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User Fees and the Demand for OHV Recreation

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Abstract

The recent boom in the demand for off-highway vehicle (OHV) recreation has created an important policy issue for public land managers who are concerned with the impacts of OHV use on environmental quality. Within the past few years, the U.S. Forest Service has recognized the need for greater authority in managing these recreation areas and has proposed to amend OHV regulations. However, not much is known about the demand for OHV recreation or how various policy tools might be applied to improve the management of OHV sites. One means of protecting environmental quality and restoring areas damaged by unauthorized OHV use is to make use of funds collected through the recreational user fee program to restore and maintain OHV areas. A second method would be to make use of volunteers from OHV clubs and other riders to help protect OHV sites. To help address and evaluate these issues, data were collected at three OHV sites in North Carolina. The demand for OHV recreation was estimated using standard and simulation-based, random parameter count data models. Econometric results from the random parameter models indicated that the most avid OHV riders did not think that user fees were an appropriate method to manage OHV recreation. In contrast, riders who volunteer to maintain trails and OHV areas are more avid riders. Consequently, it seems

that the encouragement of volunteer effort and labor could be a viable and productive means to improve trail maintenance and environmental protection at OHV sites.

1. Introduction

Off-highway vehicle (OHV) use on public lands is becoming a major policy issue for the U.S. Forest Service and other land management agencies. The demand for OHV use on public land is not new - motorcycles have been used off-road for almost a century (Havlick 2002). Because dirt bikes are relatively difficult to ride, the demand for this type of recreation is relatively stable. However, the change in technology from two-wheeled to four wheeled vehicles has dramatically altered the demand for OHV use. This is evident in the boom in popularity for four-wheel drive (4WD, SUV) and all-terrain vehicle (ATV) use on public lands.

OHV recreation has become an important policy issue on public lands because these vehicles can have negative impacts on the environment by increasing soil erosion, decreasing water quality and impairing wildlife and visual aesthetics. Attempts to regulate OHV use on public lands are not new. Executive Orders E.O. 11644 (1972) and E.O. 11989 (1977) addressed safety and environmental concerns with OHVs by authorizing the Forest Service to manage OHV use so as to protect the land as well as the safety of all users of those lands. Within the past few years, however, the Forest Service has recognized the need for greater authority in managing these recreation areas and has proposed to amend the OHV regulations in an attempt to mitigate unacceptable environmental damage to Forest Service lands (USDA Forest Service 2004).

One means of protecting environmental quality and restoring areas damaged by unauthorized OHV use is to make use of funds collected through the recreational user fee program authorized in 2004. This program gives federal agencies the authority to collect user fees at certain sites and invest the revenues at the site where they were collected. Collected fees could be used to close trails where environmental impacts are unacceptable, or to perform trail improvements that would help protect environmental quality.

Another approach to protecting environmental quality and restoring areas damaged by unauthorized OHV use is to collaborate with trail riding clubs and organizations that provide volunteers for trail maintenance. Because people who use OHV trails have a stake in maintaining access to those areas, trail riding organizations have traditionally participated in protecting the quality of, and access to, the riding environment.

We are unaware of any published studies that evaluate the economic demand for, or value of, OHV use on public lands. In this paper, we present analysis of OHV demand and consumer surplus at three Forest Service sites in North Carolina. Empirical estimates are obtained using standard and simulation-based random parameter count data models in order to evaluate respondent heterogeneity. We are particularly interested in understanding how the avidity of OHV users (as proxied by the number of OHV trips) is related to two key policy variables: (1) whether or not the collection of user fees is an

appropriate way to manage OHV recreation, and (2) whether or not the respondent has ever volunteered to conduct trail maintenance.

The paper is organized as follows. In section 2, we describe the study area and the data collection method. In section 3, we describe the empirical methods we used. In section 4, we present our results and in section 5 we present the conclusions of our study.

