ESO 1749

RECREATION DEMAND MODEL WITH ENDOGENOUS TRIP DURATION AND TRIP COSTS

Leroy J. Hushak and Huei-Yann Jeng
The Ohio State University

August, 1990

Department of Agricultural Economics and Rural Sociology
Ohio Agricultural Research and Development Center
Ohio Sea Grant College Program
The Ohio State University

Selected Paper presented at the American Fisheries Society annual meeting, Pittsburgh, Pennsylvania, August 27-30, 1990.

RECREATION DEMAND MODEL
WITH ENDOGENOUS TRIP DURATION AND TRIP COSTS

Leroy J. Hushak and Huei-Yann Jeng
The Ohio State University

INTRODUCTION

Several Ohio Sea Grant studies have been conducted of economic values of Lake Erie and **have shown wide variation in recreation trip duration and on-site costs and that trip duration and on-site costs are correlated with distance to the recreational site.** In economic valuation studies of western basin walleye and yellow perch fishing in 1981, trip duration was positively and significantly correlated with distance to the recreational site, and negatively and significantly correlated with number of trips. In a statewide survey to study participation in water-based recreation activities at Lake Erie, the correlation coefficient of trip duration with distance was also positive and significant, while that with number of trips was negative but not significant (Hushak et.al., 1988). In the 1987 Ohio Lake Erie sport fishing survey used in this study, the correlation coefficient between duration of trips and the travel costs of making trips is 0.56, and the correlation coefficient between number of trips and duration of the trip is -0.11, both significant at 0.01 level. Wilman (1980, 1987) and Kealy and Bishop (1986) are other studies which have confronted similar issues.

Empirically and intuitively, recreational costs are positively related to the number of days per trip when the on-site costs are included, because those who spend more days on site will incur higher monetary expenditures. Number of trips is negatively related to the duration per trip because those who have come from greater distances are likely to stay for longer periods and make fewer trips. This implies that the choices of trip duration and on-site recreational costs are both endogenously determined. Trip duration is determined by the distance traveled from home to a recreation site and the recreation cost per trip is dependent on the duration.

The traditional travel cost model is applicable where all visits to sites by all individuals are of the same duration. Since recreational trip duration is far from homogeneous, there is potential bias. In the household production framework (Becker 1971), the recreationist uses scarce time during the on-site part of the trip as well as during travel and varies trip length according to the availability of recreational time and other predetermined conditions. When trip length is a variable of choice for the individual, it is endogenously determined. In resolving the non-homogeneous recreational trips problem, several methods have been proposed (Wilman, 1980; Kealy and Bishop, 1986; and Wilman, 1987). However, the endogenized duration and on-site cost specification is yet to be explored in the recreational model.

Time cost has been an important issue in recreational models. Accounting for travel time and on-site time are important because both represent the use of a scarce resource implying a positive opportunity cost. The issue in considering these opportunity time costs is how to incorporate and value time in the recreation demand function. Several studies use some explicit proportion of the individual's wage rate (Hushak et al., 1988; Bishop and Heberlein, 1980). Other researchers proposed an explicit money cost to be imputed to scarce travel time (Cesario and Knetsch, 1970). In other studies, travel time and on-site time are considered as variables in the choice process of utility maximization (Bockstael et al., 1987; McConnell and Strand, 1981; Cesario, 1976). McConnell and Strand (1981) estimated the value of recreation time by entering money costs per trip and time costs per trip as separate variables. Bockstael et al. disaggregated the sample into those who can and those who cannot substitute work and leisure time.

Jeng and Hushak (1989) proposed that the value of recreational time is affected by the individual's demographic characteristics. Demographic factors were also identified to have effects on the participation and the economic values of outdoor recreation activities in economic recreational models (Jeng and Hushak, 1988). When the duration and costs of recreational trips are endogenous, the choices of duration, costs, and number of recreational trips are expected to be affected by the individual's demographic characteristics.

In this paper, we have two primary objectives. The first is to develop and estimate a model where duration of trips, cost of trips, and value of recreational time are choice variables. The second objective is to compare the results of this alternative model with more traditional recreational demand models. In the next section, we develop the methodology of the endogenous trip duration or repackaging model which includes procedures for estimating the value of human time and for controlling variation in demographics of the sample respondents. We then discuss the database followed by the results. We compare the parameters and the economic value estimates of the repackaging model to those of more traditional models. A brief discussion of implications concludes the paper.

REPACKAGING RECREATION DEMAND MODEL

1. **Repackaging Model (Muellbauer, Wilman) with multiple demand equations was reduced to single demand equation because we could not identify multiple trip duration demand equations.**

When trip length is a variable of choice for the individual, it is endogenously determined. In resolving the non-homogeneous recreational trips problem, several methods have been proposed. Wilman (1980) developed a model that can include on-site time in a price/cost variable under certain conditions. Her model also allows for different visit lengths to the same site by treating different duration trips as different goods.

Kealy and Bishop (1986) proposed another resolution in which "recreation days" rather than "trips" is the homogeneous unit of recreational demand models. In their specification, Kealy and Bishop postulated that individuals maximize their utility by choosing the total number of days, which is the product of the number of trips to the site and the average number of days per trip. They assume that individuals first decide upon the optimal duration, and then on the number of trips. This seems not reasonable because average duration is positively correlated with distance traveled and is negatively correlated with total number of trips.

By using the simple repackaging model of Muellbauer (1974) and Fisher and Shell (1971), Wilman (1987) derived constant visit length demand curves from variable visit length travel cost demand curves. In her model, "the simple repackaging model treats visit length (i) and the number of visits of length i (n_i) within a time period as contributing to a package of visitor days (d), where $d = \sum in_j$. The recreationist only values the total number of visitor days." The ordinary travel cost demand is transformed into a constant visit length demand curve which can be interpreted as marginal value per unit of use. Therefore, in the empirical estimate, the number of visits for an individual is a function of the marginal cost of a visit. Assuming constant marginal cost per day and positive travel cost, either a one-day trip or a more-than-one-day trip is chosen by the individual.

