^{s,j}, D_h, t_h^j, S_h)$, as defined by (8), be the utility difference between policy package (s, j) (at price t) and the status quo. We also define:

$$H_{s,j} = 1 + e^{\Delta V(s,j)} \quad (22a)$$

$$H_{s,jk} = 1 + (e^{\Delta V(s,j)/\sigma} + e^{\Delta V(s,k)/\sigma})^{\sigma} \quad (22b)$$

In sequence I, SVS is introduced as the first component, and the response probabilities are those of a simple dichotomous choice model:

$$Pr(0) = 1/H_{I,1} \quad (23a)$$

$$Pr(1) = e^{\Delta V(I,1)}/H_{I,1} \quad (23b)$$

where (I,1) refers to the package consisting of SVS alone. In sequences II and III, the response probabilities are given by the multiple-response nested logit model with the tree structure of Figure 2. With M=2, the response probabilities are given as (24a)-(24d):

$$Pr(0,0) = 1/H_{s,jk} \quad (24a)$$

$$Pr(0,1) = 1/H_{s,j} - 1/H_{s,jk} \quad (24b)$$

$$Pr(1,0) = 1/H_{s,k} - 1/H_{s,j} \quad (24c)$$

$$Pr(1,1) = 1 - 1/H_{s,j} - 1/H_{s,k} + 1/H_{s,jk} \quad (24d)$$

with (j, k) = (2, 3) for sequence II and (j, k) = (1, 2) for sequence III.

The functional form used for ΔV is linear in parameters:

$$\Delta V(s, j|X) = \alpha_{s,j} X \tag{25}$$

where $\alpha_{s,j}$ is a vector of parameters to be estimated, and X is a vector of variables selected to explain the respondents' valuations of the improvements in the environment of Big Darby Creek. The variables include respondents' sociodemographic characteristics; their attitudes toward environmental management in general; whether or not their version of the questionnaire included a warning statement that funding of these projects might reduce funding for other environmental management initiatives; and the posted price levels in the referendum vote questions. These variables are listed in Table 2.

The parameters are estimated by the maximum likelihood estimation with the log-likelihood function expressed as:

$$\log L = \sum_h (K_{I,h} \log L_{I,h} + K_{II,h} \log L_{II,h} + K_{III,h} \log L_{III,h}) \tag{26}$$

Table 2. Definition of Independent Variables

Variable	Definition
Income	$\log(D/D_{mm})$, where D is the household annual income from allsources, represented the midpoint of each income level; and D_m is the mean income value of the respondents
Gender	1 male 0 female
Age	$\log(R/R_m)$, where year is the age of the respondent, and R_m is the mean age of the respondents
Educa1	1 if the respondent received some high school education or lower 0 otherwise
Educa2	1 if the respondent received some college education 0 otherwise
Educa3	1 if the respondent completed college education 0 otherwise
Educa4 education	1 if the respondent received graduate or professional 0 otherwise
PL	$\log(pl/pl_m)$, where pl represents an index of environmental attitudes derived from the respondents' views on public land use and the preservation of open space; and pl_m is the mean value of pl for respondents. Three levels were arbitrarily assigned to the following answers: 1 we do not need any more public land or to preserve any more open space 2 we need specific pieces for specific purposes 3 we need more public and open space preservation in general
Price referendum	$\log(pr/pr_m)$, where pr is the preassigned price level in the question, and pr_m is the mean value of the price levels
Cavea	1 respondent received the warning statement regarding the allocation of funds to Darby Creek management and to other environmental management initiatives 0 respondent did not receive the warning statement (applicable to sequence I questionnaires only)

where K_I, K_{II}, and K_{III} are dummy variables defined for valuations from sequences I, II and III respectively. L_I, L_{II} and L_{III} are the likelihood functions generated from each sequence, using the response probabilities specified in (23) and (24). That is,

$$\log L_{I,h} = \log \Pr[R_h | \Delta V(I,1|X_h)] = \log \Pr[R_h | \alpha_{I,1}, X_h] \tag{27}$$

$$\begin{aligned} \log L_{II,h} &= \log \Pr[R_h | \Delta V(II,2|X_h), \Delta V(II,3|X_h), \sigma] \\ &= \log \Pr[R_h | \alpha_{II,2}, \alpha_{II,3}, \sigma, X_h] \end{aligned} \tag{28}$$

and

$$\begin{aligned} \log L_{III,h} &= \log \Pr[R_h | \Delta V(III,1|X_h, \Delta V(III,2|X_h), \sigma] \\ &= \log \Pr[R_h | \alpha_{III,1}, \alpha_{III,2}, \sigma, X_h] \end{aligned} \tag{29}$$

The marginal effect of SVS will appear in the parameter differences between $\alpha_{II,3}$ and $\alpha_{II,2}$ for sequence II and between $\alpha_{III,2}$ and $\alpha_{III,1}$ for sequence III. As a consequence, the test of sequence dependence for the value of SVS is performed under the restriction:

$$H_0: \alpha_1 = \alpha_{II,3} - \alpha_{II,2} = \alpha_{III,2} - \alpha_{III,1} \tag{30}$$

In order to keep a consistent notation, Table 3 defined a set of five "generic" policy packages A,B,C,D,E) for each of the three components. The explanatory variables are then interaction terms between the corresponding dummy variables $K_A, \ldots, K_E$ and the independent variables of Table 2; this allows all five evaluations to be estimated jointly. In this notation, the dummy variables K_I, K_{II} and

K_{III} in (26) become $K_A, K_C - K_B$ and $K_E - K_D$.

