MEASURING USE VALUE FROM RECREATION PARTICIPATION

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Abstract

Recreation demand studies have traditionally utilized a two-step valuation method, estimating conditional recreation participation probabilities and then intensity of use decisions. These two steps of analysis are combined to estimate the use value of natural resource recreation sites. The purpose of this paper is to provide a method by which use value can be estimated solely from the participation decision. The one-step resource valuation method allows estimation of use values from coefficients of the logistic regression recreation participation equation. The benefits of the method are the reduced data and effort required to value natural resource areas.

Key words: logistic regression, recreation participation, use value.

Estimated on-site natural resource use value is one type of information that is useful when decisions about allocation of natural resources must be made. Use value can be determined from hypothetical, constructed markets (contingent valuation) or from revealed behavior (travel cost) recreation demand studies (Forster 1989). Recreation demand studies have traditionally utilized a two-step valuation method, estimating conditional recreation participation probabilities and then intensity of use decisions (McConnell 1985; Rockel and Kealy 1991). These two steps of analysis are combined to estimate the value of the resource site (Clawson and Knetsch 1966; Cicchetti 1973; Charbonneau and Hay 1978). The purpose of this study was to provide a method by which use value can be estimated solely from the participation decision.

The two-step outdoor recreation study can be used to forecast recreation demand and value recreational activities and sites. The participation decision, the first step, is the choice of whether or not to travel to a natural resource site and engage in a recreational activity while there. The decision is usually modeled based on reduced form household demand and supply equations with socioeconomic characteristics and resource supply variables influencing the participation decision (Charbonneau and Hay 1978; Deyak and Smith 1978; Hay and McConnell 1979, 1984; Miller and Hay 1981; Walsh et al. 1989). The intensity of use decision is the choice of how many trips (days, hours, etc.) to take to the resource site conditional on the decision to participate. Relative to the participation decision, the travel cost demand model has received much more attention in the recreation economics literature (Forster 1989).

The travel cost recreation demand model can be used to directly estimate the value of a recreation trip or day. The value of recreation trips or days can then be combined with information on the forecasted number of visitors, determined from the first-step, participation equation, to estimate the value of a natural resource site. For instance, Miller and Hay (1981) value the economic loss to waterfowl hunters of wetlands conversion by multiplying the estimated loss in hunter days by an estimate of consumer's surplus per hunting day. Recently, information on recreation nonparticipants has been combined with travel cost models and jointly estimated to measure the value of natural resource sites (Zeimer et al. 1982; Smith 1988; Bockstael et al. 1990).

A limitation of the two-step approach is that computation of the second-step demand function requires the extra computing expense of estimating visitation with varying travel costs. In contrast to the two-step valuation strategy described above, this study presents a one-step resource valuation method based solely on the recreation participation decision. A benefit of this approach is the reduced data and effort required for valuing recreation sites.

THEORETICAL AND EMPIRICAL MODELS OF VALUE

Defining Use Value

Assume that individuals possess a utility function $u(x_i,y)$ where $u(\cdot)$ is the utility function, x_i is recreational visits to resource site i ($i = 1,...,n$), and y is a

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composite market good. The consumer problem can be modeled as an effort to minimize expenditures subject to the constraint that utility is equal to the reference utility level

$$(1)\quad e(p_i,u) = \min \left[\sum_{i=1}^{n} p_i x_i + y \mid u(x_i,y) = \tilde{u} \right]$$

where $e(\cdot)$ is the expenditure function, p_i is the trip cost for a visit to resource site i, and $\tilde{u}$ is the reference utility level. Trip costs include both money and time costs.

To define use value, suppose the individual contemplating a visit to the resource site is facing a trip cost increase, such as an entrance fee, that makes the trip a less attractive activity. If the increase in the trip cost to site 1 is above the reservation price, p_1^*, no visit to resource site 1 will be made. Use value for resource site 1 is

$$(2)\quad UV_1 = e(p_i^*,\tilde{u}) - e(p_i,\tilde{u})$$

where UV is the use value and $p_i^* = (p_1^*,p_2,...,p_n)$, $p_1^* > p_1$. Use value is the amount of money that the recreationist would be willing to pay to avoid the price increase, holding utility constant. At the individually determined use value, the potential recreationist is indifferent between paying the use value in the form of higher entrance fees and taking trips or not taking trips and leaving income intact. For nonusers who already face their reservation (or a greater) price, use value is equal to zero because there is no observed price change. The nonuser faces the reservation price before and after the entrance fee increase.