Brown and Mendelsohn (B&M) (1984) combined hedonic and travel cost models to estimate the value of quality of a fishing site. They considered a recreation site as a differentiated good which can be described by a vector of its attributes or quality. An individual at a given location faces an array of alternative sites with different characteristics and each available at a different price where price includes any entry fee and the cost of travel to the site. A hedonic price function can be estimated for these sites as a function of site characteristics. We derive a hedonic price function for a single site as a function of duration and demographic characteristics as part of the repackaging model.

By introducing a quality parameter, the simple repackaging model provides a potential solution to different levels of duration of recreational trips. The quality parameter enters directly into the utility function (Muellbauer 1974). By treating on-site time as a characteristic of a recreational trip, e.g., an i-day trip is characterized by the individual spending i days on the recreation site and t hours of travel, $\theta_i(.)$ is then described as a function of the duration and other characteristics.

(1) $\theta_i = \theta_i(i, \ldots)$

By noting that there is a positive relation between on-site time and travel time , on-site time can be specified as a function of travel time

(2) $i = i(t)$

The characteristics function can then be rewritten as

(1') $\theta_i = \theta_i(i(t), \ldots)$

where on-site time is implicitly determined by travel time. If we assume there is only one site, the case of this study, the travel time from the location of the individual is fixed. With a fixed linkage between distance travelled and travel time, trip duration can be specified as function of the distance traveled by the individual in equation (2).

The utility maximization problem can be written as

$$\text{(3)} \qquad \text{Max } U\Big(g\big(\sum_i \theta_i(i, \ldots)Z_i\big),\ Z_0\Big)$$

$$\text{s.t.} \quad \sum_i Pz_i Z_i + P_0 Z_0 = Y = wt_w + E$$

and

$$\sum_i (i + t)Z_i + t_w = T$$

where Pz_i is monetary cost for Z_i and Pz_i varies with on-site time (i), θ_i is the characteristic parameter of the trip with duration i, i is on-site duration for a trip, t is travel time to a site, Z_i is number of trips of i days on site, and t_w is work time.

<u>Valuing Time</u>

2. **The value of recreation time, following Bockstael, is handled by disaggregating the sample:**

   a) those who can substitute work time for recreation time with recreation time valued at the wage rate

   b) those who cannot with recreation time valued at zero

Bockstael et al. (1987) began with the household production model, and incorporated a labor supply framework, to derive a recreation demand model which can reflect various degrees of substitutability between work and leisure time. They specified recreation demand as a function of vectors of money cost and the time required for a trip for individuals who cannot marginally adjust work time, and as function of a vector of money cost plus time cost valued at the wage received in discretionary employment for individuals whose work time is discretionary. Their model implies that opportunity time cost emerges only for workers with discretionary work time. For those working at a job with fixed work time, the amount of time required for a trip acts as a determinant of rather than as a component of travel cost in the demand function.

If work time is a substitute for recreational on-site time i, the time constraint can be substituted into the budget constraint:

(4) $$\sum Pz_i Z_i + P_0 Z_0 = w\ [T - \sum(i+t)Z_i] + E$$

The first order condition of the utility maximization problem now becomes

(5) $$(\partial U/\partial g)(\partial g/\partial Z_i) = \delta[Pz_i + w(i+t)]$$

This gives the implicit hedonic price function

(6) $$\begin{aligned} Pz_i &= [MU_g\ \theta_i(i,\ \ldots) - \delta w(i+t)]/\delta \\ &= \gamma\theta_i(i,\ \ldots) - w\ (i+t) \end{aligned}$$

The marginal implicit price/cost of on-site time i is

(7) $$\partial Pz_i/\partial i = \alpha_0\ (\partial\theta_i/\partial i) - w$$

This equation implies that when work time is substituted for recreational time, wage rate will reflect the opportunity cost of recreational time in the marginal implicit price of on-site time. Following the terminology in Bockstael et al. we call this interior solution.

If work time is not a substitute for recreation time, which is called a corner solution in Bockstael et al., the time constraint is implicitly in the repackaging of the time distribution among different trips. Therefore the result is the same as in the case where only the budget constraint exists. The first order condition of the utility maximization problem is

(8) $$(\partial U/\partial g)(\partial g/\partial Z_i) = \delta\ Pz_i$$

The implicit hedonic price function is

(9) $Pz_i = \gamma\ \theta_i(i,\ \ldots)$

The marginal implicit price of on-site time i is

(10) $\partial Pz_i/\partial i = \gamma\ (\partial\theta_i/\partial i)$

<u>The Three-Equation Model</u>

3. Repackaging Concept led, however, to three equation model where duration and price (cost) are choice variables:

trip duration equation: $i = i(\text{Distance, D})$

hedonic price equation: $Pz = Pz(i,\ \alpha(D))$

demand equation: $Z = Z(Pz,\ Y,\ \beta(D))$

where D is a set of demographic variables, Y is full income

The repackaging model contains a duration equation, a hedonic price equation, and a single demand equation.

(11) trip duration equation: $i = i(\text{Distance, D})$

(12) hedonic price equation: $Pz = Pz(i,\ \alpha(D))$

(13) demand equation: $Z = Z(Pz,\ Y,\ \beta(D))$

where D is a set of demographic variables to be discussed later and Y is full income. Although recursive in form, predicted values of i and P_z are used in equations (12) and (13), respectively. In our data, we were unable to identify the set of m equations of varying durations as implied by the repackaging concept. The set of trips Z_i reduces to a single type of trip Z. However, we are still able to take advantage of treating trip duration and price as endogenous, and incorporate on-site costs as part of trip price.

