The Role of On-Site Time in Recreational Demand for Wilderness

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Treatment of time in travel cost models has been a source of contention among economists. The debate persists because welfare estimates, which are the principal objectives of these studies, are highly sensitive to the treatment of time. The present study examines the dual role of on-site time using evidence from two wilderness areas in Alabama. The empirical results comply with the theoretical expectation that on-site time is both a source of utility and cost. The exclusion of on-site time from demand functions results in biased parameter estimates. In particular, it yields smaller own-price coefficients and higher welfare estimates.

Key Words: full income, on-site time, recreation demand, travel cost model

JEL Classifications: C24, D60, J20, Q26

Outdoor recreation is a time-consuming process. Even before the actual consumption of recreational goods starts, a significant amount of time is spent on making a trip to the recreational site. On the other hand, the level of satisfaction derived from participating in recreational activities depends on the amount of time spent consuming recreational goods. This distinguishing feature of outdoor recreation makes time an important factor in determining the demand for recreational activities (Bockstael, Strand, and Hanemann).

The treatment of time in travel cost models has been a consistent source of debate among economists (Bockstael, Strand, and Hanemann; Cesario and Knetsch; McConnell; McConnell and Strand 1981). This contention

persists because the consumer surplus estimate, which is the "ultimate" goal of these models, is highly sensitive to the treatment of time (Kealy and Bishop; McConnell and Strand 1981). In general, time in travel cost models has been treated in two ways—as a source of utility and as a trip cost (McConnell; Smith).

Most of the earlier studies focused on the cost aspect of time and attempted to find ways to measure the opportunity cost of time used in recreation (Johnson; McConnell and Strand 1981, 1983; Ward). Smith, Desvousges, and McGivney used a household production framework to examine the role of travel and on-site time on demand for 43 recreation sites and found that about half of the estimated models were affected by the method of measuring opportunity cost of on-site time. Kealy and Bishop maintained that on-site time is exogenous because a recreationist decides first the optimal length of time to recreate at a site and then he decides on how many trips of that optimal length to make. Even though they were not concerned about the utility-generat-

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ing aspects, their model is consistent with both aspects of on-site time (McConnell).

On-site time could be a choice variable or a predetermined variable for a recreationist. For example, leisure time is a choice variable for individuals who can freely allocate time between work and leisure activities, whereas it would be a predetermined or exogenous variable for those who cannot make such allocations.[1] Smith contended that, in either case, three modeling strategies could be adopted. First, on-site time can be assumed as fixed for all recreationists, as in the case of classical travel cost models. Second, it could be fixed for an individual, but it may vary across individuals as assumed by Kealy and Bishop. Third, the number of recreational trips and on-site time could be determined simultaneously.

Recently, McConnell analyzed the dual role of on-site time for both exogenous, as well as endogenous, cases. He used beach demand data from New Bedford, MA, to explain his arguments, and his results showed that on-site time is endogenous and the implications of ignoring on-site time are negligible. Smith explored the consequences of misspecifying on-site time (ignoring the role of on-site time as a source of utility) and excluding on-site time from demand functions for the exogenous case using Monte Carlo simulations. In both cases, consumer surplus estimates were biased, and the consequences of misspecification were found to be more serious than excluding on-site time from demand functions. However, no study to our knowledge has tested the empirical validity of the theory that on-site time is both a component of trip cost and a source of utility.

The main objective of the present research was to test whether on-site time really plays a dual role, using evidence from the Cheaha and Sipsey wilderness areas of Alabama. A secondary objective was to examine the impact of ignoring the utility-generating aspect of on-

site time on welfare estimates. Because the choice of empirical model depends on the nature of on-site time, we begin by checking for endogeneity of on-site time. Then, based on test results, a recreational trip-demand function, which included both aspects of on-site time, was specified and estimated by using truncated count data estimators. This specification of the demand model made it possible to perform an empirical test on the dual role of on-site time. Unlike in previous studies, the results show that the exclusion of on-site time from the empirical demand function would result in a smaller own-price coefficient and higher values of consumer's surplus estimates.

Conceptual Framework

On-site time in wilderness recreation plays a dual role. First, it is a source of utility, because more time on-site augments the level of satisfaction derived from recreational activities. Second, it contributes to the cost of the trip because the time spent on recreational activities could possibly be used in other income-generating activities. This dual role of on-site time requires adjustments in both utility function as well as budget constraints.