2. Study Area and Data Collection

The three study sites are all located in the National Forests of North Carolina and allow opportunities for trail bikes, ATV and 4WD use. Two of the sites are in the mountains of western North Carolina and the third site is in the Piedmont physiographic region. The Upper Tellico is a premier regional site located in the Nantahala National Forest. This site is highly scenic and the steep, rugged trails are designed for use by experienced riders only. The other mountain site, Brown Mountain, is located in the Pisgah National Forest, contains less severe terrain and offers recreational opportunities for beginning to advanced riders. The third site, Badin Lake, is located in the Uwharrie National Forest. Although not as high in elevation as the other two sites, Badin Lake contains an abundance of steep, rocky terrain and opportunities for all classes of riders.

Data were collected using a paper and pencil survey that was administered on-site to riders as they were exiting the trail system during the summer of 2000. Volunteers from local trail riding organizations were used to collect the data. Respondents were asked to enumerate the total number of trips they made to each of the OHV sites during each of

the previous three years. Although this procedure may induce some degree of recall bias, the number of trips taken to sites is relatively small, which would mitigate possible recall bias. Data for the three years were pooled for analysis.

Respondents provided information regarding the origin of their current trip, which allowed us to compute travel costs (estimated as $0.34 per mile). In addition, questions were asked to respondents regarding their riding experience, skill, type of vehicle used, OHV related expenses, age, education, and income. Respondents were also asked two questions that would help us evaluate possible means for protecting and restoring environmental quality at OHV sites. First, respondents were asked "Have you ever volunteered to maintain OHV trails?" Second, respondents were asked "Do you think that user fees can be a good tool to manage public recreation areas?"

3. Empirical Methods

During the past decade, there has been an explosion of interest in the use of count data models to estimate the demand for outdoor recreation (e.g., see Englin et al. 2003). In contrast to earlier Hotelling-Clawson-Knetsch travel cost models that used ordinary least squares regression methods, count data models emphasize the non-negative, integer nature of the data on the number of trips taken and are most useful when the per person counts are small. This condition is met with count data for OHV recreation.

A second development during the past decade has been the development of simulation-based econometric methods that allow the estimation of respondent preference

heterogeneity via random parameters. This is accomplished by replacing integrals of large dimensions in the probability density function with simulated counterparts (Gouriéroux and Monfort 1996). The use of simulation for investigating preference heterogeneity has been applied most frequently in discrete choice analysis (Train 2003). However, similar methods can be applied to other econometric models. In this paper, we use simulation-based methods to investigate preference heterogeneity in count data models of recreation demand.

Random parameters are estimated using what is known as a 'mixed function', which is the weighted average of several functions and a mixing distribution provides the weights (Train 2003). Perhaps the best known mixed function count data model is the negative binomial (NegBin) model. In the NegBin model, the mean λ of the Poisson distribution is considered a random variable and the mixing distribution is the gamma density (Cameron and Trivedi 1986). The fit obtained with the NegBin model is often superior to the Poisson fit because the NegBin accounts for overdispersion of the data (i.e. it allows the variance to exceed the mean). As pointed out by Mullahy (1997), unobserved heterogeneity, or population mixing, implies overdispersion of the data, but overdispersion does not necessarily imply heterogeneity. For example, the zero-inflated Poisson model accounts for overdispersion in the data (Haab and McConnell 1996), but does not imply unobserved heterogeneity in the conditional mean.

One limitation of the NegBin model is that it assumes that heterogeneity arises solely in the mean event rate of the Poisson parameter λ. More recent models have been

developed to account for heterogeneity in the mean event rate *and* the regression parameters β. If the mixing function g(β) is discrete, where β takes only a limited number of classes, it is referred to as a latent class (or finite mixture) model. Wedel and others (1993) developed a latent class Poisson model to account for heterogeneity in count data parameters β across market segments. If the mixing distribution is continuous, rather than discrete, heterogeneity in the parameters of count data regressions can be modeled as randomly distributed parameters (Greene 2002).

