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IN RECREATION DEMAND EQUATIONS
Chin-Chien Liao, Jack E. Houston, Jr. and John C. Bergstrom*

## INTRODUCTION

Increased income and leisure time, combined with advances in transportation technology, have made outdoor recreation an important consumption commodity in the United States. Much of the opportunity for such activity is provided by the public sector of the economy. Because this kind of commodity is a non-market good, it has been recognized that the value of some of this consumption is not explicitly determined through market transactions. Thus, the subject of recreation demand has increasingly attracted the attention of economic researchers to develop non-market methods to estimate its consumptive value, and of policy makers to modify the policy of the recreation site (Burt and Brewer, 1971; Walsh, 1986; Ward and Loomis, 1986)

To construct recreation demand equations, this paper presents a method for choosing socioeconomic, demand-shifting explanatory variables by using principal components analysis. The study applies the travel cost method (TCM), using travel costs as a proxy for prices. Selection of an appropriate set of regressors for recreation demand equations are discussed first. Next, results of the principal components analysis and demand equation estimation are discussed. Conclusions are provided in the final section.

## CHOICE OF REGRESSORS

To specify any recreation demand equation, the initial problem is the choice of an appropriate set of regressors. From standard neoclassical demand theory, demand equations can be derived which express the quantity of a particular commodity consumed as a function of the price of the commodity, quality of the commodity. prices of related commodities, household income, and other variables--usually socioeconomic in character--which are related to systematic changes in preferences (Ziemer et al., 1980). There generally exists some correlation among regressors for recreation demand equations. If all of these variables are included in a regression model, the reliability of the regression results may be in doubt because of multicollinearity problems. Still, it may not be valid to exclude certain variables from the model because they may be important determinants of the demand for recreation activities.

To alleviate potential multicollinearity problems, without dropping important explanatory variables, principal components analysis can be used. The concept of principal components analysis essentially amounts to transforming a set of $k$ variables with $n$ observations on each into a new set of variables which will be pairwise uncorrelated. One application of principal components analysis is index construction. That is, the

[^0]collective behavior of a large number of variables can be represented by a smaller number of indexes or factors--typically one. It is noteworthy that if there is no correlation among any variables, there will be no principal comnonent, because every component is as good or as bad as the other; each will account for only a unit variable (Kim and Mueller, 1978).

An important consideration in using principal components analysis is the extraction of the initial factors which can be used to further the analysis. How many extracted factors can be used? One commonly-used criterion for addressing the number of factors is to retain factors with an eigenvalue of one or greater (for more detail, see Kim and Mueller, 1978). In this study, we also use the orthogonal rotation method, which will provide the simplest possible factor structure. Wetzstein and Green (1978) noted that estimates of recreation demand based on a principal components attractiveness measure can provide substantially better explanatory capacity than alternative measures.

Zarembka (1968) noted that economic theory has provided little guidance on the appropriate functional form for demand functions. Ziemer et al. (1980) found that by using a different functional form one can produce dramatically different consumer surplus estimates. McConnell (1975) noted that demand theory does require that the functional form must allow for the cross-partial derivatives of quantity with respect to price and income $=0$ be non-zero. The linear form and ordinary least squares (OLS) were used in this study.

DEMAND FUNCTIONS AND DATA

A major concern of this analysis was to examine the relationship between the number of activity trips in which people participated on a 12 -month basis and own price, cross-activity prices and site quality. The dependent veriables selected for the recreation demand equations were the number of waterfowl hunting, freshwater fishing, and saltwater fishing trips taker. to a Louisiana wetlands area. The independent variables included tc: $\equiv 1$ round-trip travel costs for each activity, total household income, site quality attributes, and several demographic variables. The latter two groups of variables were combined through principal components analysis to extract the initial factors for further analysis.

The use of number of trips as the dependent variable was specified by McConnell. The travel cost method (TCM) has been widely mentioned, modified, and employed in many studies (Burt and Brewer; Loomis; McConnell; Morey; and Seller et al.). For this analysis, a demand system was specified:

$$
\begin{equation*}
\text { TRIPS }_{i}=\alpha_{i}+\sum_{j=1}^{3} \beta_{j} \text { EXP }_{j}+\gamma_{i} \text { INC }_{i}+\sum_{k=1}^{3} i_{k i}^{\text {or }} \text { FACTOR }_{k i}+\varepsilon_{i} \tag{1}
\end{equation*}
$$

where,
i,j are the $1, \ldots 3$ recreation activity, i.e., waterfowl hunting (W:), freshwater fishing (FF), saltwater fishing (SF);
$k$ is the $1, \ldots .3$ or 4 initial extracted index;
TRIPS $_{1}$ is the number of trips for the ith recreation activity;
EXP $_{j}$ is total travel cost for $j$ th recreation activity;
$I N C_{i}$ is total household income for the participant in the ith recreation activity;
FACTOR $_{k i}$ is the kth index extracted from principal components analysis for the ith recreation activity;
$\alpha, \beta, \gamma$, and $\delta$ are the parameters to be estimated; and
$\varepsilon_{i}$ is the random error term.
This system is specified in a linear framework for the analysis of socioeconomic and site quality factors influencing wetlands recreation activities demand.

