Modeling the Demand for and Value of OHV Recreation in Tennessee

Charles B. Sims¹, Donald G. Hodges², Burton English³, J. Mark Fly⁴, and Becky Stephens⁵

Abstract: This analysis is an extension of research undertaken for the Study Committee on Off-Highway Vehicles to assess the importance of off-highway vehicle recreation to the state of Tennessee. This research aims to address a need for economic modeling focused on off-highway vehicle (OHV) recreation. With the rise in popularity of this sport and the shortage of places to participate, advanced research techniques are needed to ensure the efficient and effective management of OHV recreation in Tennessee. Travel cost techniques are used to model the demand for and value of OHV recreation. A conventional welfare measure, maximum willingness to pay, is estimated from travel cost information.

Key Words: Consumer surplus, travel cost method, willingness to pay, Poisson

Funding for the project was provided by the Tennessee Agricultural Experiment Station and the Tennessee Department of Environment and Conservation

INTRODUCTION

Public and private lands alike offer a variety of trails coupled with beautiful surroundings that make Tennessee a popular area for off-highway vehicle (OHV) recreation.⁶ It is estimated that each year over 500,000 people visit national forests, state riding areas, or private lands to enjoy the natural surroundings and their vehicles (Fly et al. 2001). Along with the growing popularity of OHV recreation in Tennessee, demand for areas that provide for such recreation has increased substantially. Most riders seek vast areas with secluded trails and prefer these trails to consist of some type of mountainous terrain. Due to increasing amounts of land development and conversion, however, available areas of mountainous wooded terrain are becoming increasingly difficult to find. State and federal agencies are often forced to designate certain areas in state and national forests for OHV riding only to prevent user conflicts with other types of recreation. However, many states do not budget funds for OHV areas. This leaves many land management agencies struggling to allocate funding for supervision, safety, and the extensive trail maintenance needed in OHV areas; ultimately, leading to closure or additional

¹ Graduate Research Assistant, Department of Forestry, Wildlife, and Fisheries, University of Tennessee, 274 Ellington Plant Sciences, Knoxville, TN 37996-4563. cbsims@utk.edu
² Associate Professor, Department of Forestry, Wildlife, and Fisheries, University of Tennessee, 274 Ellington Plant Sciences, Knoxville, TN 37996-4563. dhodges2@utk.edu. 865-974-2706.
³ Professor, Department of Agricultural Economics, University of Tennessee-Knoxville, 308 Morgan Hall, Knoxville, TN, 37996-4518. benglish@utk.edu. 865-974-3716.
⁴ Associate Professor, Department of Forestry, Wildlife, and Fisheries, University of Tennessee, 274 Ellington Plant Sciences, Knoxville, TN 37996-4563. markfly@utk.edu. 865-974-7979.
⁵ Senior Research Associate, Department of Forestry, Wildlife, and Fisheries, University University of Tennessee, 274 Ellington Plant Sciences, Knoxville, TN 37996-4563. rstephe1@utk.edu. 865-974-5495.
⁶ Off-highway vehicles are considered to be any type of motorized vehicle that can be taken off of the road. Examples may include off-highway motorcycles, ATVs, four-wheel drive vehicles, or rail buggies.
restrictions imposed on the recreation site. Restrictions and closures in public riding areas often result in riders’ venturing onto restricted public and private properties. Tennessee Code Annotated Section 70-7-101, et seq., (commonly called the “Recreational Use Statute”) protects both private and governmental entities from injury lawsuits unless the landowner charges a fee or “consideration” to ride on his land. In most cases, landowners who do not charge a fee are protected from liability for simple negligence. However, landowners who allow riding on their property and charge a “consideration” or fee to offset the costs related to the OHV activity forfeit any protection offered under the Recreational Use Statute.

In November 1999, Tennessee Governor Don Sundquist appointed the Study Committee on Off-Highway Vehicles to evaluate the use, impact, and availability of OHV recreation in Tennessee and to address emerging economic, social and environmental issues related to this growing sport. The state extended invitations to relevant public agencies and to citizens’ groups to participate in the committee. The Governor’s Study Committee on Off-Highway Vehicles recommended that a formal OHV program be established in Tennessee with the goals of providing sufficient opportunities for the sport, propelling the associated economic benefits to the state, and properly managing OHV use to protect public safety, property owners, and natural resources.

The increase in the popularity of the sport and the decreasing opportunities for OHV recreation, make OHV management in the state of Tennessee a formidable task. Despite its growing popularity and apparent need for new management strategies, there is no published research devoted to modeling behavior or estimating the basic value of OHV recreation. Previous research efforts have looked at the economic impact of OHV recreation in addition to basic use estimates; however, no research has been devoted to economic modeling of the demand for OHV recreation.