Because $\tilde{u} = v(p_i,m)$, where $v(\cdot)$ is the indirect utility function and m is income, equation (2) can be expressed as

$$\begin{aligned} & UV_1 = e(p_i^*,v(p_i,m)) - e(p_i,v(p_i,m)) \\ (3)\quad & UV_1 = e(p_i^*,v(p_i,m)) - m \\ & UV_1 = f(p_i^*,p_i,m) \end{aligned}$$

which simplifies since the expenditure function evaluated at indirect utility is equal to income.[1] The function $f(\cdot)$ is the recreation valuation function. Individuals will participate in recreation at site 1 if the use value of recreation is greater than zero: $x_1 \geq 1$ if $f(p_i^*,p_i,m) > 0$.

Measuring Use Value from Logistic Regression

Empirical estimates of use value must be consistent with the theoretical definition of use value. The recreation participation decision provides observable behavior from which the determinants of the behavior, such as trip costs and income, can be found using logistic regression participation equations. Estimates of use value that conform to the theoretical definition of use value can be derived from empirical recreation participation equations.

The recreation participation decision is a discrete choice: whether or not to visit a natural resource site. Single-site participation data is of the form

$$(4)\quad I_{1j} = \begin{cases} 1 \text{ if } x_{1j} \geq 1 \\ 0 \text{ otherwise} \end{cases}$$

where I_{1j} is a participation indicator variable and j represents each individual in the sample, j = 1,...,m. From equation (4), recreation participation will be observed if the number of trips is greater than or equal to one.

The recreation valuation function, and therefore use value, depends on reservation prices, trip costs, and income. Differences in recreation valuation will also arise from differences in individual tastes and unobservable differences in individuals. Acknowledging these sources of differences in individual valuations, the empirical recreation valuation function can be specified as the mean valuation function with random error

$$(5)\quad UV_1 = f(p_i^*, p_i, m; \tau) + \varepsilon$$

where ε is a mean zero error term. Subscripts for individuals have been suppressed for simplicity. Each individual is assumed to possess a common valuation function with observable differences represented by τ and unobservable individual differences accounted for with the error term, ε. By substitution, equation (4) becomes

$$(6)\quad I_{1j} = \begin{cases} 1 \text{ if } f(p_i^*, p_i, m; \tau) + \varepsilon > 0 \\ 0 \text{ otherwise} \end{cases}$$

Individuals will participate in recreation if the benefits of participation outweigh the costs. That is, if

[1] An alternative, but equivalent, definition of UV is found using the indirect utility function. The implicit definition of UV is: $v(p,m) = v(p_i^*, m - UV)$. UV is the maximum willingness to pay to avoid the cost increase and leave the individual just as well off. Using the implicit definition, it can be seen that UV leaves the individual indifferent between participation and nonparticipation.

use value is positive, individuals will be observed participating in recreation.

The probability of participation is equal to the probability that the mean valuation function with mean zero random error is greater than zero

$$(7)\ \pi_1 = \pi\,[f(p_i^*, p_i, m; \tau) + \varepsilon > 0\,]$$
$$\pi_1 = \pi\,[f(p_i^*, p_i, m; \tau) > -\varepsilon\,]$$

where π_1 is $\pi(x_1 \geq 1)$. The probability of participation can be estimated with one of several discrete choice econometric models (Amemiya). The logistic regression model has been recommended for recreation economic applications and is used here (Stynes and Peterson 1984). The logit equation specifies the log odds of recreation participation to depend on a linear specification of the index variable in equation (6) as:[2]

$$(8)\ \ln\left(\frac{\pi_{1j}}{1-\pi_{1j}}\right) = \alpha + \beta p_{1j} + \gamma' \mathbf{z_j}$$

where π_{1j} is the probability of participation by individual j at site 1, α and β are coefficients, $\boldsymbol{\gamma}$ is a coefficient vector, and **z** is a vector of independent variables to account for individual differences, including income. From the theoretical valuation function, trip costs and income are required in estimation of the participation equation. Taste and preference indicator variables should also be included in the regression. No restrictions on functional form is suggested by theory.