Consider a consumer who makes a number of recreational trips (x) to various wilderness areas and consumes a composite bundle of goods (z) so as to maximize utility (U), subject to income and time constraints. The utility-generating aspect of time can be incorporated in the model by including on-site time as an argument in the recreationist's utility function (McConnell)—i.e.,

$$(1) \quad U = U(x, t, z), \qquad \delta U/\delta x \geq 0, \quad \text{and}$$
$$\delta U/\delta t \geq 0.$$

In this specification, utility is an increasing function of both the number of trips (x) as well as the amount of time on site (t). However, on-site time without a trip or trip without on-site time would not yield utility—i.e.,

$$(2) \quad \delta U(0, x, z)/\delta t = \delta U(x, 0, z)/\delta x = 0.$$

This joint weak complementarity between the

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[1] Some issues related with labor market situation and the nature of time constraint faced by an individual are discussed in Bockstael, Strand, and Hanemann. They argue that, for individuals who face flexible working hours in the labor market, time spent working is an endogenous variable.

number of trips and on-site time makes interior solutions more plausible (see McConnell for details).

On the other hand, the cost aspect of on-site and travel time is generally modeled by introducing a time constraint in the consumer's optimization problem (Larson and Shaikh; McConnell; Shaw 1992; Smith, Desvousges, and McGivney). In this framework, a wilderness visitor is assumed to face income (Y) as well as time (T) constraints

$$(3) \quad Y = c_x x + c_t t x + c_z z, \quad \text{and}$$

$$T = (t_x + t)x + t_z z,$$

where c_x is the price or cost of a trip to the wilderness area, c_t is the on-site cost per unit of on-site time, c_z is a composite price for the Hicksian bundle, T is the time available for consumption activities, t_x is travel time, t is on-site time, and t_z is time spent in consuming the Hicksian bundle.

Under the assumption that the recreationist can easily allocate time between work and consumption activities, income and time constraints can be combined to derive a single budget constraint (Bockstael, Strand, and Hanemann; Larson and Shaikh; McConnell)—i.e.,

$$(4) \quad Y + wT = y = x(p_x + p_t t) + pz,$$

where y is full income (i.e., wage plus non-wage income); $p_x = c_x + wt_x$ (travel expenses plus opportunity cost of travel time per trip), $p_t = w + c_t$ (opportunity cost of time plus on-site expenses per unit of on-site time), and $p = c_z + wt_z$ (consumption expenses plus opportunity cost of time for each unit of the Hicksian bundle consumed). After this adjustment, the consumer's choice problem becomes

$$(5) \quad \max U$$

$$= U(x, t, z) + \lambda[y - x(p_x + p_t t) + pz].$$

The solution to this optimization problem depends on whether on-site time is a choice variable or determined exogenously. Smith, Desvousges, and McGivney contended that

on-site time is an endogenous variable and estimated on-site time and recreation trip demand functions simultaneously. Under the assumption that on-site time is endogenous and time is freely substitutable between work and consumption activities, McConnell derived the demand for on-site time and recreation trips to be

$$(6) \quad t = f(p_x, p_t, p, y), \quad \text{and}$$

$$x = f(p_x, p_t, p, y).$$

The most interesting part of McConnell's analysis lies in the argument that even if on-site time is endogenous, a single-equation estimation of x will not cause bias in parameter estimates. Thus, there is no need to estimate the demand for on-site time and recreation trips simultaneously.

On the other hand, Kealy and Bishop postulated that on-site time is a predetermined variable. They argued that the recreationist decides first the optimal length of time to recreate at a particular site and then how many trips of that optimal length to make. Although the amount of on-site time for an individual is assumed to be predetermined, it is allowed to vary across the individuals. They compared ordinary least-squares (OLS) and maximum likelihood (ML) estimators and found the difference between these two estimators to be very large. The welfare measures obtained from OLS estimators were found to be 3.6 times higher than the measures based on ML estimators.

On-site time should be included as an explanatory variable in the trip demand function, when it is predetermined to an individual but varies across the individuals (Kealy and Bishop; McConnell; Smith). In this case, the trip demand function for an exogenous case can be derived as[2]

$$(7) \quad x = f(p_x^*, p, y, t),$$

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[2] It is likely that inclusion of both aspects of on-site time in a single demand function would make trip cost and on-site time collinear. However, it may not necessarily be restrictive, because the opportunity cost of on-site time is only a component of total trip cost.

where $p_x^* = p_x + p_t t$. In this specification, the dual role of on-site time can be observed as

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(8) \quad \delta x / \delta t = p_t (\delta x / \delta p_x^*) + \delta x / \delta t.
$$

The first term on the right represents the cost side of on-site time, which should be negative, and the second term represents the utility-generating role of time and is expected to be positive. Also, the implications of excluding onsite time from demand function can be easily seen from this specification of the demand function. Because the relationship between recreational demand and on-site time is expected to be positive, the omission of on-site time from the empirical demand function would suppress the size of cost coefficient and inflate consumer's surplus estimates.[3]