The previous literature concerning OHV recreation is somewhat limited. No previous travel cost or contingent valuation studies have been performed on OHV recreation to our knowledge. Previous work has focused on other aspects of OHV recreation ranging from trail design to fuel use (e.g., Wernex 1993; Federal Highway Administration 1994).

The Tennessee Study Committee on Off-Highway Vehicles appointed the University of Tennessee to perform a survey of OHV users in 1999. This survey sought to gather information concerning opinions, user demographics, trip characteristics, motivations, and economic impact. Population estimates from this survey suggest that there are 553,000 OHV users in the state of Tennessee with 156,000 households containing at least one active user. Survey demographics reveal that the average OHV rider in Tennessee is a 38- to 44-year old white, male, with a high school degree and some college education. This representative individual earns between $50,000 and $74,999 per year (Fly et al. 2001). The annual economic impact of OHV activity in Tennessee was found to be $3.6 billion (for fiscal year 2001). The total number of jobs affected by OHV recreation in Tennessee was found to be 52,300 (English et al. 2001a). The estimated economic impact of OHV special events was found to range from $225,470 for the Dixie Run event to $65,420 for the Appalachian Jeep Jamboree (English et al. 2001b). All economic impact estimates were generated using IMPLAN. Researchers considered expenditures incurred in preparing for, traveling to and from organized events and individual riding excursions. While these numbers exhibit the importance of OHV recreation to the state and local economy, they do little to supply information on OHV user behavior that is critical for proper OHV management.
Survey and Sampling Methodology

Data were collected using a combination of on-site, telephone, and mail surveys. Three subpopulations were identified and surveyed, including OHV special event participants, Tennessee sportsmen, and the general population. Event riders consisted of participants in four OHV special events. These events included the Dixie Run and the Appalachian Jeep Jamboree in the Nantahala National Forest of North Carolina, the Gateway to the Cumberlands in south-central Kentucky, and the VSTA off-road motorcycle event in Middle Tennessee. These respondents filled out a short on-site survey and were asked if they could be contacted in the future. Participants in the events who reside in Tennessee and agreed to be contacted were sent a mail survey. Of those 340 participants, 169 completed and returned mail surveys for a response rate of 49.7% (Fly et al. 2001).

Tennessee sportsmen interviewed during Fall 2000 Tennessee Wildlife Resources Agency (TWRA) hunting and fishing survey were asked if they owned or used an OHV for recreational purposes. Those who responded “yes” were asked if they could be contacted for a follow-up survey. A random sample of those agreeing to be contacted was selected to receive an OHV mail survey. Of those 587 sportsmen, 180 completed and returned mail surveys resulting in a response rate of 31.7% (Fly et al. 2001).

A randomly generated sample of Tennessee telephone numbers was purchased from Survey Sampling, Inc for the general population survey. The person answering the phone was asked if anyone in the household had driven or ridden an OHV in the past 12 months. If the response to this question was affirmative, the person administering the survey asked to speak with the primary OHV user in that household. Using Random Digit Dial (RDD), 721 households were contacted, and 411 interviews were completed by telephone for an RDD Telephone response rate of 57.0%. A follow-up mail survey was then sent to 158 OHV users identified in the RDD Telephone survey. Of those follow-up surveys, 60 were completed and returned for a 38.0% response rate (Fly et al. 2001).

Survey responses from the event surveys, the TWRA surveys, and the general population surveys were then aggregated. Out of the 409 surveys that were returned from all three survey procedures, 271 were usable. Because of significant differences in the costs experienced by the different OHV user groups, these 271 usable surveys were broken down by the type of OHV user. The three types of OHV users identified were off-highway motorcycle users (n=86), ATV users (n=89), and four-wheel drive users (n=96).
Travel Cost Method

OHV recreationists’ (off-highway motorcycle, ATV, or four-wheel drive) choice of the number of visits to make to an OHV recreation site was modeled using an individual travel cost model. The utility structure was based on a number of factors. These included total time spent at the site, the quality of the site, and the quantity of visits. The individual solves the following utility maximization problem:

\[
\text{Max: } u(X, r, q)
\]

subject to the twin constraints of monetary and time budgets:

\[
M + p_w \cdot t_w = X + c \cdot r
\]

and

\[
t* = t_w + (t_1 + t_2) r
\]

where

- \(X\) = the quantity of the numeraire whose price is one,
- \(r\) = the number of visits to the recreational site,
- \(q\) = environmental quality at the site,
- \(M\) = exogenous income,
- \(p_w\) = wage rate,
- \(c\) = monetary cost of a trip,
- \(t^*\) = total discretionary time,
- \(t_w\) = hours worked,
- \(t_1\) = round trip travel,
- \(t_2\) = time spent on site.