Once the maximum likelihood coefficients are found for equation (8), the logit equation can be solved for the unobserved probability of participation for each individual in the sample

$$(9)\ \hat{\pi}_{1j} = \frac{1}{1 + \exp\{-[\hat{\alpha} + \hat{\beta} p_{1j} + \hat{\gamma}' \mathbf{z_j}]\}}.$$

Ex-ante, each individual has a nonzero probability of choosing to participate. An individual is expected to participate (not participate) if the estimated probability is $\geq$ (<) .50. Exploiting this information allows estimation of the latent use value. First, the probability of participation for each individual is set to .50 to solve for the maximum trip cost that would be tolerated by the individual

$$(10)\ p_{1j}^*(\pi_{1j} = .5) = \frac{\hat{\alpha} + \hat{\gamma}' z_j}{\hat{\beta}}.$$

The maximum trip cost is the maximum willingness to pay per trip. A property of maximum willingness to pay per trip is that if the recreation probability is greater (less) than .50, maximum willingness to pay per trip will be greater (less) than the observed trip cost.

Next, the difference between the estimated maximum willingness to pay and the observed trip cost for each individual ($p_{1j}^* - p_{1j}$) can be calculated. This value is positive for expected recreation participants. The difference in the maximum willingness-to-pay per trip and the observed trip cost is the use value per trip (UV_{1j} / x_{1j}). Use value per year is equal to use value per trip multiplied by the number of trips taken during the past year. For expected recreation nonparticipants, use value per trip is negative. But, because the actual trip cost is observationally equal to the reservation price for expected recreation nonparticipants, the expected number of trips and use value must be equal to zero for this group. Therefore, use values for expected nonusers are set equal to zero.

EMPIRICAL ESTIMATES OF USE VALUE

The Study Area

In the western Kentucky coalfield along the lower Ohio River, surface coal mining is a competing use of wetlands that contributes to the conversion of wetland acreage. These wetlands provide functions such as fish and wildlife habitat, water quality improvement, flood control, and outdoor recreation. Surface coal mining directly reduces wetland functions by converting wetlands to mined areas and indirectly reduces wetland functions by its negative effect on the water quality of downstream wetlands. Within the western Kentucky coalfield a three county recreation region was identified from maps of the area (Mitsch et al. 1983).[3]

Within the three-county region, the Kentucky Department of Fish and Wildlife Resources (KDFWR) manages public hunting areas, and private coal companies, in cooperation with the KDFWR, manage reclaimed surface coal mines as wildlife areas, recreation areas, and waterfowl refuges. The region is a popular deer hunting area (Shadowen et al. 1984;

[2] The standard conceptual model of recreation participation utilizes the household production function approach (Deyak and Smith 1978). The valuation function approach used in this paper results in identical empirical specifications of the participation decision.

[3] The counties were Hopkins, Muhlenberg, and Ohio.

Gleason and Schaaf 1986). Also, the Kentucky Nature Preserves Commission manages a nature preserve within the coalfield that is habitat for the swamp rabbit (a threatened species), great blue heron, red-shouldered hawk, and marsh hawk (Mitsch et al. 1983). Due to past mining in the coalfield, however, outdoor recreational quality has been degraded. For example, in 1981 fishery resources were designated "poor" by the Kentucky Department of Natural Resources and Environmental Protection. This designation was primarily attributed to acid drainage from surface coal mining.

Table 1. Summary of Data from Mail Survey[a]

Variable	Mean	Standard Deviation
Trip cost (1990 $)	$43.27	44.10
Gender (Male = 1)	48.7%	49.98
Age (Years)	49.14	17.36
Education (Years)	12.58	2.85
Children (Number in Household)	0.70	1.07
Hourly Wage Rate (1990 $)	$12.73	9.66
Urban (Reside in City ≥ 50,000)	33.3%	47.19
Conservationist (Member = 1)	18.7%	37.88

[a]Sample size = 477.

