Estimating the Cost of Leisure Time for Recreation Demand Models

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Abstract

In this paper, we propose a method of determining the opportunity cost of leisure time with an empirical recreation demand application. Typically, the opportunity cost of leisure time is assumed to be some fraction of the wage rate. This practice has limitations. First , it assumes that individuals can trade time for money at their wage. Second, it offers no guidance as to how to value the time of an individual who is not in the labor force. This paper proposes a method of determining this cost that doesn't suffer from these drawbacks. An empirical example is provided which demonstrates the proposed approach and contrasts it with commonly applied approaches.

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Introduction

The decision to participate in recreational activities is likely to be as heavily influenced by time constraints than by money constraints. Over three decades ago, economists recognized the role of time in the decision process and began incorporating the opportunity cost of leisure time as a component of the trip cost (e.g., Johnson, 1966; Cesario and Knetsch, 1970). Several studies have demonstrated that welfare estimates from recreation demand models are sensitive to the opportunity cost assigned to leisure time (e.g., Bowker et al, 1996; Bishop and Heberlein, 1980; Cesario, 1976). How to actually determine this cost time remains relatively unexplored.

Recent articles dealing with time in recreation demand (Larson, 1993; McConnell, 1992) advocate the use of the wage rate as the cost of time. Utilizing the wage rate, or some fraction of the wage rate, as the cost of leisure time has been a standard practice for some time. In the early transportation literature, authors proposed deriving a percentage of the wage rate as a cost of time from empirical data (e.g., Beesley, 1965; Quarmby, 1967). Percentages of the wage rate were used in early recreation demand studies (e.g., Cesario, 1976) and continue to be used today (e.g., Bowker, et al., 1996). Other approaches, such as hedonic wage equations (Smith, Desvousges and McGivney, 1983) are occasionally employed, but dependence on the wage rate itself is the common practice.

Early attempts to incorporate time into more general consumer theory (e.g., Becker, 1965; DeSerpa, 1971), and to explain behavior in labor markets (e.g., Heckman, 1974) suggested that the wage rate represented the cost of time. These models relied on the assumption that individuals are able to freely adjust the hours that they work. The ability of an individual to achieve equilibrium in these models depends on flexible work hours. For many individuals however, hours of work are likely to be constrained. More refined models of labor force participation recognized this by incorporating a fixed hour constraint directly into the labor force participation decision (e.g., Moffitt, 1982; Tummers and Woittiez, 1990; and Zabel, 1993). Generally, these models assume that individuals decide whether or not to accept employment by comparing offered hours with desired hours. If desired hours exceed offered hours, then the individual enters the labor force. In this situation, it is unlikely that most individuals entering the labor force would choose to work exactly a fixed 40 hours per work week if they were free to adjust their work hours. Given a choice between the fixed hour job and no job, working is preferable, but the fixed schedule is not likely to be optimal. This leads to situations of either under-employment or over-employment where the wage rate does not accurately reflect the cost of leisure time[1].

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[1]There is considerable evidence that under-employment and over-employment are common in the U.S. workplace. Perlman (1966), Mossin and Bronfenbrenner (1967) and Altonji and Paxson (1988) document under-employment in the workplace. Ham (1982) found that unemployed and under-employed workers ranged from 19.2% in 1973 to 28.2% in 1970 (The University of Michigan's Panel Study of Income Dynamics from 1967 to 1974 was used in the analysis). On the over-employment side, Tarling (1987) claims that "Recent evidence indicates that many employees would be prepared to forgo some of their earnings in order to reduce their hours of work." (pp. 85). Bockstael et al. (1987) make a similar observation noting that in their sample, "individuals with fixed working hours appear to value time much more highly than the wage rate and would be willing to trade work for leisure" (pp. 301). Hahnel (1998) concluded that results from a 1994 survey suggest that U.S. workers have a slight preference for pay cuts in order to reduce their work hours. About 50% of the respondents claimed they would accept some reduction in salary in order to work a four day week.