Empirical Model

Most recreation studies are based on data gathered from user surveys. In such surveys, the demand for recreation (x) is measured as the number of trips made by an individual to a wilderness within a period of time, which is a positive integer truncated at zero. In this case, truncated Poisson and truncated negative binomial estimators are considered to be superior to the estimators based on continuous distributions (Creel and Loomis; Maddala; Shaw 1988). Count data models have been used widely in recent empirical studies. Hausman,

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[3] This point can be expressed as follows. Let the true model be $x = X_1 \beta_1 + X_2 \beta_2 + \epsilon$ and the estimated model is $x = X_1 b_1 + e$, where X_1 includes all relevant variables except for on-site time and X_2 denotes the on-site time. Then the expected value of b_1 would be $E(b_1) = \beta_1 + [\text{cov}(X_1, X_2)/\text{var}(X_2)] \times \beta_2$. Thus, under the assumption that X_1 and X_2 are not independent, the expected value of b_1 would be biased. In this case, the coefficient associated with the cost of wilderness visitation (own price) would be biased downward because $\beta_1 < 0$, $\beta_2 > 0$, and $\text{cov}(X_1, X_2) > 0$. This will lead to higher values of consumer surplus estimates. However, if $\text{cov}(X_1, X_2) < 0$, then the coefficient would be biased upward, which would lead to lower values of consumer surplus. We are thankful to one of the anonymous reviewers for reminding us about the second possibility. This would be a case when more distant visitors substitute fewer but longer trips for many shorter trips.

Hall, and Griliches used Poisson and negative binomial models to analyze patents issued, whereas Cameron and Trivedi used similar models to analyze medical visits. Creel and Loomis compared several count data models using empirical data on demand for deer hunting in California and found that truncated Poisson and truncated negative binomial-regression models perform better than the alternative estimators.

In recreation demand studies, the price or cost of a wilderness visit is generally defined as a total of travel cost, entry charges, and opportunity cost of time. The travel cost of a wilderness visit is typically estimated by multiplying total distance traveled by a standardized average cost (Creel and Loomis; McConnell). The issue of opportunity cost of time, however, is vague. Various attempts have been made to measure the opportunity cost of travel and on-site time. Some of the early studies used a minimum wage rate (Cesario and Knetsch) or a fraction of market wage rate (Nichols, Bowen, and Dwyer) to measure the opportunity cost. McConnell and Strand (1981) contended that the opportunity cost of time should be a fraction of the market wage rate and that this fraction should be estimated from the sample itself rather than choosing it arbitrarily.

The opportunity cost of an individual's time, however, would depend on the availability of alternative uses of time and on the nature of time constraints faced by the recreationist (Freeman). It may also depend on the type of site visited and the nature of recreational activities undertaken. Smith, Desvousges, and McGivney asserted that the time constraint and the opportunity cost of time spent at a local recreation site would be different from the time constraint and opportunity cost of time spent at a national site that serves people from different parts of the country.

Another important issue, which is often ignored in empirical studies, is the treatment of substitutes. The exclusion of close substitutes from the recreation demand models may result in biased parameter estimates (Cuddington, Johnson, and Knetsch; Rosenthal). Although information required for estimating the price

of substitute sites was not available from the original data set, the distance from a center of each of the 67 counties of Alabama to Cheaha and Sipsey wildernesses were estimated. Using these estimated distances and information about the hourly wage rate of workers in Alabama, the cost of visiting a substitute site was imputed. The county of origin of out-of-state visitors, however, was not recorded. Because the cost of substitute sites for out-of-state visitors could not be estimated, they were excluded from the sample. Moreover, Cheaha and Sipsey are the only two wilderness areas of Alabama, and most visitors to these two wilderness areas are Alabama residents. Thus, these wilderness areas are probably the two most relevant substitutes available to Alabama residents.

The data set used in the present study includes both campers as well as day visitors, which differ significantly, at least in terms of the amount of time spent on site. This difference in time violates one of the basic assumptions of travel cost model (Freeman). To address this problem, Ozuna and Gomez used a dummy variable, equaling one for campers and zero otherwise, to account for such differences in on-site time. A more robust estimation procedure, however, would be to model campers and day visitors separately. Because there was not much variability in on-site time variable (see "Data" section and footnotes in Tables 1 and 2 for details), we estimated both on-site time and trip-demand models combining the day and overnight users. For comparison, separate trip-demand functions of campers and day visitors were also estimated.