Incorporation of Demographic Variables

4. **Three demographic variables (age, education, family size) are incorporated in the demand function as both slope and intercept shift variables using the Gorman Specification,**

$$Z = t_z + m_z \, h(P,Y),$$

where t_z and m_z are functions of demographic variables and h(P,Y) is the demand for Z

In Gorman's specification for demographic variables (Pollak and Wales 1980, 1981), the modified demand function is obtained by first scaling and then translating the original demand function. Mathematically, the demand function incorporating the demographic variables is:

(14) $$Z = g\ (P,Y,\beta(D)) = t_z + m_z\ h\ (P,\ Y)$$

where P is the price vector, h(P,Y) is the demand for Z_i, $t_z = \sum\alpha_{zj}d_j$, $m_z = 1 + \sum\delta_{zj}d_j$, and the d_j's are the demographic variables.

Jeng and Hushak (1988) applied Gorman's specification to the traditional travel cost model. They found that incorporation of demographic factors results in larger estimated responses to travel costs and income at the means of the demographic variables than when they are excluded. Also, they found that aggregate consumer's surplus is approximately one-third smaller at the means of the demographic variables than when the demographic variables were excluded. Jeng and Hushak (1989) proposed that the valuation of human time varied with the demographic variables of an individual and found that the consumer's surplus at the mean values of the demographic variables was less than when demographic factors were excluded.

We assume a linear demand function,

(15) $h\ (P,Y) = a + bP + eY$

where b is coefficient vector of P. We then obtain the repackaging demand function with D as in equation (14).

(16)
$$
\begin{aligned}
Z_i &= t_z + m_z\ (a + bP + eY) \\
&= t_z + am_z + bm_zP + em_zY \\
&= [T_z(d_1,\ \ldots,\ d_n) + aM_z(d_1,\ \ldots,\ d_n)] \\
&\quad + [bM_z(d_1,\ \ldots,\ d_n)]P + [eM_z(d_1,\ \ldots,\ d_n)]Y \\
&= f_0(d_1,\ \ldots,\ d_n) + f_p(d_1,\ \ldots,\ d_n)P + f_y(d_1,\ \ldots,\ d_n)Y \\
&= f_0(D) + f_p(D)P + f_y(D)Y
\end{aligned}
$$

If the demographic variables have no effect on the demand function, then t_z is zero and m_z is unity, and the repackaging demand function reduces to a function of P (endogenous) and Y (exogenous).

THE 1987 SPORT ANGLER SURVEY

During the summer of 1987, we contacted 1,481 private-boat sport anglers at ramps and marinas along Ohio's Lake Erie coast. A questionnaire was mailed to the selected anglers in February, 1988, which asked respondents to provide information about the 1987 fishing season at Ohio's Lake Erie. Four weeks later a second questionnaire was mailed. A total of 858 completed questionnaires were returned, of which 838 were usable and coded for a response rate of 57%.

The variables used in the empirical model are defined as follows.

i = average on-site time, i.e. duration of recreation trips (days).

Dist = weighted average one way direct distance from the respondent's county seat of origin as the sum of the direct distance to each of the six zones on Lake Erie multiplied by the proportion of trips taken to each zone (miles).

t = round-trip travel time to Lake Erie, (2 x Dist)/50, (hours)

Z = number of trips to Lake Erie;

Pz = total per person costs of a trip to Lake Erie; this includes on-site monetary cost plus travel monetary cost plus travel and on-site time costs where substitution is possible. On-site monetary cost (OC) includes per person expenditures on bait, fishing equipment, gas and oil for the boat, boating supplies, launching and docking fees plus docking supplies, repairs on boat, food and beverages, overnight lodging, and miscellaneous expenditures. Travel monetary cost (TC) is defined as

[2 x Dist x ($0.15 + $0.97/MPG)]/Group Size,

where 2 converts one-way distance to round trip distance, $0.15 represents cost per mile of automobile maintenance and oil, $0.97 is the approximate 1987 price of gasoline per gallon, Group Size is the mean size of fishing group, and MPG is the reported miles travelled per gallon of gasoline.

Travel and on-site time costs are

(i + t) x income/2080

where income/2080 represents marginal hourly wage rate.

Y = family income as the midpoint of each income class ($,000).

Age = years of age of respondent.

Edu = years of schooling of respondent.

FS = number of family members in respondents family excluding the respondent.

In Bockstael et. al. (1987), the distinction between interior and corner solutions is based on employment opportunities. This includes those who are self-employed professionals and individuals working second jobs or part-time jobs. We classify our sample by the employment status of the respondents. For our sample, the respondents whose income is earned from owned business or partnership are assumed to be at the interior solution. At the corner solution, the individuals work for fixed hours or are unemployed. We have two separate corner solutions: 1) employed workers whose income comes from hourly, daily, or weekly wage and annual salary, and 2) the retired and unemployed. In Figure 1, those who have fixed work times are at point B, while those who are retired or unemployed are at point C. With flexible work hours, those who are self-employed owners can choose any point on the segment AC.

The means of variables used in estimation from the sample data are summarized in Table 1. The average sample member made 21.4 trips and travelled about 72.5 miles one way to a site on Lake Erie. Among the three subgroups, retired and unemployed made the most frequent, longest, and most expensive trips to Lake Erie, while they are the oldest group with the lowest education, income levels and family size. The interior solution group has the lowest number of trips and the highest income.