In this paper, we propose a method of determining the opportunity cost of leisure time with an empirical recreation demand application. Issues such as whether time should be incorporated into recreational demand models and whether that time quantity includes on-site time or only travel time are not addressed here. Instead, we focus on how to estimate an individual's opportunity cost of leisure time. Although the emphasis is on recreational demand, valuing leisure time has applications in other areas of applied research. For example, a common problem in labor supply estimation is how to value the time of an individual who is not in the labor force. This is sometimes accomplished through the use of a hedonic wage estimation where observed wages are regressed on observed socio-economic characteristics (e.g., van Soest, 1995; Moffitt, 1990; Macurdy, Green and Paarsch, 1990). The resulting equation is then used to infer the "wages" of those not in the work force. One drawback of using these imputed wages is the implicit assumption that both workers and non-workers come from the same population. This practice ignores factors that may explain why a given individual chooses not to enter the labor force. Another example where the procedure has practical applications is in the transportation literature where the opportunity cost of time spent commuting is included as a component of total commuting costs (e.g., Fernandez, 1994).

The next section describes a method first proposed by Heckman (1974) that is extended to accommodate situations where the individual is employed in a fixed hour job resulting in either over-employed or under-employed. An empirical application follows using survey data collected specifically for the proposed method. The opportunity cost of leisure time is recovered for each individual and used in a travel cost model of river recreation. This model is then compared to other models utilizing different costs of leisure time based on wage rates or a hedonic wage model.

The Heckman Model with a Fixed Hour Employment Extension

Heckman (1974) assumed that individuals maximize a utility function subject to time and income constraints. The utility maximization problem is:

Max $U(X_1,...,X_n,L)$ subject to

(1) $\Sigma_i P_i X_i = wh + A,$

(2) $T = L + h,$

where X_i is the I-th market good with price P_i, L is leisure time, A is non-labor income, h is time spent employed at wage w and T is total available time. The Lagrangian is written as:

$$U(X_1,...,X_n,L) - \lambda_1(\Sigma_i P_i X_i - A - wh) - \lambda_2(T - L - h),$$

where λ_1 and λ_2 are Lagrange multipliers. The first order conditions are:

(3) $U_{xi} - \lambda_1 P_i = 0 \quad I=1,...,N$

(4) $U_L - \lambda_2 = 0$

where U_{xi} (U_L) is the partial derivative of the utility function with respect to X_i (L). Solutions to (3) and (4) will be a system of equations for $X_1,...,X_n,\lambda_1,\lambda_2$ and L which are functions of $P_1,...,P_n$, w and A. The ratio of multipliers λ_2/λ_1 -- commonly labeled the "resource value of time" (e.g., DeSerpa, 1971; de Donneau, 1972; Collings, 1974) -- can be expressed as:

(5) $\lambda_2/\lambda_1 = U_L/\lambda_1$.

Equation (5) describes the monetary value the individual places on the marginal units of leisure time L.

Under certain assumptions, for an arbitrary w, Heckman (1974) defines W^*, the value of leisure time, or the "shadow wage" as:

(6) $W^* \equiv U_L/\lambda_1 = k(h, wh + A, P_1, ..., P_n)$,

where k(.) is the shadow wage function which has continuous first partial derivatives with respect to its arguments. The shadow wage function k(.) is defined whether or not a labor supply function exists, allowing for corner solutions in the labor market. The shadow wage W^* is assumed to vary with h in a positive manner. As more hours of work are chosen, the marginal cost of leisure time increases. The market wage w, on the other hand, is assumed to be fixed and independent of the number of hours worked.

For those who are free to choose their hours of employment, the number of hours chosen (h^*) equates the market wage w to the shadow wage W^* evaluated at h^* resulting in the following equilibrium condition:

(7) $w = W^*|_{h=h^*}$.

Because W^* and h are positively related, it must also be true that the perceived shadow wage while being employed exceeds the perceived shadow wage from being unemployed:

(8) $w = W^*|_{h=h^*} > W^*|_{h=0}$.

Individuals who choose not to enter the labor force place a higher value on their leisure than the wage they can obtain. If the shadow wage evaluated at h=0 exceeds the market wage, then the individual will not to enter the labor force:

(9) $$w < W^*|_{h=0}.$$

Relations (8) and (9) describe the two labor-leisure cases considered in Heckman's (1974) analysis. The first case, $h^* > 0$, is illustrated in Figure 1. Here, the individual choice of $h^* = T - L^*$ hours of work satisfies relation (8). This is the only situation where the wage rate reflects the marginal value of leisure time. The second case, $h^* = 0$, ($L^* = T$) is illustrated in Figure 2. Here, the market wage the individual can obtain is less than the value of leisure time at any positive hours of work.

