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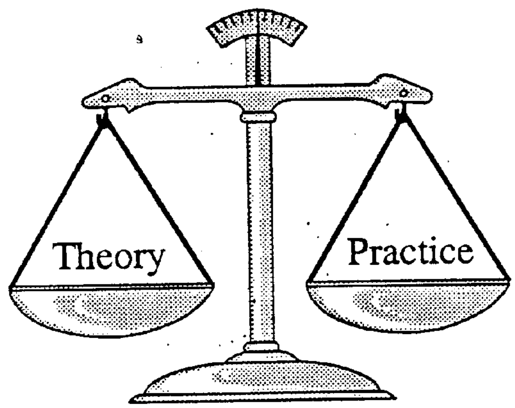

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A DEMAND ANALYSIS OF OFF-ROAD MOTORIZED RECREATION

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We examine individual demand and per-trip consumer surplus associated with off-road vehicle (ORV) recreation at the Croom Recreation Area in Florida. First, we estimate individual trip demand functions using the travel cost method and truncated count data regression models. We find mean per-trip consumer surplus point estimates between $12.88 and $66.17 depending on modeling assumptions. We also test for demand differences between four-wheel (ATV) demand and two-wheel (motorcycle) demand and fail to reject the hypothesis of congruence. This result implies that discriminatory user fee prices are unwarranted for economic efficiency. In addition, price elasticity of demand is mildly inelastic for most models estimated indicating that increased user fees would mean increased revenues.

Off-road vehicle recreation, including motorized all terrain vehicles and off-road motorcycles, is among the more economically important forms of outdoor recreation. Cordell et al. (1990) estimate that 80 million trips are taken annually nationwide for this activity. Moreover, it is estimated that in 1992, 3.3 million motorcycles and ATV's were used in off-highway recreation generating more than $3.3 billion economic impacts (Motorcycle Industry Council, 1993).

The economic importance and popularity of the sport notwithstanding, there has been little or no research conducted into the demand for and value of this activity. For example, Walsh, Johnson and McKean (1992) provide a review and analysis of the vast majority of outdoor recreation demand studies from 1968 through 1988 and list no studies specifically on ORV activies. Bergstrom and Cordell (1991) report individual and aggregate economic surplus values for general "offroad" driving based on an estimated national aggregate model however they do not report model parameter estimates. We know of no published site-level ORV demand studies.

In this paper, we use a variant of the travel cost method (TCM) to examine individual trip demand and estimate per-trip consumer surplus for ORV recreation at the Croom Recreation Area (CRA) in Florida. We estimate demand using an individual travel cost model (ITCM) and a truncated sample based on an on-site survey conducted in 1995. We test for differences in the structure of demand between ATV and motorcycle users. We also examine differences across a number of cost-per-mile and time cost combinations. Finally, we calculate price elasticity across a range of model assumptions and discuss our findings in regard to the current interest in user fees on public lands.

METHODS

The travel cost method is based on reported behavior and a number of assumptions, foremost of which is that individuals perceive and respond to changes in the travel-related component of the cost of a visit to a recreation site in the same way as they would respond to a change in admission price (Freeman, 1993). TCM in its various forms (see Fletcher, Adamowicz, and Graham-Tomasi, 1990; Smith, 1989; or Ward and Loomis, 1986) has been lauded for its behavioral base and is generally accepted for estimating nonmarket use value in water resources and forest recreation related studies (US Water Resources Council, 1983, Bergstrom and Cordell, 1991).

Economic surplus may be derived via the TCM construct indirectly by developing a quantity (trip)- price (travel cost) relationship empirically and solving for Marshallian or income-constant consumer surplus. The theoretically more appealing Hicksian measures can also be easily obtained (Creel and Loomis, 1990). However, in situations where income effects are small, including most outdoor recreation trips, Marshallian and Hicksian measures should be reasonable approximations.