ESTIMATION AND RESULTS

The Choice of Econometric Model

Our sample includes only participants of private-boat fishing to Ohio's Lake Erie in 1987. Because of this truncated sample, the truncated Tobit model is appropriate for the demand equation. The standard Tobit model is

$$(17) \qquad Z^* = X'B + U_Z$$
$$Z = Z^* \quad \text{if } Z^* > 0$$
$$= 0 \text{ if otherwise,}$$

where X represents vector of the variables on the right-hand side of the equation. When we observe neither Z nor X when $Z^* \leq 0$, the model is a truncated regression model. Ordinary least squares (OLS) estimates are biased (Maddala 1983 p.166). As suggested in Maddala, maximum likelihood estimation methods are applied for the truncated Tobit model, also called 'conditional maximum likelihood' estimation. The likelihood function of the truncated Tobit model can be written as

$$(18) \qquad L = \Phi(X'B/\sigma)^{-1}\sigma^{-1}\phi[(Z-X'B)/\sigma]$$

where $\Phi(.)$ and $\phi(.)$ are the distribution and density functions of the standard normal variable $X'B/\sigma$, respectively.

OLS is applied to the duration and the hedonic price equations. One adjustment in the complete model of the truncation feature is sufficient for the whole sample. This adjustment is performed on the demand equation.

Testable Hypotheses

If recreation is a normal good, the price response is expected to be negative, and the income response is expected to be positive. The effect of age on the price response is expected to be positive because older persons have more time and will be less price responsive. The effect of education on price response may be positive or negative. Work commitment may keep some from participating more in recreation trips. The retired with higher education level may have higher income and time for recreational activities. The effect of family size on the price response is expected to be negative because larger families will be more price responsive.

Age of the angler is hypothesized to negatively affect participation in recreation. Many outdoor recreation activities require considerable physical strength (Neipoth, 1973). An offsetting factor is that time available for recreation increases when a person is retired. The family size effect on recreational activities is expected to be positive (Napier et al., 1986). One reason is to fulfill perceived needs of children (Kelly, 1974). At the same time, larger family size means higher money costs. Education level may be positive or negative.

The hedonic price equation is expected to have a positive first order derivative with respect to the duration variable, so that marginal hedonic value of duration is positive. Age is expected to have a positive effect on the cost of the trip; older persons tend to make higher quality trips and have higher expenditure on each trip. Individuals with higher education may also take higher quality trips and have higher cost for each trip. With larger family, the cost share of the individual will be lower due to economy of size. The expected sign of the coefficient for family size is negative.

In the duration equation, it is expected that age has a positive effect on duration because retired persons have more available time for longer duration of trips. The education level may have positive or negative effects on duration. Work commitments and allowed vacation times have potentially off setting effects on duration as well as on trips. Finally, the duration equation is expected to have a positive relationship with the distance variable. Those who have come from greater distances are expected to stay longer periods and make fewer trips.

Empirical Estimates of the Model

There are 684 observations after deleting all observations that contain missing values. The estimated duration equations are presented in Table 2. All subgroups have expected signs on the coefficient of the duration variable which is highly significant. Among the demographic variables, both age and family size variables have the expected signs except the age variable for the unemployed and retired.

In Table 3 we present the estimates of the hedonic price equations in linear functional form for the three subgroups. Estimates of semi-log equations yielded results with similar implications. The coefficient of the duration variable is positive and significant in all three cases as expected. Most estimated coefficients of the demographic variables are not significant at the 0.01 level except for the education variable in the owner subgroup and the age variable for employed workers which has an unexpected sign.

Table 4 presents the conditional maximum likelihood estimates of the single demand equation for the three subgroups. The estimated price and income coefficients have the expected signs, however, only the price coefficient for employed workers is significant at 0.01 level. The total effect of the price variable is obtained by taking the first partial derivative with respect to P_Z. The demographic variables affect the total price response. The effect of age on the price response has the expected sign in all subgroups. However, only the employed worker group has a significant coefficient on the price and age interaction term. The effects of family size on the price response are as expected in both corner solutions and are not significant in any of the three cases.

Calculated at the means of the demographic variables, the coefficients of the weighted repackaging demand equations for each subgroup are presented in Table 5. Estimates of the demand equations for the three subgroups without demographic variables are also presented in Table 5.

Comparison of Estimates from Alternative Models

In this section we compare the estimated coefficients and economic values from our repackaging model with the traditional travel cost model (TCM), the McConnell and Strand model (M&S), and the repackaging model estimated for the total sample (corner and interior). The M&S model is

(18) $Z = Z(Px + kwi)$,

where k is the percent of discretionary wage at which recreation time is valued.

As shown in Table 5, all models have coefficients with expected sign on the price variable. The log likelihood ratios of the repackaging models as compared to null equation without any variables (LRT_0), and the TCM model (LRT_1) are highly significant. Without the demographic variables, the coefficient of the price variable for the interior solution repackaging model is about 70% smaller than in the M&S model and is about 90% smaller than in the TCM. For the corner solution the price coefficient is about 30% lower than in the TCM but 70% higher than in the M&S model. This suggests that endogenization of the duration and cost in the recreational model lowers the coefficient of price. Overall, incorporating demographic variables into the demand equation of the alternative models yields higher estimated responses to the price variable.

For the owner subgroup of the weighted model, the price coefficient is about 65 percent smaller than the total sample repackaging model. For employed workers, the price coefficient is about 70 percent larger. The retired and unemployed group has the highest price coefficient among all cases. It is two times higher than that of the total sample. Comparing the price coefficient estimates and elasticities, both corner solutions are higher than the interior solution. This suggests that those whose work time is not a substitute for recreation time exhibit more price elastic behavior than those who can substitute work time for recreation time.

Economic Values of Recreation Trips

Based on the estimated demand equations and the mean values of the variables, the economic value of private-boat fishing in Ohio's Lake Erie is estimated by the willingness to pay and the consumer's surplus for angling trips. Marshallian consumer's surplus (CS) is employed to proxy the exact welfare measures. Bockstael et al. (1987), showed that for linear demand equations (15,16), consumer's surplus per trip is

$$(19) \qquad cs = -\bar{Z}^2/2\alpha_1 = -\bar{Z}^2/2f_p(D)$$

where $\bar{Z}$ is the mean of Z, α_i is the coefficient of Pz with demographic variables excluded, and $f_p(D)$ is the coefficient of Pz at the mean of the demographic variables. Consumer's surplus per person (CS) is then

$$(70) \qquad CS = cs \times \bar{Z}$$

Willingness to pay (WTP) represents the maximum amount of money the individual would be willing to pay for the trip. It is defined as the consumer's surplus plus total travel and on-site costs (Figure 2).