Heckman's (1974) analysis considered situations where individuals are free to choose their hours of labor. The outcomes are either an interior solution ($h^* > 0$), or a corner solution ($h^* = 0$). It is far more likely that an individual is faced with a “take it or leave it” situation of fixed hour employment. Heckman’s (1974) model treats all employed individuals as having the freedom to determine there own work hours. Zabel (1993) criticized this assumption as being too restrictive because “individuals are usually constrained, possibly by choice, in the number of (work) hours they can choose and seem to have more control over the decision to work rather than how much they work” (p. 388). Unless the fixed hours offered exactly match what a given individual would choose in the absence of the constraint, the result is either under-employment or over-employment.

Extending this model to account for either under-employed or over-employed individuals is relatively simple. Figure 3 describes the fixed hourly over-employment case. Given a choice of working zero hours or $T - L^*$ hours, the individual will choose to work $T - L^*$ hours. In Figure 3, the individual prefers $h = T - L^*$ over $h = 0$, but would prefer to choose h between 0 and $T - L^*$ if hours of work could be freely adjusted. This suggests that at $h = T - L^*$, the value of time exceeds the wage rate. The condition describing this case is:

(10) $$W^*|_{h=0} < w \leq W^*|_{h=T-L^*}.$$

The under-employment case is described in Figure 4. In this case, the individual desires to work more hours at the prevailing wage, but is prevented from doing so because of the fixed hour nature of the job. Figure 4 illustrates that given a choice of working zero hours or $T - L^*$ hours, the individual will choose $T - L^*$ hours even though more hours are desired. If work hours could be freely adjusted, the individual would choose $h > T - L^*$. The condition describing this case is:

(11) $$W^*|_{h=T-L^*} < w \leq W^*|_{h=T},$$

where T is maximum number of hours in the decision period[2].

Estimating The Procedure

Following Heckman (1974), stochastic wage and shadow wage functions are specified and a likelihood function is constructed using (8), (9), (10) and (11). Define the shadow wage equation as:

[2] Although individuals in these situation have the option to find additional employment, potential secondary jobs may offer lower wages or unattractive, lengthy fixed hours. Those who work at secondary jobs are considered to be special cases of (8), (10), or (11), depending on job characteristics.

(12) $W^* = \theta Y + \beta_1 h + \epsilon$,

where W^* is the shadow wage, θ is a vector of parameters, Y is a vector of exogenous variables, β_1 is a scalar parameter, h is hours of work. Define the market wage equation as:

(13) $w = \Omega Z + \mu$,

where w is the market wage, Ω is a vector of parameters and Z is a vector of exogenous variables. The error terms are assumed to be jointly normally distributed with $E(\mu) = E(\epsilon) = 0$, $Var(\mu) = \sigma_\mu^2$, $Var(\epsilon) = \sigma_\epsilon^2$, $Cov(\mu,\epsilon) = p\sigma_\epsilon\sigma_\mu$. In Heckman's (1974) paper, the individuals studied were married women. The exogenous variables in the Z vector were an intercept term, experience and education; the exogenous variables in the Y vector were an intercept term, number of children less than six years of age, net assets and wage rate of the husband.

For employed individuals who can freely adjust their work hours, relation (8) holds. Using (8), equations (12) and (13) can be equated to derive a reduced form simultaneous system of equations for labor supply h and wage w:

(14) $h = (\beta_1)^{-1}[\Omega Z - \theta Y] + [\epsilon - \mu]/\beta_1$

(15) $w = \Omega Z + \mu$.

Since (ϵ,μ) are jointly normal $([\epsilon - \mu]/\beta_1, \mu)$ are also jointly normal with mean zero and variance-covariance matrix τ,

$$\tau = \begin{bmatrix} (\sigma_\mu^2+\sigma_\epsilon^2-2\rho\sigma_\epsilon\sigma_\mu)/\beta_1^2 & (\sigma_\mu^2-\rho\sigma_\epsilon\sigma_\mu)/\beta_1 \\ (\sigma_\mu^2-\rho\sigma_\epsilon\sigma_\mu)/\beta_1 & \sigma_\mu^2 \end{bmatrix}$$

The likelihood function for these individuals (L_1) is:

(16) $L_1 = j(h,w \mid W^*|_{h=0} < w) * \Pr(W^*|_{h=0} < w)$,

where j(.) is the joint conditional distribution of observed hours h and wage w. The joint distribution in (16) can be written as:

(17) $j(h,w \mid W^*|_{h=0} < w) = n(h,w) / \Pr(W^*|_{h=0} < w)$,

where n(.) is the joint unconditional distribution of observed hours h and wage w. Using (17), the likelihood function given by (16) collapses to:

(18) $L_1 = n(h,w)$,

where $n(h,w) = (1/2\pi)|\det(\tau)|^{-½}\exp[-½(h-D,w-F)\tau^{-1}(h-D,w-F)']$,

$D \equiv (\beta_1)^{-1}[\Omega Z - \theta Y]$,

$F \equiv \Omega Z$.

For individuals who choose not to work, relation (9) holds. In this case, the likelihood function (L_2) is:

(19) $L_2 = \Pr(w < W^*|_{h=0}) = \Pr(\Omega Z + \mu < \theta Y + \epsilon)$.

Since ($\mu - \epsilon$) is distributed normally with mean zero and variance Γ^2 ($\Gamma^2 = \sigma_\mu^2 + \sigma_\epsilon^2 - 2p\sigma_\epsilon\sigma_\mu$), equation (19) can be written as:

(20) $L_2 = \Phi[(\theta Y - \Omega Z)/\Pi]$,

where Φ[.] is the univariate cumulative standard normal distribution function. The portions of the likelihood function (L_1 and L_2) derived above are found in Heckman's (1974) paper. Below, the portions corresponding to conditions (10) and (11), the conditions not considered by Heckman (1974), are derived. In these cases, we observe the fixed work hours $f = T - L^*$, and the wage rate w. Although similar to the case where hours adjust freely, this case differs because at observed fixed work hours f, the reduced form hours of labor equation given by (14) does not hold. Note that the wage equation given by (15) does hold. The likelihood function for the sample of over-employed workers (L_3) can be written as:

(21) $L_3 = \Pr(W^*|_{h=0} < w \leq W_i^*|_{h=f} \mid w = \Omega Z + \mu) * \Pr(w = \Omega Z + \mu)$.

Since w is observed, (21) can be written as:

(22) $L_3 = \Pr(W^*|_{h=0} < w \leq W^*|_{h=f}) \Pr(w = \Omega Z + \mu)$,

where the first term on the right hand side of (22) is:

$$\Pr(W^*|_{h=0} < w \leq W^*|_{h=f}) = \Phi([\theta Y + \beta_1 f - \Omega Z]/\Gamma) - \Phi([\theta Y - \Omega Z]/\Gamma),$$

and the second term on the right hand side is:

$$\Pr(w = \Omega Z + \mu) = \varnothing([w - \Omega Z]/\sigma_\mu),$$

where $\varnothing(.)$ denotes the univariate standard normal probability density function.

The likelihood function for the sample of under-employed workers (L_4) is derived in a similar manner:

(23) $L_4 = \Pr(W^*|_{h=f} < w \leq W^*|_{h=T} \mid w = \Omega Z + \mu) * \Pr(w = \Omega Z + \mu)$,

where the first term on the right hand side of (23) is:

$$\Phi([\theta Y + \beta_1 T - \Omega Z]/\Gamma) - \Phi([\theta Y + \beta_1 f - \Omega Z]/\Gamma),$$

and the second term on the right hand side of (23) is:

$$\varnothing([w - \Omega Z]/\sigma_\mu).$$

Assuming that the sample size is N, the entire likelihood function (L) can be written as:

N δ_{i1} δ_{i2} δ_{i3} δ_{i4}

(24) $L = \prod_{I=1} (L_1) \quad (L_2) \quad (L_3) \quad (L_4)$

where

$$\delta_{ij} = \begin{cases} 1 \text{ if person I is in labor choice group j (j=1,...,4),} \\ 0 \text{ otherwise.} \end{cases}$$

An Empirical Application

This section presents the results of an empirical application with a recreation demand emphasis. First, the extended Heckman model is estimated and shadow wages are computed for each individual. Next, a discrete-count travel cost model of river recreation is estimated using shadow wages as the opportunity cost of travel time. For purposes of comparison, this model is compared with other discrete-count models estimated using different approaches to account for the opportunity cost of time including fractions of the wage rate and a hedonic wage model.