The random parameters count data model allows some parameters to be random (β_i) while others are not (β). The random parameters include an unobservable latent random term ν_i for each individual i:

$$\beta_i = \beta + \Gamma \upsilon_i \qquad (1)$$

where ν_i has zero mean and variance one and Γ is a diagonal matrix which produces the variance matrix of the random parameters. Given this structure, the log-likelihood for the random parameters count data model is:

$$\log L = \sum_{i=1}^{n} \log \int_{\nu_i} g(\upsilon_i) P(y_i | x_i, \upsilon_i) d\upsilon_i \qquad (2)$$

where $P(y_i|x_i,\nu_i)$ is the Poisson or NegBin probability conditioned on covariates x_i and ν_i, and y_i is the number of trips. Simulation of the log likelihood function

$$\log L = \sum_{i=1}^{n} \log \frac{1}{R} \sum_{r=1}^{R} P(y_i | x_i, \upsilon_{ir}) \qquad (3)$$

over a large number R of simulated draws from the distribution of ν_i is used to estimate the parameters of the model.

Economic theory does not provide guidance on which parameters of the model should be specified as random and which ones should not. Consequently, to simplify the presentation, we only specify our two policy variables as having random parameters. Randomness in the parameters of a count data model of recreational trips reveals information on the relationship between the variable and the number of trips taken by the respondent. We interpret the randomness, then, as an indication of how the 'avidity' of recreational users changes with respect to the policy variables. This is consequential for policy analysis because, *ceteris paribus*, people who are more avid participants in a sport are more likely to be concerned about potential changes to the recreational resource. In our analysis, potential changes include expanded scope for utilizing user fees to pay for environmental protection at recreation sites and the use of volunteer effort to maintain the recreational environment.

4. Results

Surveys were completed for 357 respondents. A profile of the characteristics of OHV riders in western North Carolina shows that, on average, riders are generally young (32 years), predominantly male (88%), and middle-class ($50,100 annual income) (Table 1). ATVs (52%) and four wheel drive vehicles (55%) are much more commonly used than are trail bikes (19%). A very small proportion of riders are handicapped (2%) and a significant proportion of riders have received injuries that required medical attention (13%). A moderate number of riders reported that drinking alcoholic beverages at OHV sites is a typical part of their OHV trip (21%). Respondents have, on average, nearly a decade of riding experience (9.8 years) and self-reported their skill level as mid-way

between Intermediate and Advanced. Average annual expenses incurred in pursuit of OHV riding were about $1,811 and riders spent about $7,053 on their most recent OHV purchase.

Count data models were estimated for each of the study sites (Tables 2, 3 and 4). The statistical fit, as measured by one minus the likelihood ratio, was better for the random parameter models than for the nonrandom parameter models. In particular, the random parameter Poisson model was found to have the best fit at all three sites. The dispersion parameter in the NegBin model was found to be significantly different than zero at Brown Mountain and Badin Lake. The value of the dispersion parameter was much smaller in the random parameter NegBin model than in the nonrandom parameter model. The random parameter NegBin model did not converge for the Upper Tellico site.

Parameter estimates on the travel cost variable were negative and statistically significant at the 0.05 level or greater in each of the model specifications. In addition, a number of socio-economic and behavioral variables were found to have a statistically significant impact on the demand for OHV trips. Parameter estimates from the random parameter Poisson models for each site (the best-fit models) provide insight into the factors that influence OHV demand. Different factors have varying impact on recreation demand depending on the site considered. For example, consider the factors that influence the demand for trips to Upper Tellico, which is considered to be a premier regional OHV destination. Estimates from the random parameter Poisson model demonstrate that riders participate more frequently at this site if they are older, more experienced, better

educated and with higher income levels. In contrast, at the other two sites, younger riders with lower incomes participate more frequently. Apparently, the OHV market can be segmented based on rider characteristics. Presumably, rider characteristics influence the type of riding experience that is being sought at each of the OHV sites.