The monetary cost of a trip to an OHV site is composed of two parts: the admission fee \(f\) and the monetary cost of travel. Since most OHV recreation sites charge no admission, total cost in most instances was comprised of the monetary cost of travel (Freeman 1999). The costs of travel were split into five parts: lodging, food and beverage, transportation, off-highway vehicle expenses, and other expenses. Since OHV recreation requires substantial purchases to begin participation (high fixed costs) and it is reasonable to believe that these purchases may play a significant part in travel choice behavior, additional OHV expenditures were needed to supplement the marginal costs experienced by OHV users on each trip. Omitting these fixed costs could result in a model with very low explanatory power. Maximizing the utility maximization problem subject to (2) and (3) will yield the individual’s demand function for visits:

\[
r = r(p_r, M, q)
\]

The data on rates of visitation and travel costs were used to estimate the coefficient on \(p_r\) in a travel cost-visitation function. The coefficient on \(p_r\) can then be used to derive the individual’s demand for visits to a site (McConnell 1985).

Several assumptions were made in the previous model that required model specification. First, it was assumed that each trip to the site was for the sole purpose of visiting the site. If the purpose of the trip included other features or was made for another purpose in which the trip to
Another specification made from the basic model described above regards the measurement of travel time and the use of the wage rate as a shadow price for the relevant opportunity cost of time. Some researchers treat travel time as an endogenous variable (Shaw and Ozog 1999; Desvouges and Waters 1995). Others have included a proportion of the wage rate as an additional factor in the travel cost measurement (Randall 1994; Englin and Shonkwiler 1995). Recent research has led some to the conclusion that “the wage does not necessarily reveal anything about the shadow value of discretionary leisure time, either as an upper or lower bound.” (Larson, Shaikh, and Loomis 1997). While it is reasonable to believe that the travel cost of time could play a large part in trip choice behavior and in consumer surplus estimates, survey data limitations and questions about the validity of the wage rate as a shadow price for leisure time force the exclusion of costs associated with travel time in this study.

A Poisson model (travel cost model) can be used to calculate willingness to pay for access from the area under the expected demand function. The observed dependent variable was assumed to be random from a Poisson distribution with mean $\lambda_i$, where $i$ represents the individual. In the Poisson model, all derivations were based on the expected demand function

$$E(X_i) = \lambda_i$$ (5)

The value of access equals the area under the expected demand curve. For the exponential demand function, the choke price ($C^*$) is infinite. Assume a simple demand specification: $x = e^{\beta_0} + \beta_1 C$ where $C$ is the travel cost, and $\beta_0$ can be a constant or a function of covariates other than own price. For any finite $C$, $x = e^{\beta_0} + \beta_1 C > 0$. Defining $C^0$ as the current travel cost, consumer surplus for access is

$$WTP = \frac{e^{\beta_0} + \beta_1 C^0}{\beta_1} = -x / \beta_1$$ (6)

where $x$ represents the number of trips taken by the individual and $\beta_1$ is the parameter estimate for travel costs. In the Poisson expression for sample mean WTP, one can use the mean of observed trips or mean of the expected trips because the Poisson model has the property that it is mean fitting (Haab and McConnell 2002).

RESULTS

**OLS Regression**

For the simple OLS regression of travel costs per trip it was assumed that the explanatory variables included natural log of the number of trips taken, experience in OHV recreation, age and education of individual, whether the individual is part of an OHV organization, and the natural log of the individual’s income. An individual’s travel cost per trip was modeled as a function of these explanatory variables:

$$travel\ costs_i = \alpha + \sum \beta_j x_{ij} + u_i$$ (7)

1 The variable on OHV group is a dummy variable where 1=member of an OHV organization, and 0=non-member
where \( j \) represents each variable, \( i \) represents the individual, and \( x \) is the value of each variable. This model was applied to off-highway motorcycle users, ATV users, and four-wheel drive users. This was done to isolate the differences in travel cost behavior between the user groups.