The estimated coefficients and the test results are shown in Table 4. The first column, labelled SVS, contains the relevant estimates for the incremental values of component SVS, and similarly for the other two columns labelled SBV and HT. The last row at Table 4 reports the χ^2 tests for the null hypothesis of no sequence dependence, i.e., $\alpha_A = \alpha_C - \alpha_B = \alpha_E - \alpha_D$ (tested separately for each of the three components); the null is rejected at the 1% significance level.

The results of the hypothesis test are consistent with prior theoretical expectation. That is, the component value varies by the position in which it appears in the valuation sequence. Thus, sequence-dependence of component benefits implies problems for component valuation: the same component might pass a benefit-cost filter if placed early in a valuation sequence but fail if placed later.

Table 3. Policy Packages Used to Estimate Incremental Valuations of Components SVS, SBV, and HT

	SVS	SBV	HT
A	(I,1) SVS	(II,1) SBV	(III,1) HT
B	(II,2) SBV+HT	(I,1) SVS	(II,1) SBV
C	(II,3) SBV+HT+SVS	(I,2) SVS+SBV	(II,2) SBV+HT
D	(III,1) HT	(III,2) HT+SVS	(I,2) SVS+SBV
E	(III,2) HT+SVS	(III,3) HT+SVS+SBV	(I,3) SVS+SBV+HT

V. Concluding Remarks

A subset of multiple referendum data is collected for a policy package consisting of proposed improvements to the environment of Big Darby Creek in Central Ohio. That project involves three specific policies, improvements in species variety (which is determined by water quality) and in streabed visibility, and an increase in hiking trail mileage. The improvements are introduced sequentially, the incremental value of each one compoment is expected to depend on its position in the sequence. Using the multiple-response nested logit model, we have estimated incremental valuations for each of these improvements in each of three different sequences.

The estimates clearly reject the null hypothesis that the marginal value is independent of the sequence. That is, the embedding effect exists in multiple-response contingent policy referendum survey. This result is consistent with standard economic theory and with the phenomenon observed with private and public goods explored by research that previously accomplished. The results, however, raise an issue that the value of a program is different if it is elicited solely to the valuation of that program or if it is included in a multiple-program, which aims at valuing others. The design for the evaluation of single versus multiple policy agenda remains an issue for further research.

Table 4. Multiple-Response Nested Logit with Cumulative Alternatives: Coefficient Estimates with Component Sequence Dependence

Variable[a]	Coefficient Estimates[b] SVS	SBV	HT
Intercept*K_A	0.06(1.32)	0.06(1.02)	0.02(1.08)
PL* K_A	2.07(0.25)	1.34(0.21)	1.31(0.37)
Income* K_A	0.03(0.38)	0.01(0.63)	0.04(0.57)
Gender* K_A	0.08(1.22)	0.02(0.03)	0.90(0.16)
Age* K_A	-0.25(0.20)	-0.34(0.36)	-0.72(0.44)
Educa1* K_A	0.01(0.79)	-0.01(0.55)	-0.34(1.14)
Educa2* K_A	0.18(0.12)	0.06(0.64)	0.46(0.73)
Educa3* K_A	0.72(0.52)	0.44(0.01)	1.96(0.62)
Educa4* K_A	1.25(0.92)	0.86(0.30)	0.56(1.29)
Price* K_A	-0.61(1.69)	-0.36(1.21)	-0.40(1.40)
Caveat* K_A	-0.25(0.95)	-----	-----
Intercept*K_B	-0.06(0.66)	0.12(0.47)	0.55(0.97)
PL* K_B	1.83(0.14)	1.34(0.09)	0.31(0.31)
Income* K_B	0.13(0.45)	-0.01(0.09)	0.69(0.04)
Gender* K_B	-0.06(0.08)	0.02(0.35)	0.28(0.82)
Age* K_B	-0.72(0.25)	-0.34(0.03)	-0.46(0.35)
Educa1* K_B	0.11(0.42)	-0.01(0.32)	-0.31(0.23)
Educa2* K_B	0.06(0.32)	0.07(1.15)	0.75(1.97)
Educa3* K_B	0.84(0.49)	0.43(0.31)	0.58(1.74)
Educa4* K_B	1.31(0.89)	0.86(0.15)	1.42(0.11)
Price* K_B	-0.73(0.87)	-0.36(0.59)	-0.68(0.99)
Caveat* K_B	-----	-0.15(0.45)	-----
Intercept*K_C	0.25(0.41)	0.15(0.42)	0.48(0.51)
PL* K_C	1.74(0.09)	1.26(0.08)	0.84(0.17)
Income* K_C	0.04(0.29)	0.07(0.08)	0.53(0.52)
Gender* K_C	-0.21(0.81)	-0.07(0.31)	-0.54(0.61)
Age* K_C	-1.05(0.15)	-0.56(0.03)	-0.34(0.86)
Educa1* K_C	0.11(0.29)	0.09(0.28)	-0.14(0.90)
Educa2* K_C	0.12(0.19)	0.09(0.41)	-1.77(0.80)
Educa3* K_C	0.94(0.79)	0.44(0.28)	-1.25(0.65)
Educa4* K_C	1.95(1.51)	0.87(0.13)	-1.02(0.97)
Price* K_C	-0.78(0.56)	-0.43(0.51)	-0.27(0.29)
Caveat* K_C	-----	-0.14(0.39)	-------
Intercept*K_D	-0.88(0.33)	-0.28(0.79)	0.01(0.37)