Because the specification of a trip demand function depends on the nature of the on-site time, a two-step estimation procedure was used (McConnell). The first stage involves testing a null hypothesis that on-site time demand function (Equation 6) parameters are not jointly significantly different from zero. If the test result confirms the hypothesis, then one would conclude that on-site time is exogenous and estimate trip demand function as specified in Equation (7). On the other hand, if it fails to support the null, then it would imply that

on-site time is endogenous and proceed by estimating Equation (6).

On the basis of the empirical issues discussed earlier and results from the on-site time demand model, the following specifications were used in estimating the recreation demand for Cheaha and Sipsey wilderness areas:

(9)   OLS: $x_i \sim N(X\beta, \sigma^2 I)$

T-POISSON:

$x_i \sim \text{T-POISSON}[\lambda = \exp(X\beta)], \quad \text{for } x_i > 0$

TNBINOM:

$x_i \sim \text{TNBINOM}[\lambda = \exp(X\beta, \alpha)], \quad \text{for } x_i > 0,$

where $X = X(Stay, Age, Age^2, Income, t, p_{own}, p_{sub})$. The dependent variable, x_i, was defined as the number of visits to the wilderness area per year and the explanatory variables include; "*Stay*" is a dummy variable that takes the value of 1 if the respondent was on a camping trip and 0 otherwise; "*Age*," visitor's age; "*Age²*," age squared; "*Income*," full income (money and time income); "*t*," time spent on site; "p_{own}," cost of visiting this wilderness area; and "p_{sub}," cost of visiting other wilderness areas. Both own and substitute prices are defined as full price that includes time and money costs (see footnotes in Tables 1 and 2 for details).

The Data

The data set used in the present study was generated through a face-to-face visitor survey conducted from June 1991 to June 1993 at Cheaha wilderness areas in Alabama. The overall response rate was 76.2% (see Clonts for other details). Because some of the important variables needed for the study, such as the cost of a trip to an alternate site (p_{sub}), total time available for consumption activities (T), and average hourly wage rate (w), were not included in the original survey, the following procedure was used to approximate them.

Because Alabama has only two wilderness recreation sites (Cheaha and Sipsey) and >80% of those who visit these wilderness areas are state resident, we treat these two sites as close substitutes. On the basis of this as-

Table 1. Variable Descriptions

Variable	Description	Mean	Std. Dev.
Trip (x)	Number of visits to this wilderness per year	5.62	8.43
Total trips (X)	Total number of visits to wilderness areas per year	9.00	13.37
Age	Age of the respondents (year)	36.26	11.13
Wage rate (w)	Hourly wage rate ($/hour)	9.69	4.92
Income (y)	Full income ($1,000)	42.97	26.60
On-site time (t)	Time spent consuming recreational goods (hour)	18.16	18.31
P_{own}	Total cost of a trip to this wilderness area ($/trip)	210.41	200.85
P_{sub}	Total cost of a trip to an alternative site ($/trip)	202.04	207.82

Note: Full income (y) is defined as: y = Annual household income (Y) + nonwage income (wT), where T is defined as the total number of visits to wilderness areas per year (X) times per-trip travel (t_x) and on-site time $[T = X(t + t_x)]$, i.e., $y = Y + w[X(t + t_x)]$. The trip cost is defined as $p_{own} = \{miles[0.30 + (w/45)] + wt\}$, where $miles$ = total distance traveled, 0.30 reflects the average travel cost per mile and the constant 45 is the average speed limit. Similarly, the cost of a trip to an alternative site is approximated by $p_{sub} = \{miles[0.30 + (w/45)] + wt\}$.

sumption, we estimated the price of substitute (i.e., the total cost of making a trip to an alternate site, p_{sub}) as follows. First, we estimated the distance between the visitor's residential area and the alternate recreational site using Alabama county maps. Then, using the estimated distance, the cost of making a trip to the substitute site was calculated as $p_{sub} = miles[0.30 + (w/45)] + wt$, where *miles* is the total distance in miles, w is the wage rate, and the constants 0.30 and 45 reflect the average travel cost per mile and an average speed, respectively. Because the discretionary wage rate was not elicited, we used respondents' employment status in imputing the average hourly wage rate. In total, there were 12 different employment categories reported in the survey. The average state level weekly wage rates (ww) for these job classifications were obtained from various U.S. Bureau of Labor Statistics publications and was used to calculate the average hourly wage (i.e., $w = ww/40$).

Next, we estimated the total time spent on wilderness recreation using the survey response to following questions "How many times a year do you typically go into wilderness?" and "Which of the following best describes the typical length of your visits into wilderness areas?" The response to the second question included following categories: (a) half day, (b) full day, and (c) overnight. Those who stayed overnight were also asked to report number of nights stayed in wilderness.

