Estimating the Value of Recreation on the Snake River Reservoirs Using a Disequilibrium Travel Cost Model

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Abstract

Demand for outdoor recreation was analyzed at four Lower Snake River reservoirs for the purposes of measuring willingness-to-pay for outdoor recreation trips.

Data were collected with a single mailing survey using a list of names and addresses collected from recreationists at the reservoirs during May through October, 1997. The survey resulted in 408 usable responses.

Outdoor recreation demand was estimated using a disequilibrium labor market travel cost model that assumed recreationists did not (or could not) give up earnings in exchange for more free time for outdoor recreation. The travel cost demand model related outdoor recreation trips (from home to site) per year by groups of recreationists to the dollar costs of the trip, to the time costs of the trip, to the prices on substitute or complementary trip activities, and other independent variables. The dollar cost of the trip was based on reported travel distances from home to site times the average observed cost of $0.202/mile for a car divided by the average party size (4.87) yielded 4.12 cents per mile per recreationist. Trips per year to the reservoirs, the dependent variable was estimated using a truncated negative binomial regression.

Consumer surplus was estimated at $71.31 per person per trip. The average number of outdoor recreation trips per year from home to the Lower Snake River Reservoirs was 8.364, resulting in an average annual willingness-to-pay of $596 per person. After adjusting for non-response bias the annual willingness to pay for recreation at the reservoirs exceeded $31 million.

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Introduction

Several salmon species in the Columbia River Basin have been listed under the Endangered Species Act as threatened or endangered. Alternative actions are evaluated in the US Army Corps of Engineers on-going feasibility study, while competing proposals are forwarded by States, tribes, environmental activists, and industry groups. The most controversial alternative for salmon recovery, is the breaching of four dams on the Lower Snake River; Lower Granite, Ice Harbor, Little Goose, and Lower Monumental. Measuring recreation benefits are a critical input to the salmon recovery plans that propose breaching the four dams.

The Travel Cost Method (TCM) has been preferred by most economists to estimate the economic value of outdoor recreation. The conventional travel cost models assume labor market equilibrium (Becker 1965) so that the opportunity cost of time used in travel is given by the wage rate. However, the equilibrium labor market travel cost model may only apply to certain individuals that have discretionary work schedules and can expect that earnings will decline in proportion to time spent in recreation. Thus, disequilibrium in labor markets may render wage rates irrelevant as a measure of opportunity time cost for many recreationists.

Dissatisfaction has also been expressed over measurement and modeling of opportunity time values. The opportunity time value methodology has been criticized and modified by, McConnell and Strand (1981), Ward (1983, 1984), Bockstael et al. (1987), and McKean et al. (1995, 1996).

The results from our previous studies and this study on the Lower Snake River reservoirs suggest using a disequilibrium labor market travel cost model designed to help overcome disagreements and criticisms of the opportunity time value component of travel cost.

Survey and Study Sites

The Lower Snake River expanded TCM survey includes detailed socio-economic information about recreationists and data on money and physical time costs of travel, outdoor recreation, and other activities both on and off the reservoir outdoor recreation sites.

Recreationists in this study were contacted at the reservoirs over the period from May through October 1997 and requested to take part in the outdoor recreation demand mail survey. The survey resulted in a sample of 408 useable responses out of 438 surveys returned. Some surveys had to be discarded because they were incomplete. A total of 630 surveys were mailed out yielding a useable response rate of 64.8 percent for the recreation demand questionnaire.

Disequilibrium and Equilibrium Labor Market Travel Cost Models

The traditional equilibrium labor market Travel Cost Model may apply to certain self-employed persons, where individuals, (1) have discretionary work schedules and, (2) can expect that their earnings will decline in proportion to the time spent recreating. According to U.S. Bureau of Census (1993) only 5.4 percent of voting age persons in the U.S. were classified as self-employed in 1992. Thus the labor market equilibrium model applies to less than 5.4 percent of recreationists who are over-represented by retirees and students.