Data

Data for the application comes from a component of the 1994 National Survey of Recreation and the Environment (NSRE). The survey focused on water based recreational activities[3] and contains demographic data that was collected specifically for the proposed time valuation procedure. The NSRE data contain complete and detailed annual trip and demographic information for 1510 respondents from four

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[3]The original survey data contain information about trips to both lakes and rivers. For brevity, we limit the models to only river recreation.

regions of the U.S.[4] The survey was administered by telephone using a random digit dialing procedure. The Indiana region includes Indianapolis, while the other three regions are predominantly rural.

A series of questions place respondents into one of the four labor categories described above. Each respondent was first asked whether they were employed: "*Are you currently employed*?" (70% responded yes). Employed individuals were then asked "*do you work a fixed hour schedule, such as 9 to 5 Monday through Friday, or are you free to choose when and how long you work*?". Those who responded that they were free to choose are treated as interior solutions shown in Figure 2 (199 persons fall into this category). Fixed schedule respondents who are paid an hourly wage were then asked "*would you be willing to work fewer hours in order to have more free time*?". Those not earning an hourly wage and working a fixed schedule were asked instead "*would you be willing to work fewer hours for a proportionally lower salary in order to have more free time? For example: if you worked 20% fewer days, you're income would also drop by 20%*" About half (212) of the respondents answered yes to this question and are classified as over-employed. The remainder (191) are classified as being under-employed.[5]

Approximately 30% (447) of the respondents reported taking one or more trips

[4]Approximately equal sample sizes were randomly drawn from locations in Washington, Pennsylvania, Indiana and Nebraska.

[5]Admittedly, this assumes that all individuals possessing fixed hour jobs are not working the number of hours they desire. We make this assumption rather than increase respondent burden by asking fixed hour workers rather they would vary their working hours if they had the opportunity

to a river for recreation purposes. Physical conditions of the sites visited are described by data from the 1992 National Resources Inventory (NRI). The 1992 NRI is the most recent of a series of inventories conducted every five years by the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS). It contains information on the status, condition, and trends of land, soil, water and related resources on non-Federal land in the U.S. The information is available on the basis of aggregated sub-county regions which constitute trip destinations in this application (see Feather and Hellerstein, 1997 for more details).

Opportunity Cost of Time Estimates

Explanatory variables used in the time cost model are similar to those used by Heckman (1974). The dependent variable, the natural logarithm of the wage rate, is assumed to depend on the respondent's age, gender, years of education and location described by regional dummy variables. The shadow wage is assumed to depend on the respondent's family size, non-labor income (i.e., household income less respondent income), gender, and weekly work hours (labor supply). Full information maximum likelihood estimates appear in the first column of Table 1. The coefficients are of the anticipated sign and, with the exception of family size, are statistically different from zero. The labor supply (weekly hours worked) and non-labor income parameters have the anticipated positive sign while the dummy variable for gender has a positive influence on market wages, but a negative influence on shadow wages. This suggests that males are paid higher wages on average, but have lower shadow wages than females. The parameters of the age variable, a proxy for experience and the education variable, a measure of human capital, have the anticipated positive sign. Family size, a factor that was anticipated to be positively correlated with the shadow wage is not significantly different from zero. The dummy variables used to capture any regional disparities in wage rates are similar in magnitude and significance with the exception of the Nebraska dummy variable which is smaller in magnitude than for the other three states.

For purposes of comparison, parameter estimates from a hedonic wage model similar to one advocated by Smith et al. (1984) appear in the second column of Table 1[6]. This equation was estimated by regressing the natural logarithm of the wage rate on regional dummy variables, age, gender and education. The signs and magnitude of the parameters are similar to those of the proposed model. These "wage equation parameters" are used to predict the "hedonic wage rate" while the "shadow wage equation parameters" are used to predict the opportunity cost of time (shadow wage) from the proposed model.