Sampling, Survey Design, and Data

A recent research effort to value wetlands faced with potential surface coal mining in the western Kentucky coalfield gathered recreation participation data which included households in the three-county region, the rest of Kentucky, and households adjacent to Kentucky (Blomquist and Whitehead 1991). The sample was stratified and drawn by the University of Kentucky Survey Research Center using a random digit dialing procedure during Spring 1990. Households in the three-county-recreation region were oversampled. The sample contained the data from 730 households who completed a phone interview; 641 of these (69 percent) gave their names and addresses for inclusion in the mail survey. Mail survey procedures followed the Dillman (1978) Total Design Method with a postcard follow-up and two follow-up mailings of the survey instrument. The response rate was 67 percent of the sample and 76 percent of the 641 mailed survey instruments. A short description, means, and standard deviations of variables for the 477 complete observations available for the logistic regression analysis are presented in Table 1.[4] The trip cost variable was measured consistent with the travel cost recreation demand literature, including travel and time costs.[5]

Table 2. On-Site Activities of Resource Users[a]

Variable	Participants	Proportion
		-percent -
Fishing	48	70.6
Hunting	28	41.2
Nature Observation	27	39.7
Nature Photography	4	5.9
Other Activities	9	13.2

[a]Sample size = 68.

The Participation Decision

Of the survey participants, 14.2 percent traveled to the wetland area to participate in outdoor recreation during the 12 months prior to the survey (Table 2). Recreationists reported each activity in which they participated on these visits. The dominant activity was fishing with 71 percent participation. Forty-one percent hunted, 40 percent observed nature, 6 percent photographed nature, and 13 percent participated in some other activity. Consumptive fish and wildlife uses of the wetland area were dominant. However, consumptive and nonconsumptive uses of nature were joint activities as found by Hay and McConnell (1984).

The dependent variable in the logit analysis was participation in any recreational activity because activities in the wetland area were often jointly chosen (Table 3). Recreation participation was specified to depend on trip cost and membership in environmental and conservation organizations as well as socioeconomic variables. The hourly wage rate was a measure of income. The natural log transformation of trip cost was employed because it outperformed the linear travel cost functional form in predicting the correct number of recreation partici-

[4]The small percentage of item nonresponse in the data was controlled with data imputation methods (Little and Rubin 1989). Income and conservation organization nonresponses were replaced with values obtained from a regression imputation method. All other missing variables were replaced by the sample mean.

[5]Trip cost = {$.20* (round trip distance) + [(.33) * (hourly wage rate) * (round trip distance)] / 40} where $.20 is the travel cost per mile, .33 is used to value travel time at 1/3 the wage rate, and 40 is average miles per hour. For this expolratory study, distance to the resource site was measured linearly on a state map which will underestimate driving distance. Therefore, a high estimate of travel costs per mile was chosen. If this valuation method is used for policy purposes, road mileage should be computed and included in the travel cost estimate.

Table 3. Determinants of Recreation Participation

Variable	Coefficient Estimate	Asymptotic t-statistic
Constant	-3.684**	-2.00
1n (Trip Cost)	-0.779*	-6.16
Gender	0.643**	2.09
Age	0.139**	2.07
Age Squared	-0.001***	1.89
Education	-0.065	-1.13
Children	0.328**	2.23
Hourly Wage Rate	0.036***	1.93
Urban	-0.676***	1.73
Conservationist	1.355*	3.70
χ^2	90.50 (9 d.f.)	
McFadden's R^2	.232	
Sample Size	477	

*, **, ***, indicate significance at the α = .01, .05, and .10 levels, respectively.

pants. The participation equation performed well statistically according to the Chi-square statistic and McFadden's R^2 statistic (Amemiya 1981).

Empirical results showed that there was a negative relationship between recreation participation and trip cost. This result was consistent with economic theory: as the cost of an activity increases, participation in the activity declines. Coefficient results on the standard explanatory variables were consistent with previous studies as described by McConnell (1985). Participation was more likely if the survey respondent was male and did not live in an urban area. Participation increased at a decreasing rate with age, and increased with number of children and income (WAGE). The membership in environmental and conservation organizations variable (CONSERVATIONIST) was included to account for leisure activities that may be complementary with recreation participation. For instance, reading magazines, newspapers, or organizational literature will increase information about recreational area availability and wetlands-related activities. It was expected that this type of behavior will increase recreation participation. Empirical results showed a strong positive relationship between leisure behavior (measured by organization membership) and recreation behavior.

Use Value Estimates

Current and forecast use values were estimated by the one-step method and are presented in Table 4. Use values were weighted to account for the oversampling of coalfield households.[6] Six percent of the sample was predicted to participate in wetlands-related recreation during 1990 and have positive use values.[7] The average use value per trip during the 1990 season was $5.16, ranging from $0.12 to $25.64. The median use value was substantially less than the mean suggesting a skewed distribution of use values. Use value per season was found by multiplying use value per trip by the sample weighted average number of trips (trips = 4.63, n = 27). Each expected participant is expected to enjoy a use value of $23.89 each season.