Statistically significant random parameters were estimated for the mean and standard deviation of the two policy variables. Four of the five random parameter estimates for the mean value of the USER FEE variable were negative, indicating that people who thought that user fees can be a good tool to manage public recreation areas were less avid riders, on average. Conversely, more avid riders did not think that user fees can be a good management tool. In the one instance that a positive random parameter estimate was found for the USER FEE variable, the estimate was not statistically significant at the 0.10 level and the magnitude of the parameter estimate was close to zero, indicating that feelings about user fees did not have any impact on avidity in that model.

All five random parameter estimates for the mean value of VOLUNTEER were positive and statistically significant at the 1 percent level. This result suggests that people who volunteer to help maintain OHV areas and trails are, in general, more avid riders. It seems that the volunteer labor and effort supplied by this group of riders could be encouraged and applied to help protect and restore environmental quality at OHV sites.

Estimates of the standard deviation of the random parameters can be used to understand respondent heterogeneity regarding the relationship between the policy variables and

OHV trip frequency (Table 5). At two of the three study sites, the vast majority (85%-88%) of riders who think that user fees are a good management tool are less avid riders. Conversely, only a small percentage (12-15%) of respondents who think that user fees are a good management tool are avid riders. At the third site, what people think about user fees does not seem to be strongly related to trip frequency. These results suggest that increased reliance on user fees to protect and restore OHV areas will not likely gain the support of the more avid users. However, at all of the study sites, the majority of people (53-78%) who volunteer to help maintain and restore OHV areas are more avid riders. This result provides further support for the idea that volunteers could be an important resource for managing OHV areas on public land.

Estimates of consumer surplus show that the value of OHV riding varies dramatically across the western North Carolina sites included in the analysis (Table 6). This variation is likely due to differences in site characteristics. For example, Upper Tellico is considered to be a premier regional site with many scenic attributes and extremely challenging trails. The value of this site for OHV use is reflected in the consumer surplus estimate ($333.33/ trip). At the other end of the spectrum, the Brown Mountain site is considered to be more favorable to beginning riders, for which more substitutes would be available, and the consumer surplus estimate is considerably smaller ($27.03/ trip). The characteristics of the Badin Lake site would fall in between the two other sites in terms of difficulty, which is captured by a moderate consumer surplus estimate ($55.00/ trip).

5. Conclusions

OHV recreation on public land is growing rapidly, largely due to the advent of ATVs (Havlick 2002). As OHVs can cause negative impacts to the environment, as well as to other riders, it is essential that public land management agencies take appropriate steps to assure the protection of the environment, restore the environment where it has been damaged, and provide safe riding conditions. Proposed revisions of OHV regulations by the USDA Forest Service demonstrate that this agency has recognized the need to improve the management of OHV recreation sites.

In this paper, we have provided estimates of the demand for, and value of, OHV recreation at three sites in western North Carolina using standard and simulation-based count data models. In addition to travel cost, a number of socio-economic and behavioral characteristics were shown to influence the demand for OHV recreation. Income, age, and education influence the demand for OHV recreation, but have different impacts at different sites. The segmentation of demand across sites is likely due to the characteristics of the sites. A better understanding of what types of riders choose to ride more frequently at various sites could help managers protect and improve important site characteristics. Alternatively, data could be pooled across sites to estimate a single visitation demand function. Heterogeneity in parameter values across sites could then be identified using the simulation-based random parameter models.

The random parameter count data models we estimated fit the data better than the nonrandom parameter models and, consequently, represent a promising new tool for

modeling recreation trip count data. Random parameters were estimated for two policy variables related to the protection and restoration of OHV recreation areas. It was discovered that increased implementation of new user fees in western North Carolina may meet resistance from more avid riders. That is, the riders who think that user fees are a good management tool are the less avid riders. In contrast, riders who volunteer to maintain trails and OHV areas are, in general, more avid riders. It seems that the encouragement of volunteer labor and effort could be a viable and productive means to improve trail maintenance and environmental protection at OHV sites. We suggest that strategies utilizing this approach, such as providing user fee vouchers for volunteers, should be evaluated through future research endeavors.