Then, on the basis of this information, time spent on wilderness recreation (t) was imputed as 4 hours for a half-day visit, 8 hours for a full-day visit, 30 hours for a full day plus overnight stay, and 24 hours for each additional night spent on site. On the average, these estimates indicate that Cheaha and Sipsey visitors spent ~18 hours in on-site recreational activities. The sample mean and standard deviation of the variables used in the study are reported in Table 1.

Because the speed limit in most state highways that lead to these wilderness areas was 45 miles per hour, travel time was estimated by dividing the total travel distance by speed limit. Once the travel and on-site time is known, the total time available for wilderness recreation to a recreationist (T_w) can be calculated as a product of the total per trip time and the total numbers of wilderness visits per year [i.e., $T_w = (t + t_x) \times X$]. Because the recreationist's discretionary time (time available for all consumption activities) was not included in the initial survey, T_w was used as a surrogate for total discretionary time $(T = T_w)$. Although it is not an accurate measure, we expect this variable to reflect the variations in discretionary time (T) across the individuals.

Now, let us look at some of the attributes of Cheaha and Sipsey visitors. As can be seen from Table 2, the average age and number of visits per year are similar for the two wilderness areas. However, Cheaha visitors have higher average family income, spent longer

Table 2. Basic Characteristics of Wilderness Visitors (Average for the Respondents)

Characteristics	Cheaha			Sipsey		
	Day	Camp	Total	Day	Camp	Total
Number of respondents (n)	93.00	58.00	151.00	124.00	59.00	183.00
Proportion of visitors (%)	61.59	38.41	100.00	67.76	32.24	100.00
Number of visits per year (x_i)	6.10	4.50	5.49	6.58	3.95	5.72
Visitor's age (years)	38.03	35.19	36.99	37.42	31.85	35.66
Full income ($1,000)	42.94	48.67	45.02	40.90	42.08	41.28
Distance traveled (*miles*)	76.96	101.91	88.11	63.55	97.19	74.04
Grown up: Rural (%)	46.24	29.83	40.40	61.98	55.93	60.22
On-site time (hours)	6.65	38.69	18.95	6.90	39.76	17.50
Cost of visit ($)	96.94	401.19	208.76	96.25	361.58	172.30
Cost of substitute ($)	132.93	431.15	241.61	141.05	387.32	211.64

Note: On-site time was measured as 4 hours for a half-day visit, 8 hours for a full-day visit, 30 hours for a full day plus overnight stay, and 24 hours for each additional night spent on site. The cost of a trip to a wilderness area was measured as $p_{own} = \{miles[0.30 + (w/45)] + wt\}$, where *miles* = total distance traveled, and the cost of a trip to a substitute site was measured as $p_{sub} = \{miles[0.30 + (w/45)] + wt\}$.

time on site, faced higher trip costs, and traveled a greater distance to reach the recreational site than Sipsey visitors. The average annual family income of the wilderness visitors is more than double that of state residents.

A basic difference between campers and day visitors is found in the distribution of age, frequency of visit, cost of trip, on-site time, and total distance traveled. The respondent's average frequency of visits and age were higher for day visitors in both wildernesses, whereas campers traveled farther to reach the respective wilderness areas, incurred more costs, and spent more time at the wilderness areas.

Empirical Results

As mentioned before, we used a two-step estimation procedure. In the first-step, on-site time demand functions for Cheaha and Sipsey wilderness areas were estimated to determine whether time was an endogenous variable (Table 3). The results show that none of the estimated coefficients were significant at the 5% level. Moreover, the F-statistic, which measures the overall significance of the model, was also insignificant in both cases. This implies that on-site time is not endogenous (McConnell). On the basis of these results, on-

Table 3. On-site Time Demand Function Parameters

	Cheaha		Sipsey	
	Coefficients	Std. Error	Coefficients	Std. Error
Constant	7.3049	13.8720	20.4035	23.1635
Age	−0.1796	0.7392	−0.3642	1.2777
Age²	0.0021	0.0090	0.0025	0.0165
Full income	0.0001	0.0001	0.0000	0.0001
Value of time (w)	−0.0769	0.2583	−0.4506	0.4069
P_{own}	0.0572	0.0518	−0.0560	0.0854
P_{sub}	0.0352	0.0549	0.2833	0.1821
n	113		151	
R^2	0.03		0.11	
F-value	0.53		1.65	

Note: These parameters are based on OLS regression. One- and two-limit tobit models were also estimated to account for possible effects of censoring due to minimum and maximum stay limits (half-day and 14 days), but the results were not significantly different from OLS estimators.