In general, TCM is not without its limitations. The most obvious of which is its limitation to use value. Moreover, as Randall (1994) points out, it is still an indirect or inferential means for quantifying values. As such, in spite of its direct link to actual behavior, some "art" is required to get from reported trips to consumer surplus. Also, from an *ex ante* policy analysis perspective, TCM is quite limited in its capacity to provide information on multiple management alternatives. This limitation arises because sampling is generally necessary under each alternative. The hedonic TCM (Brown and Mendelsohn, 1984) and a generalized TCM (Smith, Desvouges, and Fisher, 1986) have been developed to circumvent the latter limitation, however, these approaches are themselves limited by rigid assumptions in visitation, model structure, and data requirements. A hybrid form of TCM based on travel costs and intended behavior in response to changes in costs or site characteristics, has also been used (see Ribaudo and Epp, 1984; Teasley, Bergstrom, and Cordell, 1994; Layman, Boyce, and Criddle, 1996). Because of its hypothetical nature however, this hybrid suffers from many of the same criticisms as contingent valuation.

The two most frequently used TCM empirical approaches are the zonal or aggregate approach and the individual approach. The zonal model (ZTCM) was the first to be developed and is still widely used (English and Bowker, 1996; Hellerstein, 1991; Richards et al., 1990). It is based on establishing a relationship between per capita participation rates at a site from various geographic origin zones and the costs incurred in travel from the origin zone to the given site. The individual travel cost model (ITCM) is conceptually similar to the zonal model, however, the travel cost/trip relationship is based solely on individual observations. Good examples of ITCM applications in recreation include Adamowicz, Fletcher, and Graham-Tomasi(1989); Creel and Loomis, (1990); and Englin and Shonkwiler (1995).

Arguments favoring ITCM over ZTCM include: (a) statistical efficiency, (b) theoretical consistency in modeling individual behavior, (c)avoiding arbitrary zone definitions, and (d) increasing heterogeneity among populations within zones. In addition, statistical methods are now available for dealing with the integer nature of individual trip demand and zero truncation common to choice-based samples (Creel and Loomis, 1990; Yen and Adamowicz, 1993). However, in defending ZTCM, Hellerstein (1991) makes the important point that truncated individual models rest on the presumption that all nonvisitors have the same demand parameters as visitors. If such is not the case, truncated individual models may be more biased than zonal models which incorporate nonvisitor information. This is an important caveat if results are intended for extrapolation to the population at large rather than to the subpopulation of users.

DATA AND EMPIRICAL MODELS

When site users and potential site users can be identified, for example by the purchase of a hunting license, a randomly drawn mail survey allows for collection of both participant and nonparticipant information which is neither endogenously stratified nor truncated. Unfortunately, most recreation activities are without a hunting license analog. For the majority of recreation demand analyses data are obtained via on-site sampling. In this study, data were collected through an on-site sampling procedure (the two-page questionnaire is available from the authors). The survey resulted in 154 completed responses. This sampling format can leave the researcher with a sample that is both zero-truncated and usually endogenously stratified (Shaw, 1988). However, it is considerably cheaper than a full-blown mail survey which would encompass users and nonusers. It also continues to be the most popular method of gathering site level recreation data.

Depending on the type of recreation activity, the definition of a trip may vary. Usually, the unit of observation is the individual and hence trips by individuals are combined with individual travel costs, income, and other variables to estimate a demand model. Such a structure works well for situations where participation and costs are individual in nature and individuals can be clearly targeted in the sampling. Examples could include activities like hunting, fly fishing, or hiking. Alternatively, when the unit of supply, e.g., a campsite, can be jointly consumed by a group or family without individual price discrimination, a household sampling approach may be more appropriate. In this study, our dependent variable is reported individual trips per month to the Croom site for motorized off-road recreation. Annual trips are the most common quantity measure in TCM modeling, however monthly trips can be used here because the user population frequents the area at rates high enough to accommodate sufficient dispersion in the dependent variable for model estimation.