Bockstael et al. (1987), hereafter (B-S-H), provide a disequilibrium labor market model in which time and income are not substituted at the margin. B-S-H show that the time and money constraints cannot be collapsed into one when individuals cannot marginally substitute work time for leisure. Thus, money cost and physical travel time per trip from home to site enter as separate price variables in the demand function and discretionary time and income enter as separate constraint variables. The B-S-H travel cost model can be estimated as;

$$r \quad = \quad b_0 + b_1 c_0 + b_2 t_0 + b_3 c_a + b_4 t_a + b_5 INC + b_6 DT \quad \textbf{(1)}$$

where the subscripts o and a refer to own site prices and alternate site prices respectively, *c* is out-of-pocket travel cost per trip, *t* is physical travel time per trip, *INC* is money income, and *DT* is available discretionary time.

The equilibrium labor market model makes the explicit assumption that opportunity time value rises directly with income. Thus, the methodology that we have rejected assumes perfect substitution between work and leisure. McConnell and Strand (1981, 1983) (M-S) specify price in their travel cost demand model as the argument in the right hand side of equation two.

$$r = f\left[c + (t)g'(w)\right] \qquad \textbf{(2)}$$

Where, as before, r is trips from home to site per year, c is out-of-pocket costs per trip, and *t* is travel time per trip. The term g'(w) is the marginal income foregone per unit time. It is assumed in the M-S model that any increase of travel cost, whether it is out-of-pocket spending or the money value of travel time expended, has an equal marginal effect on visits per year. The term [c + (*t*)g'(w)] imposed this restriction because it forces the partial effect of a change in out-of-pocket cost (Mf/Mc) to be equal in magnitude to a change in the opportunity time cost Mf/M[(*t*)g'(w)].

Ward (1983,1984) proposed that the "correct" measure of price is the minimum required round trip expenditure since any excess is a purchase of other goods and is not a relevant part of the price of a trip to the site. This own-price definition suggests that the other (excess) spending during the trip is associated with some of the closely related goods whose prices are likely to be important in the demand specification. Empirical estimates of partial equilibrium demand could suffer under-specification bias if the prices of closely related goods were omitted. Traditional TCM demand models seemingly ignore this well known rule of econometrics and exclude the prices of on-site time, purchases, and other trip activities which are likely to be the principal closely related goods consumed by recreationists.

Variable definitions are shown in Table 1. The dependent variable for the travel cost model is (r), annual reported trips from home to the four Lower Snake River reservoirs.

The money price variable in the B-S-H model is c_r, which is the out-of-pocket travel costs to the outdoor recreation site. The average out-of-pocket travel cost for recreationists was about 20.2 cents per mile per car. The average party size was 4.87 resulting in a 4.12 cents per mile per recreationist. Reported one-way travel distance for each party was multiplied times two and times $0.0412 to obtain the money cost of travel per person per trip.

The physical time price for each individual in the B-S-H model is measured by t_o which is round trip driving time in hours. Possible differences in sensitivity to time price were accommodated by creating separate time price variables for different occupations. It would be expected that jobs with the least flexibility to interchange work and leisure hours would be the most sensitive to time price. Seven occupation or employment status categories including student, retired and unemployed were obtained in our survey. Dummy variables were created for each and the time price, multiplied times the dummies to created separate price variables.

The B-S-H model calls for the inclusion of t_a, round trip driving time from home to an alternate outdoor recreation site, as the physical time price of an alternate outdoor recreation site. The variable was not significant and appeared to be highly correlated with the monetary cost of travel. The remaining alternate site price variable is c_a, the out-of-pocket travel costs to the most preferred alternate outdoor recreation site. This variable also was not significant.

Available free time is *DT*. The discretionary time constraint variable is required for persons who cannot substitute time for income at the margin. Restrictions on free time are likely to reduce the number of trips taken. The discretionary time variable has been positive and highly significant in previous disequilibrium labor market recreation demand studies and was highly significant in this study (Bockstael et al. 1987, McKean et al. 1995, 1996).