Table 4. Cheaha Trip-Demand Function Parameters

	Combined		Day Visitor		Campers	
	OLS	T-Poisson	OLS	T-Poisson	OLS	T-Poisson
Constant	−17.2788	−4.4253**	−16.0841	−2.5214**	−29.6647*	−12.0424**
	−(1.60)	−(6.66)	−(1.11)	−(3.47)	−(1.75)	−(7.08)
Stay	−16.1481**	−2.4368**				
	−(3.18)	−(11.91)				
Age	0.9654*	0.2625**	0.6358	0.1666**	0.8823	0.4840**
	(1.69)	(8.05)	(0.83)	(4.73)	(1.00)	(6.37)
Age^2	−0.0102	−0.0029**	−0.0062	−0.0017**	−0.0083	−0.0054**
	−(1.47)	−(7.35)	−(0.67)	−(4.06)	−(0.74)	−(5.83)
Income	−0.0262	−0.0047**	−0.0473	−0.0091**	0.0220	0.0040
	−(0.60)	(−2.53)	−(0.78)	−(3.69)	(0.34)	(0.99)
On-site time	0.8377**	0.1146**	1.5175**	0.1148**	0.6519**	0.1229**
	(4.31)	(19.05)	(3.62)	(15.21)	(3.30)	(11.05)
P_{own}	−0.0779*	−0.0162**	−0.1044*	−0.0170**	−0.0496	−0.0228**
	−(2.31)	−(9.25)	−(2.22)	−(7.65)	−(0.98)	−(4.83)
P_{sub}	0.0469	0.0116**	0.0761*	0.0129**	0.0228	0.0173**
	(1.48)	(7.11)	(1.75)	(6.81)	(0.47)	(3.92)
n	151	151	93	93	58	58
Log-likelihood	−413.39	−564.57	−274.33	−421.63	−134.13	−123.64
LR-statistics	23.50**	445.23**	16.60**	242.90**	14.34*	232.11**

Note: Numbers in parentheses are *t* values. The log-likelihood ratio test statistics (LR-statistics $\sim \chi^2_{[7]}$) measures the overall significance of the model.
**, * Denote significantly different from zero at 1% and 5% levels, respectively.

site time was treated as an exogenous variable in specifying the recreational demand for both Cheaha and Sipsey wilderness areas (Equation [9]).

In the second step, the trip demand functions were estimated using three different estimators, OLS, truncated Poisson (T-Poisson), and truncated negative binomial (results not reported but available on request). The model selection parameter, α, which measures the degree of overdispersion, provides the basis for choosing between two truncated estimators. This parameter is not significant in both Cheaha and Sipsey models, which implies that there is no need to account for overdispersion. The combined as well as separate estimators for day and overnight users are reported in Tables 4 and 5.

In Cheaha models, all of the coefficients, except for income, hold the expected signs, and all are highly significant (Table 4). The coefficient of the *Stay,* a dummy variable, which takes a value of 1 if the respondent was on a camping trip and 0 otherwise, is negative

and highly significant. This result is consistent with the observation that campers, who travel a much longer distance (~30 miles more) than day visitors, may substitute fewer but longer trips (camping) for many shorter trips (day visits).[4]

The coefficients of the income variable are significantly negative in combined as well as day visitors' models. Although the income coefficient, a priori, is expected to be positive, a negative coefficient associated with income has been a commonly encountered problem in travel cost models (Creel and Loomis; Duffield; Grogger and Carson; Mendelsohn).

As expected, the coefficients of age and age^2 variables held opposite signs (positive and negative signs, respectively), which implies that the demand for wilderness recreation increases initially as the age of the visitors increases, then reaches a maximum, and then

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[4] We are thankful to anonymous reviewers for suggesting that we estimate a combined model and examine the substitution possibility between *t* and *x*.

Table 5. Sipsey Trip–Demand Function Parameters

	Combined		Day Visitor		Campers	
	OLS	T-Poisson	OLS	T-Poisson	OLS	T-Poisson
Constant	4.1180	1.3740**	3.0547	1.3622**	6.4062	1.2535
	(0.82)	(3.76)	(0.47)	(3.17)	(0.86)	(1.39)
Stay	−1.2227	−0.2550				
	−(0.63)	−(1.49)				
Age	−0.0507	−0.0047	0.1063	0.0303	−0.4574	−0.0759
	−(0.19)	−(0.24)	(0.31)	(1.36)	−(1.08)	−(1.54)
Age^2	0.0014	0.0002	−0.0008	−0.0003	0.0068	0.0010
	(0.39)	(0.73)	−(0.18)	−(1.06)	(1.20)	(1.50)
Income	0.0235	0.0041**	0.0124	0.0029	0.0836**	0.0233**
	(1.09)	(2.71)	(0.45)	(1.61)	(2.59)	(5.29)
On-site time	0.0457	0.0101*	0.4123	0.0204	0.0590	0.0159*
	(0.66)	(1.78)	(1.34)	(0.81)	(1.11)	(2.11)
P_{own}	−0.0306*	−0.0059**	−0.0386	−0.0072**	−0.0640**	−0.0173**
	−(1.77)	−(4.38)	−(1.42)	−(3.67)	−(2.82)	−(5.52)
P_{sub}	0.0249	0.0046**	0.0057	0.0009	0.0565**	0.0152**
	(1.50)	(3.59)	(0.25)	(0.58)	(2.65)	(5.25)
n	183	183	124	124	59	59
Log-likelihood	−448.12	−521.84	−323.14	−376.49	−115.60	−111.14
LR-statistics	9.66	59.62**	6.54	53.01**	12.60	53.47**