Table 4. (continued)

PL* K_D	2.07(0.06)	1.26(0.17)	1.08(0.58)
Income* K_D	0.03(0.27)	0.07(0.12)	0.02(0.22)
Gender* K_D	0.09(0.33)	-0.07(0.35)	-0.35(0.28)
Age* K_D	-0.25(0.14)	-0.56(0.78)	-0.56(0.41)
Educa1* K_D	0.01(0.26)	0.09(0.71)	0.47(0.61)
Educa2* K_D	0.18(0.41)	0.09(0.35)	0.39(0.32)
Educa3* K_D	0.72(0.33)	0.44(0.35)	0.18(0.39)
Educa4* K_D	1.25(0.35)	0.87(0.22)	0.76(0.48)
Price* K_D	-0.61(0.89)	-0.43(0.22)	-0.47(0.41)
Caveat* K_D	-----	-----	-0.33(0.18)
Intercept*K_E	-0.53(0.20)	-0.02(0.55)	-0.01(0.37)
PL* K_E	1.83(0.04)	1.18(0.12)	1.08(0.58)
Income* K_E	0.13(0.01)	0.07(0.09)	0.02(0.22)
Gender* K_E	-0.06(0.20)	-0.09(0.15)	-0.35(0.28)
Age* K_E	-0.72(0.01)	-0.66(0.59)	-0.56(0.41)
Educa1* K_E	0.11(0.52)	0.11(0.53)	0.47(0.61)
Educa2* K_E	0.06(0.20)	0.28(0.53)	0.39(0.32)
Educa3* K_E	0.84(0.19)	0.66(0.15)	0.18(0.39)
Educa4* K_E	1.31(1.73)	1.35(0.80)	0.76(0.48)
Price* K_E	-0.73(0.05)	-0.43(0.24)	-0.47(0.14)
Caveat* K_E	-----	-----	-0.54(0.32)
σ	0.45(0.41)	0.57(0.60)	0.55(0.54)
χ^2 Value	48.56	61.56 50.56	

a: K_A , ...,K_E are dummies for the policy packages A,...,E as defined in the text.

b: Numbers in parentheses are standard errors.

Footnotes

1. Comprehensive discussions and evaluation of contingent valuation methods are given in Cummings, Brookshire, and Schultze (1986), in Mitchell and Carson (1989), and in Hausman (1993). Some of the first applications to environmental resource valuation are given by Davis (1963) and Randall, Ives and Eastman (1974).
2. Applications of the contingent valuation method to multidimensional policy analysis include, for example, Majid, Sinden and Randall (1983) and Bergstrom and Stoll (1987).

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多元議決條件評估的嵌入效果

吳珮瑛*

摘要

關鍵詞：複反應巢型羅吉模型、因素順序相依、封閉式條件評估調查、生物多樣化。

本文主要目的是在實証上檢驗由條件政策議決所評估之非市場財貨的嵌入效果，此類資料在分析上雖然較複雜，但這種探索可以擴展條件政策議決資料的應用範圍，採用複反應巢型羅吉模型,可用來估計多元議決資料中個別政策因素的邊際價值。實証分析資料來自一組評估美國俄亥俄州中部維護一生態保護區價值的調查。該政策包含維護改善多項自然環境資源，受政策影響的各項環境資源(政策因素)依序置放於政策評估的不同順序中。

實証檢定結果顯示，由多元議決條件評估所得到的個別政策因素之邊際價值，依該因素位於不同評估順序而有差異，也就是說，嵌入效果存在於條件政策議決之調查中。此結論與經濟理論上之預期一致，且與過去的研究探討私有財及開放式條件評估公共財觀察到的現象是相同的。

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