The mean willingness to pay and consumer's surplus for the sample and the three subgroups are presented in Table 6. To compare the economic values of the alternative models on the same basis, the average on-site monetary expenditure is included in the willingness to pay for the TCM and the M&S

models, because the price variable in these two models does not include the on-site monetary cost. Furthermore, on-site time cost using the estimated k is added to the willingness to pay in the M&S models because the M&S models include only travel time cost.

The consumer's surplus in TCM is $120.38 per person per year and the willingness to pay is $1017.04 per person per year. Incorporation of demographic variables in TCM yields about 2.5 percent lower consumer surplus and about 0.3 percent lower WTP than in TCM without the demographic variables. Time value is not incorporated in this model.

In the M&S model without D, recreation time is valued at 34.9 percent of the average household's discretionary wage rate as compared to 9.6 percent in the M&S model with D. In the M&S model with demographic variables, consumer's surplus is 52.41 percent and willingness to pay 51.58 percent of the M&S model without D. The consumer's surplus calculated at the sample means for the total sample repackaging model with D is about 6 percent lower for the corner solution and 12 percent lower for the interior solution than the model without demographic variables.

The consumer's surplus calculated for the subgroups with demographic variables yields about 6, 48, and 29 percent lower estimates for the owner, employed workers, and retired and unemployed, respectively, than without D. Among the three subgroups, the retired and unemployed have the lowest consumer's surplus, while the owners have the highest CS, with and without the demographics. When the price variable includes time cost, the demand equation becomes steeper, an effect also seen in the total sample repackaging estimates. This result suggests that dividing the sample into subgroups where the work time is or is not a substitute for recreation time, the consumer's surplus varies among the sub-samples. Those who can substitute their work time for recreation time have the highest consumer's surplus and willingness to pay, with or without the demographics variables. Those who do not have a job or are retired have the lowest consumer's surplus, while those who have fixed working hours have the lowest willingness to pay, where both subgroups are at corner solutions.

Weighted average economic values of the subgroup estimates are also presented in Table 6. The weights are the proportion of group fishing hours to total sample fishing hours. The weighted average consumer's surplus without demographics is about 30 percent higher than that of the total sample corner solution, and is about 53 percent lower than that of the total sample interior solution. With demographic variables the repackaging model yields a weighted consumer's surplus that is similar to the total sample corner solution model.

Finally, these results suggest that inclusion of demographic variables lowers the economic value estimates. Also, when the cost variable is treated as exogenous, the consumer's surplus is lower, except for the M&S without D.

Aggregate Economic Values

Based on Status and Trend Highlights (1988) data on private-boat angler hours and the mean total fishing hours per angler per year from our sample, 33,342 anglers made trips to Lake Erie in 1987. The aggregate economic values estimated as the product of the per angler values in Table 6 and total anglers (33,342) are shown in Table 7. Estimated consumer's surplus ranges from $\$3.9 \times 10^6$ in the TCM with D to $\$19.5 \times 10^6$ in the full sample repackaging model, interior solution without D. The best estimate, in our judgment, is $\$5.6 \times 10^6$ from the weighted repackaging model with D.

IMPLICATIONS

The results of the duration and the hedonic price equations supported our hypotheses. However, the estimates of multiple demand equations were infeasible because we could not econometrically distinguish prices for trips of alternative durations. A single demand equation was estimated in our alternative specification. The estimated coefficients are statistically significant with correct signs.

The endogenization of the trip duration and cost variables lowers the price response in the demand function. Incorporation of demographic variables into the demand equation yields higher price elasticities at the means of demographic variables than in comparable models which exclude them.

Furthermore, consumer's surplus varies substantially among the subgroups who can and cannot substitute work and leisure time. Those who can substitute their work time for recreation time have the highest CS and WTP, with and without D, because they have a positive value attributed to their recreation time. Those who do not have a job or are retired have the lowest CS, while those who have fixed working hours have the lowest WTP.

The estimates of the consumer's surplus and willingness to pay for the alternative models imply that when the cost variable is treated as exogenous and excludes demographic factors, the consumer's surplus may be under-estimated. Comparing the CS estimates with and without demographic variables in the repackaging models, when the demographic factors are not incorporated the consumer's surplus may be over-estimated.

Table 1. Means of Variables

Variable	Sample	Owners	Employed Workers	Unemployed & Retired
Trips	21.4	16.8	20.9	26.6
Distance	72.5	69.0	74.5	65.8
Days	1.8	1.6	1.7	2.2
Hours/Day	7.0	7.0	6.9	7.2
Income	37,266	46,793	39,166	23,590
Age	45.5	43.6	41.6	60.5
Education	13.0	13.5	13.1	12.2
Family Size	1.4	1.6	1.5	0.7
On-Site Cost	31.5	30.1	30.3	35.4
Travel Cost	10.4	9.1	10.9	9.6
N	684	92	450	133

Table 2. Duration Equation Estimate, by Sub-sample*

Sub-Sample	Intercept	Distance	Age	Education	Family Size	R^2
Owner (Interior)	1.453	0.009	0.001	-0.040	0.029	0.31
	(2.7)	(5.9)	(2.7)	(0.2)	(0.9)	
Employed workers (Corner)	0.920	0.006	0.011	-0.013	0.055	0.18
	(2.3)	(9.5)	(2.1)	(0.6)	(1.3)	
Unemployed & Retired (Corner)	1.602	0.004	-0.008	0.049	0.267	0.06
	(0.9)	(2.3)	(0.4)	(0.6)	(1.1)	