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Table 1. Profile of OHV riders in western North Carolina

Variable	Description	Mean	Std. dev.	N
Income	Dollars	50,100	10.95	282
Age	Years	32	10.36	351
Male	Percent	88	0.33	345
Education	Years	13.6	2.47	354
Injury	Percent needing medical attention	13	0.33	354
Drinking	Percent responding drinking alcohol at OHV site is typical part of trip	21	0.41	354
Handicap	Percent having a Handicapped Parking Permit	2	0.13	357
History	Number of years have been riding	9.8	8.5	354
Skill	Self-reported 3-point scale (Beg.-Int.-Adv.)	2.5	0.6	342
ATV	Percent of respondents who ride this vehicle	52	0.50	354
4WD	Percent of respondents who ride this vehicle	55	0.49	354
Trail bike	Percent of respondents who ride this vehicle	19	0.39	354
Annual expense	Average spent per year on OHV equipment and gear, dollars	1,811	2,240	315
Most recent purchase	Expenditure on most recent OHV, dollars	7,053	6,816	327
User fee	Percent agreeing	77	0.43	342
Volunteer	Percent who have volunteered	45	0.50	351

Table 2. Count Data Models for Brown Mountain

Variable	Poisson parameters	NegBin parameters	RP Poisson parameters	RP NegBin parameters
		Nonrandom Parameters		
Constant	-1.23	1.64	4.35	11.08
	(-3.31)	(1.28)	(14.82)	(12.51)
TCOST	-0.006	-0.02	-0.04	-0.015
	(-6.08)	(-3.29)	(-20.75)	(-3.51)
YEARRIDE	-0.04	0.02	0.03	-0.08
	(-6.33)	(0.71)	(5.43)	(-4.68)
AGE	0.02	0.03	-0.02	0.09
	(5.90)	(1.52)	(-4.92)	(7.68)
SCHOOL	-0.18	-0.23	-0.16	-0.76
	(-8.98)	(-2.57)	(-7.77)	(-14.51)
SKILL	0.15	-0.58	-0.75	-2.21
	(1.80)	(1.68)	(-8.89)	(-8.60)
INCOME	0.01	0.01	-0.01	0.01
	(10.13)	(1.90)	(-11.16)	(2.54)
DRINKING	0.65	0.87	0.12	1.55
	(7.30)	(2.06)	(1.48)	(6.12)
TRAIL BIKE	1.36	0.85	0.90	1.52
	(13.51)	(1.95)	(9.44)	(5.02)
ATV	0.30	0.31	-1.72	-1.28
	(3.70)	(0.85)	(-21.24)	(-5.97)
USER FEE	0.18	-0.29	--	--
	(1.85)	(-0.67)		
VOLUNTEER	1.93	1.77	--	--
	(16.74)	(5.18)		
		Mean for Random Parameters		
USER FEE	--	--	-5.73	-2.06
			(-30.26)	(-6.66)
VOLUNTEER	--	--	0.87	2.26
			(9.52)	(11.36)
		Standard Deviation for Random Parameters		
USER FEE	--	--	5.47	6.08
			(42.31)	(15.08)
VOLUNTEER	--	--	2.80	0.53
			(39.53)	(3.86)
		Dispersion Parameter		
α	--	11.61	--	0.29
		8.01		16.18
$1-L_1/L_0$	0.33	0.61	0.75	0.64

Note: Parameters in parentheses are t-statistics.