The income constraint variable, *INC,* is defined as average annual family income resulting from wage earnings. Restrictions on income should reduce overall purchases, but it may also cause a shift to "inferior" types of consumer goods. Thus, the sign on the income coefficient conceptually can be either positive or negative.

Three other closely related goods prices were significant in the model: t_{os}, time spent on site at the four reservoirs, c_{os}, money spent on site at the reservoirs, and c_a, money spent on-site at alternate outdoor recreation sites away from the reservoirs during the reservoir recreation trip. Spending more time-on-site at the reservoirs could increase the value of the trip leading to increased trips, or it could be substituted for trips. Money spent on site is expected to be for complementary goods used at the reservoirs while money spent at an alternate site away from the reservoirs is part of the cost of a substitute recreation experience.

A price variable, c_{md}, measuring money travel cost for the second leg of the trip for recreationists visiting a second site away from the Snake River reservoirs was insignificant. If significant, this variable would have indicated how much the recreation demand at the Snake River reservoirs was influenced by the cost of going from the reservoirs to a second site for those considering multi-destination trips.

The strength of a recreationist's preferences for recreation over other activities should positively influence the number of trips taken. The variable, *TASTE* is days recreated divided by available days, is used as one indicator for tastes and preferences. A second indicator related particularly to the study site is the number of years the recreationist has visited the reservoirs. Variable *EXP* measures this. The reservoirs may also have a unique demand thus each reservoir was represented by a dummy variable. Only Lower Granite Reservoir near the towns of Lewiston and Clarkston showed a significant difference in demand relative to the other reservoirs. Age has often been found to influence various types of outdoor recreation activity. A dummy variable, *BOAT*, was used to identify recreationists that used a boat either all or part of the time. Possession of a boat was expected to positively influence visit rates.

Empirical Results

Truncated Poisson or truncated negative binomial regression is appropriate for dependent variables with integer data. Because the data for the dependent variable (visits per year), are integers, truncated below one visit per year, equation estimation by ordinary least squares regression (OLS) is inappropriate. Truncation occurred because the on-site survey excluded persons not consuming recreation at the study site. Maddala (1983) shows that the regression slopes estimated by OLS will be biased toward zero when the dependent variable data are truncated. The result is that the least squares method understates price elasticity and overstates consumers' surplus.

Poisson and negative binomial functional form is mathematically equivalent to a logarithmic transformation of the dependent variable. Some independent variables are log transformed resulting in a double log functional form for these variables. Other independent variables are not transformed resulting in a semi-log functional form for these variables.

The significance of the coefficients in a Poisson regression can be greatly overstated if the variance of the dependent variable is not equal to its mean (over-dispersion). The negative binomial regression does not have this shortcoming but the iterative solution process may fail to converge. Convergence was not a problem for this data set. Tests for over-dispersion in the Poisson regressions (Greene, 1992) were conflicting. However, the t-values appeared inflated in the Poisson regressions. A second test is available by actually running the negative binomial regression. When the truncated negative binomial regression was estimated, the coefficient on the over-dispersion parameter was 0.385 with a t-value of 8.94. This provided strong evidence of over dispersion. The t-values found in the negative binomial regression were much smaller than in the Poisson regression. This was further evidence that Poisson regression had over-dispersion. Thus, the negative binomial regression technique was used.

Many of the exogenous variables in the truncated negative binomial regressions were log transforms. When the independent variables are log transforms the estimated slope coefficients directly reveal the elasticities.

Price elasticity of out-of-pocket travel cost is -0.1393. As expected for a regionally unique consumer good, the number of trips per year is not very sensitive to the price.

The elasticity for physical travel time for retirees in the sample is -0.349, for students is -0.516, for hourly wage earners is -0.265, for professional is -0.293. Most other categories had few members represented in the sample and the coefficients were not significant.