The primary data were provided by a wetland recreation use survey, which was conducted in 1985-86, by the U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi. The study area was a large portion of Louisiana's coastal wetlands, encompassing approximately $6.000,000$ acres. Key variables collected in this study were number of trips taken to the study area, distances and time traveled, site quality, and socioeconomic characteristics of users. The travel cost method uses travel costs as a proxy for the price of the recreation commodity and was defined:
(2) $\operatorname{EXP}=[T C P M * M / S H+1 / 3(H * \operatorname{INC} / \mathrm{MH})] * 2$
where,
EXP is defined as the equation (1);
TCPM is the estimated cost of operating a medium-sized motor vehicle per mile;
$M$ is total one-way distance;
SH is share of person (if any);
$H$ is the one-way driving time in hours;
INC is total household income; and
MH is total working hours per year.
This form expressed that the travel costs used will be those the recreationist can most easily recognize as his/her cost for the trip, namely travel expenditures costs plus the costs of time in taking a trip. Other than travel costs, variable costs incurred by the recreationist which are specific to the recreation trip will not be used in this study.

As indicated by Seller et al. (1985), the travel cost method does have weaknesses which determine under which conditions it is most appropriately used. The model works best when visitors travel from a wide range of distances to the site. Additionally, if the recreationist makes a multipurpose trip, there is a problem determining the proper allocation of costs among each activity. The model works best when the recreationist visits only one site during his/her trip. Also, if a visitor enjoys a scenic drive to the site, there is a problem determining what proportion of travel costs are attributable to visiting the site itself. More attention to these problems in travel cost method studies may be fruitful. In this analysis, these problems were necessarily assumed minimal or insignificant, given data limitations.

## Principal Components Factors

The principal components analysis for waterfowl hunting is shown in table la. Three initial factors were extracted. According to the loadings, factor 1 can be explained by the joint effects of natural scenery at the recreation site (SCE), level of pollution at the recreation site (POLL), level of wildlife encountered per day in the recreation site (ENCT), level of isolation at the recreation site (ISOL), and number of fowl birds per day for waterfowl hunting (BAGA). Factor 2 can be explained by the level of education of a recreationist (EDUC), whether respondent is a member of an outdoor club (CLUBOWN), and/or an outdoor/recreation magazines subscriber (MAGZ). Factor 3 can be explained by the number of years the respondent participated in the recreation activity (YEAR), age of the recreationist (AGE), and whether respondent owned a recreation boat (BOATOWN). The classification of each factor seems reasonable, and the percent of variance explained by each factor is $34.84,11.47$, and 8.96 , respectively. The total percent of variance explained by these three factors is 55.28 .

Four initial factors were extracted (Table lb) for freshwater fishing indexes. Again, using the same method of classification as in the previous case, factor 1 can be explained by SCE, ENCT, POLL, ISOL, and CATA (fish caught per day). Factor 2 is an index explained by EDUC, CLUBOWN, and MAGZ. Factor 3 can be explained by YEAR and AGE. Factor 4 can be explained by whether the respondent is an owner or shares ownership of a camp in the recreation site (CAMPOWN) and the negative effects of skill for freshwater fishing (SKILL). The percent of variance explained by each factor is 26.17. 12.59. 9.79. and 7.27, respectively. The total percent of variance explained by these four factors is 55.82.

The classification of variables in the case of saltwater fishing, Table lc, is somewhat different from the previous two cases. Factor 1 involves SCE, ENCT, POLL, and ISOL variables. Factor 2 includes SKILL. CATA, and number of non-recreation boats seen by the respondent per day at the recreation site (SEEB) variables. Factor 3 combines CAMPOWN, CLUBOWN, and MAGZ variables, and factor 4 involves YEAR and AGE variables. The percent of variance explained by each factor is 19.83, 12.95, 10.36, and 7.53, respectively. The total percent of variance explained is 50.67 .

## Demand System Estimation Results

Each equation in the demand system depicted in equation (1) was estimated by OLS. Equation (A) in table 2 shows the estimation results for waterfowl hunting. The coefficients of factors 1 through 3 are all significant at the 0.01 level. That is, the demand for waterfowl hunting is significantly affected by these three factors. The signs of the coefficients for these three factors are all positive, which satisfies prior expectation. The total waterfowl hunting expenditures (TWHEXP) variable is significant at the 0.05 level, and the sign of the coefficient also satisfies theoretical expectation. That is, if total expenditures increased, then demand for waterfowl hunting activity would diminish.