The OLS model was corrected for heteroskedasticity using White’s correction (White 1980); the adjusted t-values represent the t-value obtained after correcting for heteroskedasticity. Adjusted probabilities were then calculated based on the adjusted t-values. A visual inspection of the tolerance levels revealed that multicollinearity between variables was minimal and had no significant effects on the model results.1

The OLS results were very promising; with the model explaining nearly all of the variation in travel costs (modified \( R^2 \) ranged from .87 for four-wheel drive users to .90 for off-highway motorcycle users) and all of the explanatory variables significant and of the correct sign. Table 1 provides results of the OLS regression on all three user groups. For all user groups, the natural log of the number of trips taken was significant at the 5% level and had a negative influence on the amount of travel cost incurred by the individual. At first glance this seems to be a contradictory result. In most instances travel costs and number of trips tend to be directly related. However, it is important to note that equipment, insurance, and repairs were incorporated into the estimates for travel cost. These fixed or sunk costs will decrease the amount spent on each trip as the number of trips increases due to the nature of these costs. In other words, if an individual spent $5,000 on a new ATV the effect of this sunk cost on the travel cost estimate will diminish as the individual engages in more OHV trips. The model, evaluated at the mean, estimated travel costs per trip around $200 for all user groups.

Table 1. Results of OLS regression for travel costs.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Off-Highway Moto</th>
<th>ATV</th>
<th>4-Wheel Drive</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>Std Error</td>
<td>Coefficient</td>
</tr>
<tr>
<td>intercept</td>
<td>6.21148**</td>
<td>0.105</td>
<td>6.02787**</td>
</tr>
<tr>
<td>lntrips</td>
<td>-0.33786**</td>
<td>0.013</td>
<td>-0.28975**</td>
</tr>
<tr>
<td>exp</td>
<td>0.00175</td>
<td>0.001</td>
<td>0.0001199</td>
</tr>
<tr>
<td>age</td>
<td>-0.00141</td>
<td>0.002</td>
<td>-0.0001928</td>
</tr>
<tr>
<td>edu</td>
<td>0.01539</td>
<td>0.010</td>
<td>-0.00491</td>
</tr>
<tr>
<td>ohvgrp</td>
<td>-0.02076</td>
<td>0.043</td>
<td>-0.0161</td>
</tr>
<tr>
<td>lninc</td>
<td>-0.00224</td>
<td>0.050</td>
<td>0.05619*</td>
</tr>
</tbody>
</table>

*significant at the 5% level of probability
**significant at the 1% level of probability

In two of the models, the natural log of income was found to be highly insignificant for prediction of travel costs. In the ATV model, the coefficient for income was highly significant. This would lead one to conclude that an increase in income for ATV users would lead to a greater amount of travel costs incurred; therefore making income and travel costs more elastic in comparison to the other two user groups. The income elasticities revealed this exact trend. The income elasticity of the ATV user groups was found to be 1.02 compared to 1.01 and 0.99 for the four-wheel drive and off-highway motorcycle groups respectively.

---

1 Tolerance levels were all found to be greater than 0.60.
**Poisson Model**

A Poisson model is used in a standard travel cost application by modeling the number of trips taken based on travel costs and a number of other variables. These variables include:

- dummy variable to determine private or public land rider (pubrider),
- amount of OHV experience (exp),
- dummy variable to gauge satisfaction with OHV opportunities (ohvopp),
- dummy variable to determine approval of OHV management (ohvmng),
- respondent’s age,
- respondent’s education level,
- whether the respondent is a member of an OHV group, and
- respondent’s income.

The standard travel cost model is modified slightly by taking the natural log of the number of trips taken to remedy the effects of a standard error greater than the mean for this variable. The range of trips taken was 1 to 120 with the average number of trips estimated at about 23. The number of OHV trips an individual takes in Tennessee was modeled in the following way:

\[
\text{number of OHV trips}_i = e^{(\alpha + \sum \beta_j x_{ij} + u_i)}
\]  

Once again this same model was duplicated for the three different user groups to identify differences in trip-taking behavior between the three groups. The results of the Poisson regression for the three user groups revealed that the model fit the data extremely well (scaled Pearson chi-square ranged from 76 to 86). Model results revealed that travel costs were significant at the 5% level in all models. As expected, travel costs negatively influenced the number of OHV trips taken. The travel cost coefficient implies that a one-dollar increase in the cost of an OHV trip in Tennessee results in a 0.05% to 0.06% decrease in the number of trips. This is small, but not surprising in this case given the limited number of substitute sites. The choke price, or the price at which no OHV trips will take place, was estimated to be around $400 for all user groups. WTP per trip ranged from $169 for the ATV user group to $200 for the off-highway motorcycle user group. Poisson regression results can be found in Table 2.