The individual travel cost demand model can be generally specified as:

(1)

$$TRIPS_i = g(TCOST_i, INC_i, SUBCOST_i, OTH_i) + u_i$$

where, for the ith individual, *TRIPS* is the quantity of recreation trips demanded per time unit, *TCOST* is the travel cost per trip, *INC* is the budget constraint, *SUBCOST* is the price of an alternative site/activity, *OTH* represents a vector including other relevant variables, e.g., other socioeconomic and site attributes, and u is random disturbance.

Defining trip cost in TCM models is, and will continue to be, a subject of debate among researchers and practicioners. In-transit costs may be based on respondents' reported trip costs or costs imputed from researcher-imposed mileage rate(s). Using mileage rates reduces information needed from respondents while presuming linearity between cost and mileage. It also imposes homogeneous per-mile costs in the sample, which as Randall (1994) argues, contributes to questions regarding the use of TCM to generate cardinal welfare measures. Gathering actual cost information allows for greater variability in trip cost data but affords an increased probability of response or recall bias, along with differences in what individuals perceive as travel costs (Ward and Loomis, 1986).

The inclusion of time costs, both in-transit and on-site is also subject to considerable debate. Theoretically, Freeman (1993) demonstrates that both kinds of time costs should be included. However, he points out a number of problems which continue to plague applied researchers. One is the inability of a large portion of the sample to easily substitute between working increased hours at their normal (or overtime) wage rate and leisure time. Another is the possibility of utility or disutility resulting from work, travel, or on-site time, hence rendering the full wage rate a potentially poor measure of the shadow cost of time. He also points out that while most surveys elicit a pretax income measure, a more realistic wage rate would be derived from after tax income. McConnell (1992) states that judgements about time and the cost of time have been dominated by theoretical considerations rather than empirical results and that a measure of the cost of time may be considered "good" when it yields an "appropriate" measure of consumer surplus.

We examine six different definitions for travel cost, *TCOST*. Each version employs a combination of operating and time costs. Baseline operating cost is the product of round-trip distance and a 10.8 cents/mile variable cost factor.[1] We also calculate operating cost based on 20 cents/mile. The opportunity of time cost is calculated as roundtrip distance divided by an average velocity of 50 m.p.h. yielding a quotient which is then multiplied by a wage rate. The two wage rates used are $6 and $12 per hour. In all cases we account for the annual permit fee of $30.

As a proxy for income, we use reported annual expenditures for off road recreation activities (*EXPYR*). This procedure is viable under the assumption of utility separability and two-stage budgeting (see for example, Deaton and Muellbauer, 1981, p.127). Our substitution price variable, *SUBCOST*, is based on calculated time and travel costs to an alternative site. The issue of substitution, whether in site or activity based recreation demand models, is unresolved and choice of a substitute variable remains arbitrary. Hellerstein (1991) used an imputed substitution price based on the site nearest the destination having similar characteristics. Such an approach assumes site rather than activity substitution and that one is headed in the general direction of the chosen site. It can as easily be argued that the substitute site should be the one closest to the individual's origin. Alternatively, Bergstrom and Cordell (1991) used a supply index based on the availability of a combination of alternative activities proximal to the individual's origin. This approach assumes both activity and setting substitution.

Two additional variables were included to assess whether demand and price response for off-road recreation at Croom is different between ATV and motorcycle users. We address the null hypothesis that the two types of demand ORV are the same by including a binary variable for ATV users, *ATVD*, along with a travel cost interaction variable for ATV users, *ATVINT*. Significance of the coeffcient on *ATVD* would indicate an autonomous difference in demand between the two groups while significance on the coefficient on *ATVINT* would indicate a different price responsemeaning different values of consumer surplus and potentially the need for setting different user fees.