* t-ratios in parentheses

Table 3. Hedonic Price Equation Estimates, by Sub-sample*

Sub-sample	Intercept	Days	Age	Edu	Fs	R^2
Owner (Interior)	-598.29	228.40	2.09	34.04	20.75	0.3
	(3.8)	(5.0)	(0.9)	(4.1)	(1.3)	
Employed workers (Corner)	-22.43	49.45	-0.49	0.09	-2.09	0.4
	(1.9)	(16.0)	(3.0)	(0.1)	(1.7)	
Unemployed & Retired (Corner)	-110.82	45.39	0.76	1.55	-12.04	0.1
	(1.8)	(3.5)	(1.3)	(0.6)	(1.6)	

* t-ratios are in parentheses.

Table 4. Demand Equation Estimates with Demographic Variables, by Subgroup

	Owner (Interior)	Employed workers (Corner 1)	Unemployed & Retired (Corner 2)
Intercept	-42.736	165.95	-472.18
	(0.5)	(1.4)	(0.9)
P_z	-0.493	-5.212	0.439
	(1.9)	(3.6)	(0.05)
Y	0.002	0.001	0.005
	(1.4)	(1.0)	(0.4)
Age	-0.647	-1.93	-0.531
	(0.4)	(2.2)	(0.1)
Edu	7.814	0.598	45.130
	(1.4)	(0.1)	(1.4)
FS	5.846	-0.663	9.161
	(0.5)	(0.07)	(1.1)
P_z*Age	0.005	0.087	0.061
	(1.3)	(3.4)	(0.6)
P_z*Edu	0.004	-0.044	0.615
	(0.3)	(0.6)	(1.2)
P_z*FS	0.041	-0.057	-1.256
	(0.9)	(0.3)	(0.9)
Y*Age	0.000009	-0.000005	-0.000004
	(0.4)	(0.3)	(0.03)
Y*Edu	-0.0001	-0.00008	-0.0003
	(1.4)	(0.8)	(0.5)
Y*FS	-0.0003	0.00007	-0.0009
	(1.6)	(0.3)	(0.6)
LRT_0	24	62	18
Log(L)	-338	-1791	-560

Table 5. Parameter Estimation of Alternative Models[a]

Model	Constant	Pz	Y or Vt	LRT_0[b]	LRT_1[b]
TCM	-2.823	-1.902 [-0.92]	-0.0002	57	--
TCM/with D^c	7.522	-1.950 [-0.95]	0.00005	61	4
M&S	1.749	-0.711 [-0.95]	-0.248	83	25
M&S/with D^c	8.781	-1.494 [-1.07]	-0.143	89	32
Repackaging (Full Sample)					
Corner	30.777	-1.253 [-2.45]	-0.0001	22	
Interior	40.793	-0.392 [-5.85]	0.0001	22	
Repackaging/with D^c (Full Sample)					
Corner	42.130	-1.331 [-2.61]	0.0007	24	
Interior	80.509	-0.4471 [-6.68]	-0.0002	78	

Table 5 cont. Parameter Estimation of Alternative Models[a]

Model	Constant	Pz	Y or Vt	LRT_0[b]	LRT_1[b]
Repackaging (Weighted)					
Owners	16.127	-0.143	0.0002		
		[-3.01]			
Employed Workers	28.875	-1.169	-0.000006		
		[-2.30]			
Retired & Unemployed	27.314	-3.018	0.0006		
		[-5.11]			
Repackaging/with D (Weighted)					
Owners	148.689		-0.155	0.0002	
		[-3.26]			
Employed Workers	43.897	-2.255	-0.0002		
		[-4.44]			
Retired & Unemployed	94.693	-4.253	0.0005		
		[-7.20]			

a. Parameters for the models with demographics are calculated at the means of the demographic variables. Price elasticity at the means of the sample is in the bracket.
b. $LRT_i = -1(\log L_i - \log L_j)$, i = o for the null equation, i = 1 for the TCM equation, $X^2_{0.05,2} = 5.99$, $X^2_{0.05,6} = 12.59$.
c. includes the vector of three demographic variables under the Gorman specification

Table 6. Average Economic Values.

Model	Consumer's Surplus ($/angler/year)	Willingness to pay ($/angler/year)
TCM	120.38	1017.04
TCM/with D	117.43	1014.09
M&S	322.05	3342.80
M&S/with D	153.27	1618.66
Repackaging (Full Sample)		
Corner	182.75	1079.41
Interior	584.13	7423.69
Repackaging/with D (Full Sample)		
Corner	172.04	1068.70
Interior	512.14	7351.65
Repackaging (Weighted)		
Owners	968.85	6903.22
Employed Workers	186.83	1047.28
Retired & Unemployed	117.22	1314.75
Weighted average*	239.11	1679.32
Repackaging/with D (Weighted)		
Owners	910.45	6844.82
Employed Workers	96.85	957.30
Retired & Unemployed	83.18	1280.71
Weighted average*	169.20	1609.37

* Weights are calculated based on the total fishing hours of each sub-sample. Total fishing hours of sub-sample i, G_i=trips*duration*hours*respondents of the sub-sample. Weight for sub-sample i, $w_i = G_i/G_1+G_2+G_3$, i=1,2,3, w_1=0.094 w_2=0.601, w_3=0.305,

Table 7. Aggregate Economic Values ($1,000/year).