Average predictions of shadow wages and hedonic wages from the two models broken down by labor supply category appear in Table 2. Observed wages are listed in the third column of the table. On average, the proposed model predicts wages that are slightly lower than the observed wage rate and the wage rate predicted by the hedonic

[6]These authors estimated a hedonic wage equation from a secondary data source because their recreation data lacked wage rate information. This is a slightly different approach than the one taken here where the equation is estimated using the employed portion of the sample. This approach does allow one to estimate "wage" rates for persons reporting to be unemployed.

model. When the sample is restricted to employed respondents, the results show that the predicted shadow wage is substantially larger than the hedonic wage, but slightly lower than the observed wage. The next four rows of the table show predictions by the four labor classes considered in the proposed procedure. These categories effect the magnitude of both the shadow wage estimates and the observed market wages, but have little impact on the hedonic estimates. The hedonic procedure invariably predicts wages approximately at the sample mean with little variance compared to the actual wage data and the predicted shadow wage estimates. The results for the over-employment case and the under-employment case agree with the conditions in (10) and (11) respectively. The shadow wage (evaluated at observed hours worked) exceeds the market wage in the over-employed case, while the opposite is true for the under-employed case.[7] If individuals can freely adjust their work hours, the proposed approach posits that the shadow wage (evaluated at observed hours worked) should equal the observed wage. Although this does not hold exactly, the proposed approach comes closer to meeting this condition than does the hedonic approach. Finally, the proposed procedure predicts very low shadow wages for the unemployed. This occurs because the shadow wage predictions for these individuals occurs at zero hours of work.

[7]Although not included in Table 2, the shadow wage estimates were also found to be consistent with the other portions of the inequalities shown in (10) and (11). The values of the shadow wage (on average) evaluated at zero hours work in the over-employment case (maximum observed hours of work in the under-employment case) were found to be less than (greater than) the observed wage rate.

Travel Cost Model Estimates

The discrete-count model used in this application was originally proposed by Feather et al. (1995)[8]. The first stage is a random utility model (RUM) describing the choice of destination on a recreational outing. The utility person k receives from visiting site l [U_{lk}] is written as:

(25) $U_{lk} = V_{lk} + \epsilon_{lk}$, $l = 1,...,L \quad k = 1,...,N$

where V_{lk} is the deterministic portion of the utility function and ϵ_{lk} is an and i.i.d. extreme value random variable with mode zero and scale parameter μ. Typically, V_{lk} is written as a linear function of income (Y_k), the cost incurred in visiting the l-th alternative (C_{lk}), and a vector of characteristics describing the l-th alternative ($\mathbf{b}_l=[b_{l1},...,b_{lm}]$):

(26) $V_{lk} = \beta(Y_k-C_{lk}) + \Theta\mathbf{b}_l$,

where β and $\Theta = [\Theta_1,...,\Theta_m]$ are parameters to be estimated. It is well known that the parameters of V_{lk} can be estimated using a multinomial logit model:

(27) $P_k(l) = \exp(\mu V_{lk})/\Sigma_j \exp(\mu V_{jk})$ $j = 1,...,L$

where $P_k(l)$ is the probability of individual k choosing elemental alternative l.

Parameter estimates appear in Table 3. Five models are estimated under different assumptions regarding the opportunity cost of travel time. The first model assigns zero value to the cost of travel time. The next two value time at 33% and 100%

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[8]The choice of which discrete-count formulation is arbitrary. No consensus on the appropriate approach exists in the literature at this time. Advocating one of the competing methods is beyond the intended scope of this paper. Other models such as those found in Parsons and Kealy (1995), Hausman et al. (1995), or Bockstael et al. (1987) would also be appropriate

of the observed wage rate respectively. The final two value time at the predicted hedonic wage rate and the predicted shadow wage rate respectively. In each model, trip cost is significant and negative, indicating that respondents prefer closer locations. Predictably, the magnitude of this parameter varies depending on how travel time is valued. The parameters associated with percentage of forested area, which is assumed to be a positive attribute, are unexpectedly negative. This may indicate that heavily forested areas are less accessible to recreationalists. Parameters associated with the percentage of privately owned land, which is assumed to represent a lack of recreational opportunities, are negative as anticipated. Average ambient soil erosion has an anticipated negative sign, suggesting that more water-based recreation occurs in areas with low erosion rates. The final variable, Log(Size), is the correction factor for aggregation bias[9].