Demand elasticity of time on site was -0.0798. Time on site is a complement to trips in that as the time price of a trip rises fewer trips are taken. Price elasticity of expenditures at the reservoirs also has a negative sign indicating that it too is complementary to the trip.

Price elasticity of expenditures at the alternate outdoor recreation site is 0.0236 and positive, indicating the alternate site is a substitute for the reservoirs.

Price elasticity of the cost of travel to an alternate outdoor recreation site was not significant. Price elasticity for the cost of the second leg of the journey for those visiting more than one site (other than the Snake River reservoirs) also was not statistically significant.

Income elasticity is zero. Quantity demanded (outdoor recreation trips from home to the reservoirs per year), was not related to income.

Elasticity of discretionary time is 0.153. As in past studies, the discretionary time was positive and highly significant. As expected, available free time acts as a powerful constraint on the number of outdoor recreation trips taken per year.

Elasticity of taste was positive showing that recreationists who recreated a larger fraction of available days were likely to take more trips per year to the reservoirs.

The outdoor recreation experience variable showed that those who have recreated the reservoirs over a long period of time tend to make more trips to the reservoirs.

Only the dummy demand-shift variable for Lower Granite Reservoir was significant. The coefficient estimated for the dummy variable indicated that many more trips are demanded by recreationists at Lower Granite Reservoir compared to the other reservoirs.

The coefficient on age is weakly significant (10 per cent level one tail test).

The dummy variable, indicating a boat was used for recreating all or part of the time had a positive coefficient. Those using a boat for recreation would take more outdoor recreation trips to the reservoirs per year than those who recreated only on shore.

Consumers Surplus

Consumers' surplus was estimated using the result shown in Hellerstein and Mendelsohn (1993) for consumer utility maximization subject to an income constraint, and where trips are a nonnegative integer. They show that the conventional formula to find consumer surplus for a semilog functional form also holds for the case of the integer constrained quantity demanded variable. The negative binomial regressions, with a linear relation on the explanatory own monetary price variable are equivalent to a semi-log functional form. Adamowicz et al. (1989) show that the annual consumers surplus estimate for demand with continuous variables is E(r)/(-ß), where ß is the estimated slope on price and E(r) is average annual visits. Consumers surplus per trip from home to site is 1/(-ß).

The estimated coefficient of -0.014023 on out-of-pocket travel cost thus consumer surplus per recreationist per trip is the reciprocal or $71.31. Average recreationist trips per year in our sample was 8.364. Total surplus per recreationist per year is average annual trips x surplus per trip or 8.364 x $71.31 = $596 per year. After adjusting for non-response bias the annual willingness-to-pay for recreation at the reservoirs was $31,578,464.

Differences in Trip Value Among the Four Reservoirs

The travel cost price variable was also introduced separately for each reservoir in the demand equation using dummy variables. This allowed getting separate estimates of value per recreationist per trip (from home to reservoir) for each reservoir. The trip value results are as follows: (1) Lower Granite, $91.16 per person per trip (t-ratio = -2.72); (2) Little Goose, $46.36 per person per trip (t-ratio = -1.36); (3) Lower Monumental, $38.55 per person per trip (t-ratio = -2.27); (4) Ice Harbor, $28.05 per person per trip. (t-ratio = -3.17)

Lower Granite Reservoir accounted for 41 percent of the visitation, compared to 31.6 percent at Ice Harbor Reservoir, 15.6 percent at Little Goose Reservoir, and 11.3 percent at Lower Monumental Reservoir. Lower Granite Reservoir had both more people taking longer trips and had more people visiting. If the consumer surplus values for each reservoir are weighted by the respective visitation share the average consumer surplus is only $58.28 per person per trip compared to $71.33 per person per trip estimated when all reservoirs were combined in a single variable.

Conclusions

Until a consistent and credible method of measuring true marginal opportunity time costs is found, the results from the equilibrium labor market Travel Cost Model will vary according to the assumptions rather than the facts.