Note: Numbers in parentheses are *t* values. The log-likelihood ratio test statistics (LR-statistics $\sim \chi^2_{[7]}$) measures the overall significance of the model.
**, * Denote significantly different from zero at 1% and 5% levels, respectively.

starts to decline. Moreover, a significantly negative coefficient associated with the own-price variable, which is measured as the sum of the travel expenses and the opportunity cost of travel and on-site time, indicates that these results are also consistent with the basic consumer demand theory. On the other hand, a positively significant coefficient associated with the p_{sub} variable, which measures the cost of making a trip to an alternative site, indicates that Cheaha and Sipsey are viewed as substitutes.

Time as a source of utility was modeled by incorporating it into the recreationist's utility function and was expected to carry a positive sign in trip-demand functions. On-site time was found to be exogenous, and it was included in the model as an explanatory variable. The coefficient of the on-site time variable, *t*, provided the basis for testing the empirical validity of the argument that on-site time is a source of utility. As expected, the coefficient of on-site time was highly significant and had a positive sign in all models.

These results are consistent with the theoretical expectations of the model.

Unlike in Cheaha, some of the coefficients of age and age^2 variables in Sipsey models held unexpected signs, but they are not significantly different from zero (Table 5). Likewise, the *Stay* variable carries an expected sign, but it is not significant. Moreover, the coefficients of the income variable are significantly positive in combined and camper models. As in Cheaha models, the coefficients of the on-site time and price variables (own and substitute price) carry the expected signs, and most of them are highly significant. These results, a positive coefficient of on-site time and a negative coefficient associated with the opportunity cost of time, support the theoretical expectation that on-site time in wilderness recreation is a source of utility as well as a component of trip cost.

The own-price coefficients obtained from the model that excludes on-site time from the demand function (model I) and the one that includes on-site time as an independent vari-

Table 6. Consumer Surplus Estimates with and without Accounting for On-site Time

	Cheaha	Sipsey
Coefficients		
Without on-site time	−0.0055	−0.0053
With on-site time	−0.0162	−0.0059
Ratio (I/II)	0.3395	0.9061
Consumer Surplus (CS)		
Without on-site time	181.82	187.06
With on-site time	61.73	169.49
Ratio (I/II)	2.95	1.10

Note: The point estimate of consumer surplus per trip is estimated from own price coefficients (p_{own}) as $CS = -(1/p_{own})$.

able (model II) are reported in Table 6. As expected, the absolute size of the own-price coefficient obtained from model I was much smaller than that from model II. As a result, the consumer surplus estimate obtained from model I is much higher than those from model II.

Concluding Comments

The role of on-site time in wilderness recreation demand was analyzed using data gathered from a user's survey of Cheaha and Sipsey wildernesses in Alabama. Truncated count data estimators, which are superior to estimator that are based on continuous distribution, were used to estimate recreation demand functions. In contrast to McConnell's results, on-site time was found to be exogenous. A trip-demand function with on-site time as an explanatory variable was specified, which allowed testing the empirical validity of the argument that on-site time in wilderness recreation plays a dual role.

The results indicated that the Cheaha and Sipsey wildernesses are substitutes. This finding is notable, because the two areas are somewhat different with respect to physical features. The relationship between on-site time and the number of trips to wildernesses was found to be positive, whereas the relationship between the opportunity cost of on-site time and the number of trips to the wilderness was negative in all cases. This result is consistent

with the theory that on-site time in wilderness recreation is both a source of utility and an opportunity cost of a trip. Thus, the omission of on-site time from demand function would result in biased parameter estimates. In particular, it would yield smaller own price coefficients and higher values of consumer surplus estimates.

References

Bockstael, N.E., I.E. Strand, and W.M. Hanemann. "Time and the Recreational Demand Model." *American Journal of Agricultural Economics* 62(May 1987):293–302.