Three forecasts of use value for the year 2000 were made. The Kentucky population was forecast to age by 2.5 years and real household income was forecast to increase by 3.7 percent (WAGE increases by $5.83) between 1990 and 2000.[8] Each forecast and a combination of both were examined. All forecasts had mostly neutral effects on the probability of participation. The aging of the Kentucky population will leave the number of participants about the same. The income increase will increase the number of participants, but this effect will be reduced by the increased trip cost from the increased opportunity costs of time. Average use values per trip ranged from $5.93 to $7.49 for the three forecasts. Use values per trip increase as the expected participants change in the future. Again, the distribution of use value was nonnormal with the median less than the mean for each group. Use value per season ranged from $27.44 to $35.96.

Aggregate use value was estimated by multiplying participants as a percent of the sample by the Kentucky household population to get the number of forecast participants. The number of forecast participants was multiplied by use value per year to get aggregate use value. The forecast use values were calculated using a population projection for 2000. Use value during 1990 was estimated as $351,183. With increasing participation rates and increased population, use value is expected to increase from 1990 to 2000. If both age and incomes increase as expected, aggregate use value will increase by 73 percent to $609,090.

[6] Households in the three-county recreation region and outside Kentucky represented 54 percent of the sample and 10 percent of the population. Households in the rest of Kentucky represented 46 percent of the sample and 90 percent of the population. The weights were equal to the percent of the population divided by the percent of the sample for each group.

[7] This number is less than one-half of the observed participants. This small number may be a result of the use of logistic regression. Logistic regression tends to underestimate the number of recreation participants when participation is low.

[8] These forecasts were made using data from the *Kentucky Statistical Abstract*, 1988.

Table 4. Estimates of Use Value from Recreation Participation[a]

	Current Year, 1990	Forecast Year, 2000		
Use Value	1	2[b]	3[c]	4[d]
Mean	$5.16	$5.93	$6.40	$7.49
Median	1.88	1.78	2.09	2.59
Minimum	0.12	0.15	0.01	0.04
Maximum	25.64	32.32	34.75	43.36
Standard Deviation	2.82	3.39	3.66	4.40
Sample Size	27	27	31	30
Use Value per Season	$23.89	$27.44	$29.93	$35.96
Forecast Participants	14,700	15,201	17,372	16,938
Aggregate Use Value	$351,183	$417,115	$519,944	$609,090

[a]All Use Value estimates are in 1990 dollars.
[b]Average age increases by 2.5 years.
[c]Average wage increases by $5.83.
[d]Average age increases by 2.5 years and average wage increases by $5.83.

CONCLUSIONS

This study introduces the one-step recreation participation method as an alternative to the two-step participation/intensity method for valuing natural resource-based recreation sites. Advantages of the one-step method are that it is relatively easy to conceptualize and implement and requires only discrete choice participation and travel distance data. The one-step method is a useful, low-cost substitute for two-step travel cost models when research budgets are limited.

The use value estimates in this exploratory study were of a plausible magnitude. More experience with this model is needed, however, before it can be viewed as an alternative to the two-step method for policy purposes. For instance, this case study shows that use values may have been underestimated for recreation sites with relatively low participation rates because the logistic regression model underestimated the number of expected recreation participants. Application of the one-step method to natural areas that supply more and higher quality recreational resources, such as lakes or wilderness areas, is needed. A limitation of further application is a lack of necessary data. National data available from the U.S. Fish and Wildlife Service (National Survey of Fish and Wildlife Associated Recreation, various years), which have been used extensively to estimate recreation participation equations, contain no information or useful proxies of trip costs faced by nonparticipants. If found to be an attractive approach, widespread implementation of the one-step method must wait on data availability.

Further experience with the one-step method could improve upon the reliability and validity of the use value estimates from participation models. In particular, inclusion of substitute site prices and quality variables would more properly specify the model and increase reliability of estimates. Attention to the issues of functional form and multi-destination trips is also warranted. Survey designs which include data appropriate for implementation of the travel cost model would allow a validity test. Convergent validity tests using correlations of use value from the participation decision with consumer's surplus estimates from the second-step intensity of use decision would increase confidence in the validity of use value from the participation decision.

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