Model	Consumer's Surplus	Willingness to Pay
TCM	4,014	33,910
TCM/with D	3,910	33,812
M&S	10,738	111,456
M&S/with D	5,100	53,969
Repackaging (Full Sample)		
Corner	6,093	35,990
Interior	19,476	247,521
Repackaging/with D (Full Sample)		
Corner	5,736	35,633
Interior	17,076	245,118
Repackaging (Weighted)	7,972	55,992
with D (Weighted)	5,641	53,660

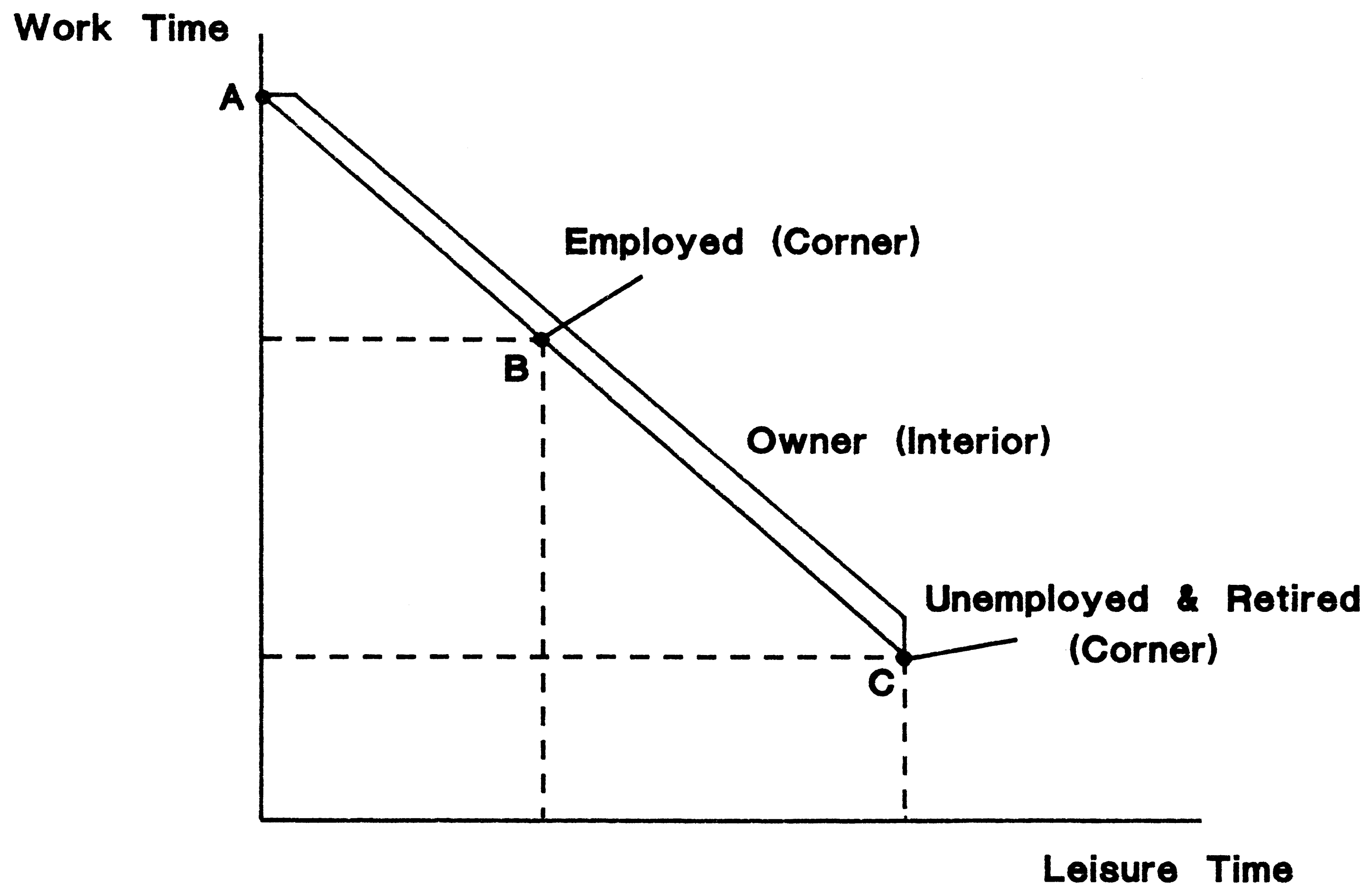

Figure 1. Interior Solution, Corner Solutions, and Time Constraint.

