Wilderness Recreation Demand:
A Comparison of Travel Cost and On-site Cost Models

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Abstract

This study used travel cost and on-site day cost models, coupled with the Forest Service's National Visitor Use Monitoring data, to examine the demand for and value of recreation access to designated Wilderness.

Key Words: Wilderness, recreation, travel cost, on-site day cost, consumer surplus

Introduction

Morton (1999) has shown that land in the National Wilderness Preservation System (NWPS) has many use and nonuse dimensions contributing to its economic value. Bowker et al. (2006) found that while per capita demand for wildland recreation access may be shrinking, overall demand continues to increase because of the greater increase in population. With a shrinking land base compared to population growth, the relative values of competing uses of wildlands become more important to land allocation decisions. While, Bowker et al. (2005) provided empirical estimates of the multiple values for Wilderness based on four decades of economic research, these studies were typically fragmented, based on suspect samples, and often unclear about the basic units of measure.

Among the most important use values for Wilderness is recreation access. In most cases, while access is free, visitors would lose considerable utility if the access was unavailable. Consequently, visitors have a positive willingness-to-pay or consumer surplus (CS) for continued access to the NWPS. Traditionally, CS for Wilderness recreation access has been measured using either the Travel Cost Method (TCM) (Smith 1975; Englin and Shonkwiler 1995) or Contingent Valuation (CVM) (Pope and Jones, 1990; Keith, J.E., C. Fawson, and V. Johnson 1996). Here, we apply and contrast TCM to the On-site Cost Model (OCM) (Bell and Leeworthy 1990), to examine recreation demand and economic value for National Forest Wilderness (NFW) access.

Methods and Data

TCM has been the dominant behavior-based nonmarket valuation technique applied to recreation resources and Wilderness. The basic premise of the TCM is that the time and travel cost expenses that people incur to visit a site represent the "price" of access to the site. Thus, the willingness-to-pay to visit the site can be estimated based on the number of trips that are made at different travel costs. This is analogous to estimating the willingness-to-pay for a marketed good based on the quantity demanded at different prices. TCM allows for the construction of a demand curve where the number of trips to a site is assumed to relate to cost, time and other demographics (Parsons 2003). If a demand curve can be estimated, the value of site access can be measured. In the case of NFW access, the empirical demand model can be generally specified as:

$$NFV = f\,(TC, SUBST, SOC, SITE) + u \qquad (1)$$

where, NFV is annual visits to the Wilderness site, TC is the travel cost per visit, SUBST, SOC and SITE are vectors of socioeconomic and site characteristics respectively, and u is random error.

Bell and Leeworthy (1990) found that the TCM broke down when dealing with beach day valuation for Florida tourists because of limited variation in the annual trips variable, yet considerable variation in days on site inspired them to develop an alternative model. This problem, attributed to spatial limits, was first described by Smith and Kopp (1980) and revisited by Kerkvliet and Nowell (1999) for anglers at Yellowstone. The latter found that while the

OCM mitigated some of the problems attributable to TCM, it was not a complete success in dealing with visitor heterogeneity. To our knowledge no further applications of the OCM have been published.

In an OCM, the visitors face two distinct types of cost, on-site cost and travel cost. It is assumed that the visitors need to pay a certain charge before the consumption of recreation service on site. It can be considered a payment for privilege of purchasing the on-site service. Hof and King (1992) demonstrated theoretical validity of the OCM to obtain consumer surplus. The empirical OCM takes the form:

$$WD = f\,(DIST, OSCST, SUBST, SOC, SITE) + u \qquad (2)$$

where, WD is annual days at the Wilderness site, DIST is one-way travel, OSCST is on-site cost per day, SOC and SITE are vectors of socioeconomic and site characteristics respectively, and u is random error.

Data were collected as part of Round 1 of the National Visitor Use Monitoring Program (NVUM) from 2000-2004 across all National Forests. Details of the stratified random exit sampling protocol are provided in English et al. (2002). This application uses only Wilderness stratum data containing expenditure and basic survey modules (approximately 25% of Wilderness stratum). Data collected on-site are zero-truncated, non-negative integers, overdispersed, and endogenously stratified (Ovaskainen et al. 2001) rendering the OLS estimation approaches used by Bell and Leeworthy (1990) and Kerkvliet and Nowell (1999) inappropriate. To address the on-site data collection problem, we use a truncated negative binomial estimator and weight the data to account for the sampling stratum and the probability of selection. Travel cost is computed as the average AAA variable cost per mile for medium vehicles from 2000-2003 (when the data were collected) of $0.1269 in the base TCM.