Individual travel cost models were estim using truncated Poisson (TP) and truncated neg binomial (TNB) estimators as described in Creel Loomis (1990) or Yen and Adamowicz (1993). Th estimators are increasingly used in recreation dem research because of their ability to address the inte nature of trips and to correct for zero-truncation (Eng and Shonkwiler, 1995). The TP density for each o independent individuals in a sample is:

(2)
$$f(Y_i = y_i | Y_i > 0) = \frac{\exp(-\lambda_i)\lambda_i^{y_i}}{y_i![1-\exp(-\lambda_i)]},$$
$$y_i = 1,2,..., \quad i = 1,2,...,N$$

where, Y_i is a discrete random variable for trips and y_i is the realized integer value. The location parameter, lambda, λ_i is conventionally parameterized as an exponential function of a vector of independent variables, $\lambda_i = exp(x_i\beta)$, allowing a regression model to be estimate by maximum likelihood. The likelihood function for th TP is:

(3)
$$lnL = \sum_{i=1}^{n} [-\lambda_i + y_i x_i \beta - \ln(y_i!) - \ln(1-\exp(-\lambda_i))].$$

Analogously, for the TNB, the density and loglikelihood functions are respectively:

(4)
$$f(Y_i = y_i | Y_i > 0) = \frac{\Gamma(\frac{1}{\alpha}+y_i)}{\Gamma(\frac{1}{\alpha})\Gamma(y_i+1)} * \frac{(\alpha\lambda_i)^{y_i}\ (1+\alpha\lambda_i)^{-(1/\alpha+y)}}{1-(1+\alpha\lambda_i)^{-(1/\alpha)}},$$
$$y_i = 1,2,..., \quad i = 1,2,...,n, \ \alpha > 0;$$

and,

(5)
$$lnL = \sum_{i=1}^{n} [\ln\Gamma(\frac{1}{\alpha}+y_i) - \ln\Gamma(y_i+1) - \ln\Gamma(\frac{1}{\alpha}) + y_i\ln(\alpha) + y_i x_i\beta - (\frac{1}{\alpha}+y_i)\ln(1+\alpha\lambda_i) - \ln(1-(1+\alpha\lambda_i)^{-(1/\alpha)})];$$

where Γ(.) represents the gamma function.

RESULTS

Truncated Poisson and truncated negative binomial models were estimated for the six variations of the full model (including ATV binary and interaction variables) and reduced model (no ATV variables)[2]. Only the TNB models are reported because the hypothesis of no overdispersion was rejected based on a Wald test equivalent to the asymptotic t-ratio on the estimated dispersion parameter, alpha (Yen and Adamowicz, 1993).

Full model results are reported in Table 1. Regression coefficients for *TCOST* and *EXPYR* are both statistically significant and have signs consistent with economic theory. Both of the ATV variablese, *ATVD* and *ATVINT*, however have estimated coefficients which are statistically insignificant. This result indicates that the null hypothesis of congruent demand structures between the two types of users cannot be rejected. Reduced models are reported in Table 2. Regression coefficients for *TCOST* and *EXPYR* are significant and have signs consistent with theory. Like the full model, the coefficient for substitute cost, *SUBCOST*, is insignificant.

Given our failure to discern a difference in the demand structure between the two types of users, the reduced models were used to derive estimates of consumer surplus (CS) and price elasticity of trip demand (E_p). In accordance with the parameterization of the TNB model, price elasticity is calculated as, $E_p = B_{tc} * TCOST$, where B_{tc} is the estimated regression coefficient on the travel cost variable. Here, depending on the variable operating and time cost assumptions, E_p ranges from -0.88 to -1.2. Our estimates indicate that price elasticity varies inversely with both time and operating costs. As well, the fact that E_p is unitary or below in five of the six models suggests that an increase in user fees will likely effect an increase in agency revenues.

Estimated mean per-trip consumer surplus, CS, is reported for each model in Table 2. Under the restrictions of the above count data models, per trip consumer surplus for the sample as well as for each individual is calculated as, CS= $1/B_{tc}$. Nintey percent confidence intervals for each CS estiamte based on the method of statistical differentials are also reported. Point estimates of CS for off-road motorized recreation use at CRA range from $12.88 to $66.17 depending mainly upon model assumptions. Here the surpluses vary directly with operating and time costs.