Cameron, A.C., and P. Trivedi. "Econometric Models Based on Count Data: Comparison and Application of Some Estimators and Tests." *Journal of Applied Econometrics* 1(1986):29–53.

Cesario, F.J., and J.L. Knetsch. "Time Bias in Recreation Benefit Estimation Models." *Water Resources Research* 6(June 1970):700–4.

Clonts, H.A. *Characteristics and Preferences of Visitors to Cheaha and Sipsey Wilderness in Alabama: Monitoring for Limits of Acceptable Change.* Alabama Agricultural Experiment Station, Technical Report. Auburn, AL: Auburn University, 1994.

Creel, M.D., and J.B. Loomis. "Theoretical and Empirical Advantages of Truncated Count Data Estimators for Analysis of Deer Hunting in California." *American Journal of Agricultural Economics* 72(May 1990):434–41.

Cuddington, J.T., F.R. Johnson, and J.L. Knetsch. "Valuing Amenity Resources in the Presence of Substitutes." *Land Economics* 57(November 1981):526–35.

Duffield, J. "Travel Cost and Contingent Valuation: A Comparative Analysis." *Advances in Applied Macroeconomics,* Volume 3. V.K. Smith and A.D. Witte, eds. Greenwich, CT: JAI Press, 1984.

Freeman, A.M. III. *The Measurement of Environmental and Resource Values: Theory and Methods.* Washington, DC: Resources for the Future, 1993.

Grogger, J.T., and R.T. Carson. *Models for Counts From Choice Based Samples.* San Diego: University of California, 1987.

Hausman, J., B.H. Hall, and Z. Griliches. "Econometric Models for Count Data with an Appli-

cation to the Patents R&D Relationship." *Econometrica* 52(1984):909–38.

Johnson, T.G. "Measuring the Cost of Time in Recreation Demand Analysis: Comment." *American Journal of Agricultural Economics* 65(February 1983):169–71.

Kealy, M.J., and R.C. Bishop. "Theoretical and Empirical Specifications Issues in Travel Cost Demand Studies." *American Journal of Agricultural Economics* 68(August 1986):660–67.

Larson, D.M., and S.L. Shaikh. "Empirical Specification Requirements for Two-Constraint Models of Recreation Choice." *American Journal of Agricultural Economics* 83(May 2001):428–40.

Maddala, G.S. *Limited Dependent and Qualitative Variables in Econometrics.* New York: Cambridge University Press, 1983.

McConnell, K.E. "Onsite Time in the Demand for Recreation." *American Journal of Agricultural Economics* 74(November 1992):918–25.

McConnell, K.E., and I.E. Strand. "Measuring the Cost of Time in Recreation Demand Analysis: An Application to Sportfishing." *American Journal of Agricultural Economics* 63(February 1981):153–56.

———. "Measuring the Cost of Time in Recreation Demand Analysis: Reply." *American Journal of Agricultural Economics* 65(February 1983):172–74.

Mendelsohn, R. "An Application of the Hedonic Travel Cost Framework for Recreation Modeling to the Valuation of Deer." *Advances in Applied Micro-Economics,* Volume 3. V.K. Smith and A.D. Witte, eds. Greenwich, CT: JAI Press, 1984.

Nichols, L.M., M. Bowes, and J.F. Dwyer. *Reflective Travel Time in Travel Cost Based Estimates of Recreation Use and Value.* University of Illinois Forestry Res. Rep. No. 78-12, AES, 1978.

Ozuna, T., and Gomez, I.A. Estimating a system of recreation demand functions using a seemingly unrelated Poisson regression approach. *The Review of Economics and Statistics,* 76,2(1994): 356–60.

Rosenthal, D.H. "The Necessity for Substitute Prices in Recreation Demand Analyses." *American Journal of Agricultural Economics* 69(November 1987):828–37.

Shaw, D. "On Site Samples' Regression: Problems of Non-negative Integers, Truncation and Endogenous Stratification." *Journal of Econometrics* 37(1988):211–23.

Shaw, W.D. "Searching for the Opportunity Cost of an Individual's Time." *Land Economics* 68(February 1992):107–15.

Smith, V.K., W.H. Desvousges, and M.P. McGivney. "The Opportunity Cost of Travel Time in Recreation Demand Models." *Land Economics* 59(August 1983):259–78.

Smith, T.P. "The Role of Onsite Time in the Demand for Outdoor Recreation (Recreational Time)." *Dissertation Abstracts,* DAI-A 52/06, 1991.

Ward, F.A. "Measuring the Cost of Time in Recreation Demand Analysis: Comment." *American Journal of Agricultural Economics* 65(February 1983):167–68.