Results

Weighted and unweighted sample means for the dependent and explanatory variables are presented in Table 1. Examining the two dependent variables, WD and NFV, reveals the large discrepancy created by endogenous stratification or avidity bias. However, the respondent’s probability of being in the sample does not appear to greatly affect distance traveled, age, gender, people per vehicle, or perception of crowding.

Table 1. Means for dependent and explanatory variables, n=1620.

Variable	Unweighted	Weighted
WD (wilderness days/yr)	26.36235	5.022633
NFV (wilderness visits/yr)	21.91667	3.094234
AVGEXPV (on-site cost/day)	95.73176	131.3282
FULLTC (full travel cost)	367.0083	418.2845
TC (travel cost w/o time)	133.9227	146.7812
PRACTDIS (distance)	544.4013	596.6717
INC (income proxy thousands)	42.10245	43.55994
SUBST (=1 if had subst; 0 o.w.)	0.511728	0.62903
GEND (=1 if male; 0 o.w.)	0.676012	0.650675
OTHSITE (other sites visited)	0.322222	0.493302
AGEGROUP	3.493506	3.438731
PEOPVEH (group size)	2.474566	2.616714
CROWDING (crowding likert)	4.080713	3.970372
DHIUSE (=1 if NFV>18; 0 o.w.)	0.25679	0.019872
TIMESITE (visit time on site)	1.62716	1.994671

Regression results and fit statistics for the TCM are reported in Table 2. Visits are inversely proportional to travel cost (TC). The binary variable (DHIUSE) for high-frequency users is highly significant. Trips were inversely related to income (INC). This result is theoretically questionable, but consistent with much of the recreation demand literature. It should be noted however, that because of federal questionnaire restrictions pertaining to income, the income variable is proxy based on the average IRS tax return for the respondent's zip code. The substitute binary (SUBST) had a negative coefficient indicating that respondents with substitute sites or activities demanded fewer visits. Being a male (GEND=1) positively affected trip demand. Respondents who visited other sites (OTHSITE) during the trip, or stayed longer at the site (TIMSITE) demanded fewer trips. The age of the respondent (AGEGROUP) was insignificant, while more people in the traveling party (PEOPVEH) led to fewer trips demanded. Finally, the Alpha coefficient being positive and significant indicated that the data are over-dispersed and thus the truncated negative binomial is preferred to the truncated poisson specification.

Table 2. TCM negative binomial parameter estimates, n=1593, dependent variable NFV

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	1.44460939	.25173208	5.739	.0000	
TC	-.00291533	.00028023	-10.403	.0000	134.409922
DHIUSE	3.77512046	.31788160	11.876	.0000	.25800377
INC	-.01710612	.00249755	-6.849	.0000	42.0690654
SUBST	-.27168992	.08899320	-3.053	.0023	.51098556
GEND	.58235099	.08670340	6.717	.0000	.67545512
OTHSITE	-.71976727	.08402700	-8.566	.0000	.32140615
TIMESITE	-.24207486	.02737227	-8.844	.0000	1.62586315
AGEGROUP	-.00412415	.03503506	-.118	.9063	3.48964218
PEOPVEH	-.15563758	.03764613	-4.134	.0000	2.46892655
Dispersion parameter for count data model					
Alpha	4.15988341	1.23900014	3.357	.0008	MFRSQ=0.34

An alternative TCM incorporating an opportunity cost for time (the product of federal minimum wage for group members over 16 and travel time) was also estimated, but is not reported here. With the exception of the price coefficient (-0.0011), all coefficients were within 5 percent of those reported in Table 2.

Results for the OCM model are reported in Table 3. Annual days in Wilderness are negatively related to on-site cost per day (AVGEXPV) and travel distance (PRACDIS) which is theoretically consistent. As with the TCM, income (INC), presence of substitutes (SUBST), visiting other sites on the trip (OTHSITE), and number of people in the traveling party (PEOPVEH) all negatively affect demand for Wilderness days. Age of the respondent (AGEGROUP) is likewise insignificant, but being male (GENDER) positively affects demand. Unlike the TCM model, a time on site variable is not included, because the unit of consumption is Wilderness days. Similar to the TCM, the Alpha parameter is significant supporting the use of the truncated negative binomial.