Table 3. Count Data Models for Badin Lake

Variable	Poisson parameters	NegBin parameters	RP Poisson parameters	RP NegBin parameters
		Nonrandom Parameters		
Constant	-0.65	1.01	-0.65	-3.57
	(-2.39)	(1.04)	(-4.02)	(-6.93)
TCOST	-0.008	-0.02	-0.02	-0.02
	(-6.95)	(-3.94)	(-16.79)	(-7.37)
YEARRIDE	-0.01	-0.004	-0.01	-0.004
	(-3.06)	(-0.02)	(-3.60)	(-0.43)
AGE	-0.03	-0.04	-0.03	-0.03
	(-8.29)	(-2.48)	(-9.18)	(-3.58)
SCHOOL	0.06	-0.02	0.06	0.40
	(4.01)	(-0.31)	(5.17)	(11.62)
SKILL	0.34	0.15	0.34	0.06
	(5.79)	(0.60)	(8.23)	(0.58)
INCOME	0.005	0.007	-0.01	0.008
	(4.64)	(1.44)	(-15.43)	(3.58)
DRINKING	0.11	0.34	0.11	1.26
	(1.47)	(0.93)	(2.20)	(8.22)
TRAIL BIKE	-0.10	0.30	0.10	-0.13
	(-1.21)	(0.86)	(1.77)	(-0.90)
ATV	0.31	0.79	0.31	-0.64
	(4.84)	(2.56)	(6.91)	(-5.06)
USER FEE	0.09	-0.08	--	--
	(1.21)	(-0.27)		
VOLUNTEER	0.56	1.06	--	--
	(8.81)	(3.20)		
		Mean for Random Parameters		
USER FEE	--	--	0.08	-1.27
			(1.63)	(-9.40)
VOLUNTEER	--	--	0.56	0.27
			(9.23)	(2.04)
		Standard Deviation for Random Parameters		
USER FEE	--	--	4.29	2.06
			(57.43)	(19.85)
VOLUNTEER	--	--	6.68	1.75
			(54.37)	(14.54)
		Dispersion Parameter		
α	--	8.58	--	0.45
		(10.69)		(17.76)
$1-L_1/L_0$	0.14	0.62	0.67	0.65

Note: Parameters in parentheses are t-statistics.

Table 4. Count Data Models for Upper Tellico

Variable	Poisson parameters	NegBin parameters	RP Poisson parameters
Constant	-3.60	-4.52	-9.75
	(-10.48)	(-6.00)	(-32.43)
TCOST	-0.006	-0.002	-0.003
	(-3.56)	(-1.96)	(-4.20)
YEARRIDE	0.01	-0.007	0.06
	(2.79)	(-0.58)	(15.82)
AGE	-0.003	0.004	0.01
	(-0.99)	(0.45)	(5.24)
SCHOOL	0.04	0.02	0.18
	(2.25)	(0.51)	(14.30)
SKILL	0.72	0.93	1.61
	(9.31)	(5.90)	(26.28)
INCOME	0.002	0.01	0.01
	(1.74)	(3.25)	(10.79)
DRINKING	0.02	0.12	1.12
	(0.20)	0.49)	(16.18)
TRAIL BIKE	-0.93	-1.18	-3.89
	(-8.89)	(-5.00)	(-31.47)
ATV	0.05	0.08	0.38
	(0.63)	(0.46)	(7.23)
USER FEE	-0.04	-0.05	--
	(-0.57)	(-0.23)	
VOLUNTEER	2.06	2.26	--
	(18.72)	(11.27)	
Mean for Random Parameters			
USER FEE	--	--	-2.68
			(-29.72)
VOLUNTEER	--	--	1.96
			(26.71)
Standard Deviation for Random Parameters			
USER FEE	--	--	2.32
			(41.09)
VOLUNTEER	--	--	2.54
			(39.81)
Dispersion Parameter			
α	--	3.19	--
		8.85	
$1-L_1/L_0$	0.35	0.33	0.54

Note: Parameters in parentheses are t-statistics.

Table 5. Preference Heterogeneity Regarding Policy Variables

	How Random Parameters Affect Trip Frequency	
	User Fee	Volunteer
Brown Mountain	85% negative	62% positive
Badin Lake	49% negative	53% positive
Upper Tellico	88% negative	78% positive
	→ People that support user fees are less avid	→ People that volunteer are more avid

Table 6. Consumer Surplus Estimates, Per Trip

	Poisson	Negative Binomial	Random Parameter Poisson	Random Parameter NegBin
Brown Mtn.	$166.00	$50.00	**$27.03**	$66.67
Badin Lake	$125.00	$45.45	**$50.00**	$50.00
Upper Tellico	$625.00	$416.66	**$333.33**	--

Note: Values in bold are for the best-fit model.