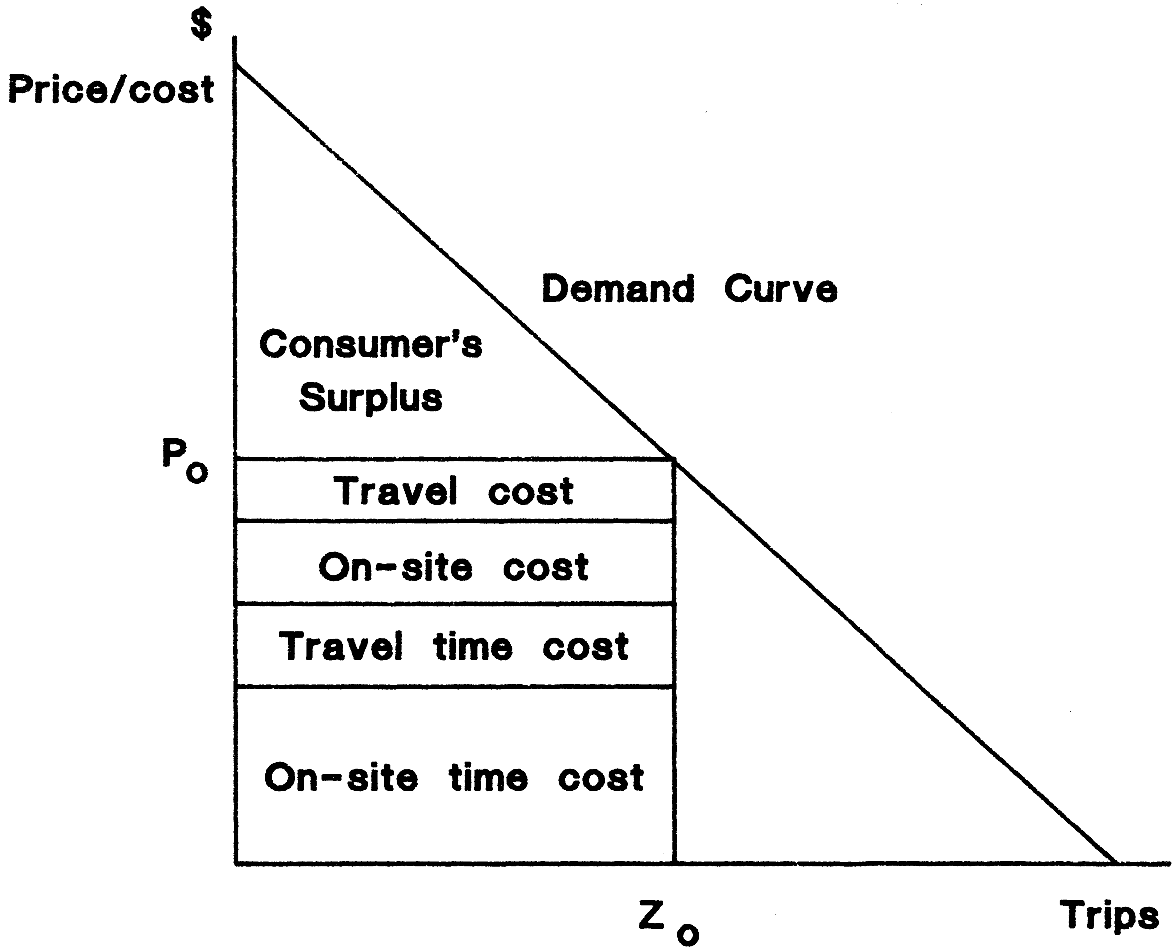

Figure 2. Consumer's Surplus and Willingness to Pay

REFERENCES

Becker, G. S. 1971. Economic Theory, New York:Alfred A. Knopf.

Bishop, Richard C., and Thomas A. Heberlein. 1980. Simulated Markets, Hypothetical Markets, and Travel Cost Analysis: Alternative Methods of Estimating Outdoor Recreation Demand, University of Wisconsin, Agricultural Economics Staff Paper Series, No/ 187.

Bockstael, N. E., I. E. Strand, and W. M. Hanemann. 1987. Time and the Recreational Demand Model. AJAE. 69(2):293-302.

Brown, G.Jr., and R. Mendelsohn. 1984. The Hedonic Travel Cost Method Review of Economics and Statistics, 66:427-433.

Cesario, F. and J. Knetsch. 1970. Time Bias in Recreation Benefit Estimates, Water Resource Res, 6:700-704.

Cesario, F. 1976. Value of Time in Recreation Benefit Studies. Land Economics, 52:32-41.

Fisher, F. M. and K. Shell. 1971. Taste and Quality Change in the Pure Theory of Cost of Living Indices, Price Indexes and Quality Change: Studies in New Methods of Measurement, ed. Z. Gilliches. Cambridge Ma. Harvard University Press.

Hushak, L. J., J. M. Winslow, and N. Dutta. 1988. Economic value of Great Lakes sportfishing: the case of private boat fishing in Ohio's Lake Erie, Transactions of the American Fisheries Society, 117:363-373.

Jeng, H-Y. and L. J. Hushak. 1989. The effects of demographic variables on measuring the cost of time in recreation demand analysis, selected paper, 1989 AAEA annual meeting, Baton Rouge, Louisianan, July 28-August 2.

Jeng, H-Y. and L. J. Hushak. 1989. The Impacts of Demographic Variables on the Price and Income Coefficients of the Travel Cost Model, selected paper, 1988 AAEA annual meeting, Knoxville, Tennessee, July 29-Aug.3.

Kealy, M. J. and R. C. Bishop. 1986. "Theoretical and Empirical Specifications Issues in Travel Cost Demand Studies," AJAE 68(3):660-667.

Kelly, J. R. 1974. "Socialization Toward Leisure: A Development Approach," Journal of Leisure Research 6(3):181-193.

Maddala, G. S. 1983. Limited-dependent and Qualitative Variables in Econometrics, Cambridge University Press.

McConnell, K. E. and I. E. Strand. 1981. Measuring the Cost of time in Recreation Demand Analysis: An Application to Sport Fishing, AJAE, 63:153-156.

Muellbauer, J. 1974. Household Production Theory, Quality, and the 'Hedonic Technique', Amer. Econ. Rev., 54(6):64-72.

Napier, T., E. Baron, S. McClaskie. 1986. Barriers and Facilitators to Participation in Outdoor Recreation Activity in Ohio, ESO #1247, OARDC, OSU.

Neipoth, W. 1973. "Users and Non-users of Recreation and Park Services," in Reflections on the Recreation and Park Movement, D. Gray and D. A. Pelegrio (eds.), William C. Brown Company.

Pollak, R. A. and T. J. Wales. 1980. "Comparison of the Quadratic Expenditure System and Translog Demand Systems with Alternative Specifications of Demographic Effects," Econometrica 48(3):595-612.

Pollak, R. A. and T. J. Wales. 1981. "Demographic Variables in Demand Analysis," Econometrica 49(6):1533-1551.

Status and Trend Highlights: Ohio's Lake Erie Fish and Fisheries. 1988. Ohio Department of Natural Resources, Division of Wildlife.

Wilman, E. A. 1980. The Value of Time in Recreation Benefit Studies. J. of Environmental Economics and Management, 7:272-286.

Wilman, E. A. 1987. A Simple Repackaging Model of Recreational Choices, AJAE, 69(3):603-612.