Table 3. OCM negative binomial parameter estimates, n=1593, dependent variable WD

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	1.74891483	.22619616	7.732	.0000	
AVGEXPV	-.00228622	.478720D-04	-47.757	.0000	95.3444935
PRACTDIS	-.00062317	.353842D-04	-17.611	.0000	546.381795
INC	-.02242522	.00151744	-14.778	.0000	42.0690654
SUBST	-.11369428	.05640536	-2.016	.0438	.51098556
GEND	.62181389	.04574014	13.594	.0000	.67545512
OTHSITE	-.80854053	.04662477	-17.341	.0000	.32140615
AGEGROUP	.13731531	.01691257	8.119	.0000	3.48964218
PEOPVEH	-.13605395	.02258053	-6.025	.0000	2.46892655
Dispersion parameter for count data model					
Alpha	6.32826739	1.32530468	4.775	.0000	MFRSQ=0.58

Discussion

The regression results alone do not provide compelling evidence that either the TCM or the OCM is superior for estimating Wilderness demand. For both models the signs of estimated coefficients conform to theory, except in the case of the income proxy. Examining the McFadden R-square fit measure (MFRSQ), the OCM (0.58) appears to describe the data somewhat better than the TCM (0.34), although both of these estimates are relatively high among similar published studies. The alternative TCM model adding an opportunity cost of time to the travel cost provided a similar MFRSQ (0.33) as the TCM model reported above.

An alternative economic measure by which the two models can be compared is price elasticity. Following Bowker and Leeworthy (1998), the own price elasticity for the TCM in truncated negative binomial form is E_{TC}= -1.1, whereas for the OCM the price elasticity is $E_{AVGEXPV}$=-0.84. In both cases, the values are within the range reported in the recreation demand literature. The TCM model using time cost yielded a much lower price elasticity, E_{TCOP}= -0.18, which is at the extreme low end of those reported in the literature. This could be further evidence in the argument against the arbitrary inclusion of time costs into many recreation demand models.

Average consumer surplus for each of the two models can be computed similarly. For the TCM model, estimated as annual NFV per group, average per group per trip CS_{NFV}= (-1/B_{TC}) = \$343. Alternatively, for the OCM, estimated as annual WD per group, average per group per day CS_{WD}=(-1/$B_{AVGEXPV}$) = \$437. To compare the two results requires bringing both measures to a common unit, consumer surplus per person per day, CSPPD. For the TCM, $CSPPD_{NFV}$= [(CS_{NFV}/(TIMESITE*PEOPVEH)] = \$148 (+/-\$15). The TCM with time cost included led to a CSPPD of \$366 (+/-\$92). For the OCM, estimated in days rather than trips or visits, $CSPPD_{WD}$=[CS_{WD}/PEOPVEH] = \$229 (+/- \$11), an increase of about 50 percent over the base TCM and nearly 60 percent lower than the time cost TCM. While each model yields values that fall within the range of consumer surpluses reported in the literature for access to high quality wildland recreation, it is interesting to note that the OCM virtually splits the difference between the conservative mileage cost only TCM and the TCM which incorporates the product of minimum wage and travel time as a proxy for the adults' value of time in travel.

Conclusions

We explored the use of the TCM and OCM approaches to value recreation access to designated Wilderness. Our findings of CS per person per day indicate a range of values from \$366 (TCM with time) to \$228 (OCM) to \$148 (TCM base) and are within the range of values reported in the literature for studies conducted at specific Wilderness areas. In this application, the TCM without time cost is probably a good lower bound for valuing per day access to the National Wilderness Preservation System, although arguments can be made in support of each of the other two models. A case can also be made for convergence validity as the on-site cost model splits the difference between travel cost models with different assumptions about travel time.

Employing the lower TCM CS value of \$148 per person per day, and aggregating across 12.4 million days for National Forest Wilderness and 16.28 million days for NWPS visitation in 2002 (Bowker et al. 2006) the consumer surplus for recreation access to Wilderness are, respectively, about $1.8 and $2.4 billion per year. Employing the OCM results, and the TCM with time, the annual net economic benefits for Wilderness recreation access are higher (Table 4).

Table 4. Annual net economic values of Wilderness recreation access (lower 48 states).

Model	$CSPPD	NFW Days	NWPS Days	$NFW/yr	$NWPS/yr
TCM base	$ 148	12.4 mil	16.3 mil	$ 1.84 bil	$ 2.41 bil
OCM	$ 229	12.4 mil	16.3 mil	$ 2.84 bil	$ 3.73 bil
TCM time	$ 366	12.4 mil	16.3 mil	$ 4.54 bil	$ 5.96 bil

Assuming a discount rate of 3 percent, and a 50-year time horizon, the present value per acre of National Forest Wilderness in the lower-48 states ranges from $1500 to nearly $3800, while for the complete NWPS in the lower-48 states the per acre value ranges from $1200 to nearly $3000 per acre depending on the valuation model selected.

Economists have claimed conceptually and reported empirically that use value or recreation access value for Wilderness is likely to be less than values derived from various non-use and existence values. Nevertheless, it is clear from this study that the value of recreation access to Wilderness is nontrivial as measured by either of the two behavior-based methods employed.

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