However, the fresh and saltwater fishing expenditures (TFFEXP and TSFEXP) are not significant, indicating that there is no relationship between these variables and the dependent variable, waterfowl hunting trips (WHTRIPS). The result of the INC variable is somewhat disturbing, but not significant.

The results of the estimation of the demand for freshwater fishing activity are shown in equation (B), table 2. Each of the four factors is significant at the 0.01 level. The sign of factor 4 , however, is negative, which indicates that owning or sharing ownership of a camp in the recreation site for the recreationist will decrease the number of freshwater fishing trips into this particular recreation site. The better the fishing skill, the more trips will be taken. The sign of the TWHEXP variable is negative and the $t$-value for this variable is significant. According to economic theory, waterfowl hunting trips and freshwater fishing trips are complementary to each other. An interesting, and useful, result.

The coefficients of the factors for saltwater fishing activity, equation (C), table 2, are all significant at the 0.01 level except for factor 3. Again, the coefficient of the TWHEXP variable is negative and the $t$-value is significant. This also implies that the activities of waterfowl hunting and saltwater fishing are complementary to each other. One explanation for this situation is that the respondents likely engage in two or more of the recreation activities instead of a single one.

## CONCLUSIONS

The more leisure time earned by people, the more recreation activities they will pursue. Many people enjoy and engage in multiple types of recreation activities. Millions of people in the United States participate annually in recreation activities, especially outdoor activities. Outdoor recreation, in terms of economic terminology, may no longer be considered a luxury good. As mentioned in the beginning of this paper, many recreation activities are non-market goods--there are no actual market prices for such goods. In addition, outdoor recreation is resource-oriented, which implies that the consumer is transported to the commodity for consumption to take place instead of vice versa (Burt and Brewer, 1971). Therefore, it is interesting and important to derive demand functions for this kind of good that more correctly characterize choices and constraints.

After reviewing the data set used in this study, many problems still exist. For example, there are many missing values in the dependent and independent variables. The estimation may not be considered unbiased if the missing values in the dependent variable exceed $20 \%$ of the sample (Judge et al.; Maddala). A second problem is the data for the income variable, which also included many missing values. This may be caused by people participating in the survey who do not want to disclose income levels. Missing values of the income variable were replaced by the mean income value. Estimates of the income variable in the demand equations suggest this process may be inadequate, or less than fully desirable.

Price regression coefficients obtained from recreation demand equations are often used to determine the value of recreational resources
in terms of consumer surplus. After mitigating some of the problems mentioned above, meaningful estimation of such values could be quite useful for policy making in this and similar recreational areas. A major contribution of the current analysis is the construction of indexes accounting for environmental and consumer characteristics which act as demand shifters for recreation activities. These indexes were statistically significant and displayed theoretically consistent effects on recreation demand. The results support the use of principal components analysis to mitigate multicollinearity problems in recreation demand equations.

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Table 1a. The Principal Components Analysis for
Haterfowl Hunting
ROTATED BACTOR PATIIRK

|  | PACTORI | - ACTOR2 | fACTORS |
| :---: | :---: | :---: | :---: |
| mesest | 0.21905 | 0.07070 | 0.07592 |
| WSSE | 0.86600 | 0.02181 | -0.00218 |
| ENCTM | 0.88996 | 0.15721 | -0.04589 |
| POLLWM | 0.90356 | 0.11630 | -0.02659 |
| 150Lm | 0.85550 | 0.04943 | 0.01851 |
| WhyEAR | 0.61593 | 0.00837 | 0.68616 |
| WHSKILL | 0.68850 | 0.18508 | 0.24179 |
| EOUC | 0.00956 | 0.65807 | -0.13820 |
| 168 | -0.27982 | -0.16736 | 0.72908 |
| SOATOW | 0.00006 | 0.19319 | 0.51868 |
| CAMPOWN | 0.26689 | 0.27727 | 0.36791 |
| CLUEOW | 0.19270 | 0.68323 | 0.14185 |
| MAG2 | 0.08636 | 0.66080 | 0.18660 |
| WFPAGA | 0.80644 | 0.04585 | 0.00493 |
| Eigenvalue | 4.87 | 1.61 | 1.25 |
| Percent of Varíance Explained | 34.84 | 11.47 | $8.96 \begin{array}{ll}  & \text { Total } \\ & =55.20 \end{array}$ |