An alternative travel cost model, by Bockstael et al. (1987), assumes labor market disequilibrium. Because a very small fraction of the voting public (5.4%) are self-employed, the disequilibrium model may be more appropriate for the majority of outdoor recreation participants. Most people are unlikely to meet the requirements, of the equilibrium model, for substitution at the margin between time and income, i.e., (1) discretionary work schedules, and (2) income foregone in proportion to time off.

A disequilibrium travel cost model was utilized to estimate the value of recreation at the four Lower Snake River Reservoirs. Consumer surplus was estimated at $71.31 per person per trip. Based on a reported 8.364 trips per year annual consumer surplus was $596 per person. After adjusting for non-response bias the annual willingness to pay for recreation at the reservoirs was $31,578,464. Trip values per person were also estimated for each of the four reservoirs: (1) Lower Granite, $91.16; (2) Little Goose, $46.36; (3) Lower Monumental, $38.55; and (4) Ice Harbor, $28.05.

Table 1. Definition of variables [2]

Variable	Units	Description
r	number	annual trips from home to the Lower Snake River reservoir fishing site (dependent variable).
c_r	$	the angler's out-of-pocket round trip travel cost to the fishing site
$L(t_{o1})$	hours	"retirees" round trip travel time to the fishing site.
$L(t_{o2})$	hours	"unemployed persons" round trip travel time to the fishing site.
$L(t_{o3})$	hours	"self-employed persons" round trip travel time to the fishing site
$L(t_{o4})$	hours	"hourly wage earners" round trip travel time to the fishing site
$L(t_{o5})$	hours	"professionals" round trip travel time to the fishing site.
c_{os}	$	"money spent on site at the reservoirs.
c_a	$	the angler's out-of-pocket travel cost to an alternate fishing site away from the reservoirs.
$L(t_{as})$	hours	time spent at an alternative fishing site away from the reservoirs during the trip.
$L(t_{os})$	hours	time spent on-site at the reservoirs fishing during the trip.
L(INC)	$	annual family earned income
L(DT)	days	the angler's discretionary time available per year.
L(Taste)	hours	the angler's typical number of hours fished per day.
FEXP	years	the angler's total fishing experience at the reservoirs, in years.
GRAN	1,0	a dummy variable that is one for persons fishing at Lower Granite Reservoir and zero for persons fishing at any of the other reservoirs.
A, AS	years	the angler's age; and AS = age squared.
BOAT	1,0	a dummy variable, one for persons who only fish from a boat or fish from boat bank and boat zero for those who either fish from bank alone.

[2] L indicates a log transformation.

Table 2. Disequilibrium travel cost model for the Lower Snake River reservoirs.[3]

Variable	Coefficient	t-ratio	Mean of Variable	Elasticity
Constant	3.547	2.89	na	na
c_r	-0.014	-3.78	9.93	-0.14
L(t_{o1})	-0.349	-3.61	-	-0.35
L(t_{o2})	-0.516	-2.15	-	-0.52
L(t_{o3})	-0.265	-8.09	-	-0.27
L(t_{o4})	-0.293	-3.40	-	-0.29
L(t_{os})	-0.08	-2.39	2.70	-0.08
c_{os}	-0.0015	-2.75	94.98	-0.14
c_a	0.00075	2.02	31.44	0.02
L(*INC*)	-0.072	-0.78	10.90	ns
L(*DT*)	0.153	3.17	3.90	0.15
L(*TASTE*)	0.418	9.53	-1.56	0.42
L(*EXP*)	0.19	4.38	2.07	0.19
GRAN	0.187	2.25	0.41	0.19
L(*A*)	-0.297	-1.51	3.77	-0.30
BOAT	0.527	5.21	0.70	0.53

[3]Travel cost per mile per recreationist assumed to be $0.0412. The dependent variable (r = trips per year to the reservoirs , mean of r = 8.364) was estimated using a truncated negative binomial regression. R^2 estimated by a regression of the predicted values of trips from the truncated negative binomial model on the actual values (R^2 = 0.55).

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