---

1 The original Pearson Chi-Square for the three groups was estimated from 1.7 to 2.1 showing that a great deal of over-dispersion was present in the model.
Table 2. Results of Poisson regression for travel costs.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Off-Highway Moto</th>
<th>ATV</th>
<th>4-Wheel Drive</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>Std Error</td>
<td>Coefficient</td>
</tr>
<tr>
<td>intercept</td>
<td>1.9956**</td>
<td>0.081</td>
<td>2.2075**</td>
</tr>
<tr>
<td>tc</td>
<td>-0.005**</td>
<td>0.000</td>
<td>-0.0059**</td>
</tr>
<tr>
<td>pubrider</td>
<td>-0.0132</td>
<td>0.023</td>
<td>-0.0077</td>
</tr>
<tr>
<td>exp</td>
<td>0.0028*</td>
<td>0.001</td>
<td>-0.0002</td>
</tr>
<tr>
<td>ohvopp</td>
<td>0.059</td>
<td>0.033</td>
<td>-0.0327</td>
</tr>
<tr>
<td>ohvmng</td>
<td>-0.0383</td>
<td>0.044</td>
<td>-0.0057</td>
</tr>
<tr>
<td>age</td>
<td>-0.0011</td>
<td>0.002</td>
<td>-0.0006</td>
</tr>
<tr>
<td>edu</td>
<td>0.0168</td>
<td>0.009</td>
<td>-0.0063</td>
</tr>
<tr>
<td>ohvgrp</td>
<td>0.0116</td>
<td>0.044</td>
<td>-0.0146</td>
</tr>
<tr>
<td>inc</td>
<td>-0.0125</td>
<td>0.009</td>
<td>0.0078</td>
</tr>
</tbody>
</table>

*significant at the 5% level of probability
** significant at the 1% level of probability

The income elasticity of demand for the off-highway motorcycle user group was estimated to be −0.090, suggesting that the demand for trips is an inferior good. In other words, as the income of a specific individual increased by 10%, that individual’s demand for off-highway motorcycle trips decreased by .90%. Several prior studies have revealed that as income increases the number of recreational trips increases producing positive income elasticities. This leads us to believe that off-highway motorcycle recreation would be dropped for other forms of recreation as income increases. The income elasticity of demand for the other user groups was positive and ranged from 0.017 to 0.055. As expected, the price elasticity of demand was found to be negative and highly responsive to travel costs. Specifically, as the price of an OHV trip increased by 10%, the demand for these trips decreased from 11.4% to 12.8%.

CONCLUSIONS

This paper provides the only estimates of a model of the demand for OHV recreation. Travel cost spending behavior for OHV trips appeared normal. Specifically, the variable on trips was found to be significant and the income elasticity ranged from 0.99 to 1.02. For recreational pursuits that involve a great deal of fixed costs to participate, the predicted travel costs decrease as the number of trips increases. This is reverse of the behavior found in other forms of recreation (hiking, swimming, fishing) that require relatively small fixed costs to participate. Individual mean WTP per trip was found to range between $170 and $200 with off-highway motorcycle users exhibiting the largest consumer surplus and ATV users the smallest. Preliminary analysis reveals that off-highway motorcycle recreation may be viewed as an inferior good. This form of recreation may be a less costly alternative for OHV participants. Income elasticities exhibited an inelastic relationship between income and the number of OHV trips but an elastic relationship between price and the number of OHV trips. These data could be useful to land managers who may wish to limit OHV use by instituting a user fee. It also provides insight into the possible decreases in OHV user rates as a result of any OHV user fee as a part of a statewide OHV management plan.
While these numbers are useful as the first model estimates of OHV recreation, it is important to pinpoint possible sources of bias. Due to survey information limitations, substitute prices and quality as well as travel and on-site time were ignored in this analysis. The omission of substitute prices will bias the WTP estimate upwards as well as affecting estimates of price elasticity. If the correlation between the two travel cost variables is positive, then omitting the substitute prices biases the own price elasticity toward zero. But if the two travel costs are inversely correlated, the estimated own price coefficient is subject to a negative bias and the price elasticity of demand for visits is biased upwards. While it is reasonable to assume that the effect of substitutes is relatively small for OHV recreation, this could be the source of possible bias. In most cases, ignoring travel and on-site time leads to much lower benefit estimates. Due to these survey data limitations and misspecifications, more regional studies should be performed. Until these areas are improved upon, this study contains one of the few if not the only available estimates of the benefits of OHV recreation.

LITERATURE CITATIONS