Table 1b. The Princioal Components Analysis
for
Freshwater Fishing

|  | factor 1 | fACTOR2 | PACTORS | factorn |
| :---: | :---: | :---: | :---: | :---: |
| frsiel | 0.28619 | 0.01261 | 0.11367 | 0.27017 |
| frsce | 0.80407 | -0.14594 | 0.02733 | 0.12987 |
| EnCTF | 0.83326 | 0.19583 | -0.01612 | -0.13192 |
| POLbIf | 0.83835 | -0.03805 | -0.06649 | -0.00678 |
| 1solf: | 0.81577 | -0.02101 | 0.04434 | 0.12930 |
| ifyear | 0.28001 | 0.18746 | 0.71608 | -0.20184 |
| frskill | 0.62894 | 0.31416 | 0.21563 | -0.51598 |
| § OUS | -0.19547 | 0.60756 | -0.14363 | -0.11308 |
| aGE | -0.18889 | -0.25716 | 0.78129 | 0.10280 |
| BOATOW | 0.06038 | 0.19082 | 0.45085 | 0.23867 |
| CAnPOW | 0.02273 | 0.33834 | 0.12483 | 0.67373 |
| CLUBOWN | 0.06876 | 0.70976 | 0.04300 | 0.19141 |
| macz | 0.08635 | 0.64771 | 0.17250 | 0.08290 |
| BFCATA | 0.62501 | 0.07150 | 0.20766 | -0.23977 |
| Eigenvalue | 3.66 | 1.76 | 1.37 | 1.02 |
| Percent of Variance Explained | 26.17 | 12.50 | 0.79 | $\begin{array}{ll} 7.27 & \text { Total } \\ & =55.32 \end{array}$ |

Table 1c. The Principal Components Analysis
for
Saltwater Fishing
ROTATED FACTOR PATTERM


Table 2. Estimated Recreation Demand Functions

|  | Equation / Dependent Variable |  |  |
| :---: | :---: | :---: | :---: |
| Explanatory Variable | (1) WHTRIPS | $\begin{gathered} (2) \\ \text { FFTRIPS } \end{gathered}$ | $\begin{gathered} \text { (3) } \\ \text { SFTRIPS } \end{gathered}$ |
| Intercept | $\begin{gathered} 5.09 \\ (16.61) \star * \end{gathered}$ | $\begin{aligned} & 15.09 \\ & (14.79) \star * \end{aligned}$ | $\begin{aligned} & 15.91 \\ & (20.55) \star \star \end{aligned}$ |
| TWHEXP | $\begin{aligned} & -0.5 E-02 \\ & (-2.31) \star \end{aligned}$ | $\begin{aligned} & -1.8 \mathrm{E}-02 \\ & (-2.42) \star \end{aligned}$ | $\begin{aligned} & -1.2 \mathrm{E}-02 \\ & (-2.03) \star \end{aligned}$ |
| TFFEXP | $\begin{aligned} & -0.3 E-03 \\ & (-0.60) \end{aligned}$ | $\begin{aligned} & 0.8 E-03 \\ & (0.40) \end{aligned}$ | $\begin{aligned} & -0.4 \mathrm{E}-03 \\ & (-0.27) \end{aligned}$ |
| TSFEXP | $\begin{aligned} & -0.3 E-03 \\ & (-0.31) \end{aligned}$ | $\begin{aligned} & -2.4 E-02 \\ & (-0.66) \end{aligned}$ | $\begin{aligned} & -0.6 \mathrm{E}-02 \\ & (-2.15) * \end{aligned}$ |
| Factor 1 | $\begin{gathered} 4.67 \\ (29.04) * * \end{gathered}$ | $\begin{gathered} 7.77 \\ (15.25) * * \end{gathered}$ | $\begin{aligned} & 2.06 \\ & (5.25) \star * \end{aligned}$ |
| Factor 2 | $\begin{aligned} & 1.25 \\ & (7.78) \star \star \end{aligned}$ | $\begin{aligned} & 1.49 \\ & (2.82) * * \end{aligned}$ | $\begin{gathered} 5.65 \\ (14.24) \star \star \end{gathered}$ |
| Factor 3 | $\begin{aligned} & 0.50 \\ & (3.24) \times t \end{aligned}$ | $\begin{aligned} & 1.71 \\ & (3.35) * * \end{aligned}$ | $\begin{gathered} 0.04 \\ (0.10) \end{gathered}$ |
| Factor 4 |  | $\begin{aligned} & -4.25 \\ & (-8.48) * * \end{aligned}$ | $\begin{aligned} & 3.44 \\ & (8.82) \star * \end{aligned}$ |
| INC | $\begin{aligned} & -0.6 E-05 \\ & (-0.83) \end{aligned}$ | $\begin{aligned} & 0.8 \mathrm{E}-05 \\ & (0.35) \end{aligned}$ | $\begin{aligned} & -0.9 E-05 \\ & (-0.48) \end{aligned}$ |
| $\mathrm{R}^{2}$ | 0.44 | 0.20 | 0.19 |

Note : t-vaiues for $H_{0}: B=0$ are in parentheses.

* significant at 0.05 level.
** significant at 0.01 level.


[^0]:    *The University of Georgia