The strength of the RUM is that it captures substitution among competing sites when quality changes occur. The drawback of the RUM is that it is unable to account for changes in the total quantity of trips when changes in site quality occur. Both of these questions are important because quality changes presumably create two effects: substitution among sites and changes in total or seasonal participation. To better address the participation component of the problem, a secondary participation model is often estimated. These models allow for changes in participation to occur when

[9] Since the destinations of these trips are sub-county aggregated sites, “aggregation bias” occurs which is reduced by the inclusion of a size variable (see Ben-Akiva and Lerman, 1985). The correction factor is meters of river length in each area. This variable was collected from a geographic information system mapping coverage of lakes and rivers in the U.S. on a 1:200,000 scale. See Feather and Hellerstein (1997) for details.

changes in site quality occur. The approach used here consists of estimating total participation, (T_k), as a function of expected trip costs, $E(C_k)$, expected destination qualities, $E(\mathbf{b}_k)$, Income, Y_k, and socio-economic variables, $\mathbf{S}$:

(28) $T_k = f(E(C_k),E(\mathbf{b}_k),Y_k,\mathbf{S})$.

Expected costs and qualities are calculated from the first stage RUM:

(29) $E(C_k)=\Sigma_i P_k(I)C_{ik}$,

(30) $E(\mathbf{b}_k)=\Sigma_i P_k(I)b_i$,

where k indexes individuals and I indexes aggregate alternatives. Participation is assumed to be directly related to expected quality and inversely related to expected costs. Changes in destination quality change destination probabilities in (27), which change expected costs and qualities in (29) and (30). Treating (28) as a demand equation allows for conventional welfare measures to be computed. To accommodate decisions of zero and nonzero participation, (28) is estimated using a double hurdle count model (Yen, 1993; Shonkwiler and Shaw, 1996). This model assumes that two "hurdles", or different vectors of variables, determine consumption. The first ($\mathbf{Z}_k$) depends on mainly demographic variables (age, gender, education, etc.) while the second ($\mathbf{X}_k$) depends mainly on economic variables (price, quality, etc.)[10]. Let DP_k denote the latent decision to participate where participation (T_k) equals zero if $DP_k \leq 0$:

(31) $E(DP_k) = \Gamma_k = \exp(\mathbf{Z}_k'\tau)$,

Where τ is a vector of parameters to be estimated. When observed participation is

[10]This specification assumes that the two hurdles are independent of one another. This assumption can be relaxed to, for example, allow site quality to influence both hurdles. These types of models are discussed in Shonkwiler and Shaw (1996).

positive ($T_k > 0$), observed participation equals desired participation (T_k^*)

(32) $E(T_k^*) = \lambda_k = \exp(P_k\delta+\mathbf{X}_k'\alpha)$,

where P_k is the expected price (travel cost), $\mathbf{X}_k$ are expected quality variables and δ, α are parameters to be estimated. In the double hurdle poisson model, the probability of observing zero participation is

(33) $Pr(T_k = 0) = Pr(T_k^* \leq 0) + Pr(T_k^* > 0)Pr(DP_k \leq 0)$

$$= \exp(-\lambda_k)+(1-\exp(-\lambda_k))\exp(-\Gamma_k).$$

The probability of observing positive participation is

(34) $Pr(T_k > 0) = Pr(T_k^* > 0)Pr(T_k^*|T_k^* > 0)Pr(DP_k > 0)$

$$= (1-\exp(\Gamma_k))\exp(-\lambda_k)\lambda^{Tk}/T_k!.$$

The expected consumer surplus using the model is:

(35) $E(CS_k) = -(1-\exp(-\Gamma_k))*(\lambda_k/\delta)$.

Expected trip cost and quality, along with income, describe the intensity of participation ($\mathbf{X}_k$) variables in the double hurdle model. The variables affecting the decision to participate ($\mathbf{Z}_k$) are income, age, gender and education. The estimation results for the participation portion of the model appear on Table 4[11]. Higher incomes and levels of education are positively associated with participation, while age is negatively associated with participation. A gender dummy variable suggests that males tend to be participants more often than females. The second stage parameters appearing on Table 5 explain the decision of how much to participate. Expected cost is

[11] Since the participation parameters are independent of the intensity parameters, they are the same for each model and only appear once in Table 4.

negative and highly significant in each model and varies in magnitude depending on how travel time is valued. The remaining parameters are fairly stable across models. Individuals living near forest land and privately owned land participate more often. High levels of ambient soil erosion and higher incomes appear to inhibit avid participation.

Discussion

The last row in Table 5 shows the average annual expected consumer surplus for river recreation. This varies considerably depending on how the opportunity cost of travel time is determined. Treating travel time as costless results in the lowest estimate of $41.71 per year on average. Using one third of the wage rate to measure the opportunity cost of time results in an average annual consumer surplus of $51.99. This increases to $81.51 when 100% of the wage rate is used as the cost of travel time. This disproportionate change in consumer surplus highlights the inability of the wage rate to value time when individuals are unemployed. Approximately 30% of the respondents in the sample report that they are unemployed. Since these individuals do not have an observable wage, they are assigned zero value of time when time is valued using the wage rate or a fraction thereof.

The hedonic wage equation provides one alternative to this problem. By assigning all individuals a predicted wage, this approach deals with unemployed individuals in a more satisfactory manner. The results here indicate that the method tends to predict sample mean wages with little variation. This “smoothing” effect removes much of the variation in the opportunity cost of time estimates which is undesirable. The average consumer surplus using this approach is $67.46 per year which is almost exactly the midpoint between consumer surplus estimates based on 33% and 100% of the wage rate. This approach has the advantage of providing time costs for unemployed persons, but with little variation across individuals.

Results using the proposed approach appear in the last column of Table 5. The proposed shadow wage procedure results in the largest level of consumer surplus: $124.20 per year. Like the hedonic method, this approach has the strength of providing value of time estimates for both employed and unemployed respondents. Unlike the hedonic model, the proposed method is sensitive to each respondent’s labor market position which is likely to influence the opportunity cost of leisure time. This results in leisure time cost estimates with more variation. Most importantly, this model is specified to predict the opportunity cost of leisure time, not the wage rate.

Conclusions

Because time is likely to be at least as constraining as money in the decision to participate in recreational activities, modeling recreation demand often involves formulating a price that includes both time and money costs. Often, the observed wage rate is used as a proxy for the opportunity cost of time. This presents problems when individuals are not employed and have no observable wage. Even when the wage is observed, it may not be an accurate measure of the value of leisure time. If work time is discretionary, then it may be argued (Bockstael et al., 1987,) using a model such as Becker's (1965), that the wage rate measures the opportunity cost of leisure time. Even if this is true, the results of recent labor market surveys (Hahnel, 1998; Schor, 1991) suggest that this is the exception rather than the rule. Only 23% of the NSRE survey respondents used in this paper report discretionary work time.

An alternative to using the wage rate is to predict wages using a hedonic model. This provides time cost estimates for both employed and unemployed individuals. Time cost estimates using this approach tended to be centered around the mean with little variation in the empirical application. Using this method may have advantages over depending on the wage rate, but reducing variation in the estimates is undesirable.

Accurately determining the opportunity cost of time is an important consideration when modeling recreation demand. The results in Table 5 illustrate that the cost assigned to leisure time has a large impact on consumer surplus estimates. The estimates here differ by a factor of three depending on how this cost is determined. Both the wage rate and a hedonic model have drawbacks that are not found in the proposed procedure. Although the procedure requires additional survey information, we believe the increase in respondent burden is small in comparison to the refinement in estimating the opportunity cost of leisure time.

Table 1--- Value of Time Wage Estimation Results

Shadow wage equation variables[1]	Proposed model[2]	Hedonic model[3]
constant	-0.0739 (-0.55)	----
family size	0.0194 (0.60)	----
non-labor income	0.0084 (3.92)	----
gender	-0.4568 (-4.00)	----
labor supply	0.0600 (21.09)	----
standard deviation	1.1409 (18.15)	----
Wage equation variables		
IN dummy	0.8729 (3.97)	0.6758 (4.61)
NE dummy	0.7667 (3.38)	0.5286 (3.51)
PA dummy	0.8940 (3.96)	0.7255 (4.82)
WA dummy	0.8980 (3.99)	0.6920 (4.60)
age	0.0100 (3.94)	0.0114 (6.77)
gender	0.2032 (2.87)	0.2379 (5.78)
education	0.0797 (5.77)	0.0844 (9.14)
standard deviation	0.8914 (21.44)	----
error term correlation	0.3746 (18.15)	----
Log likelihood	-1321.69	-426.18

[1]Family size is the number of persons in the house including the respondent, non-labor income is family income less respondent income, gender equals one if the respondent is male and zero otherwise, labor supply is the number of hours worked per week, IN/NE/PA/WA dummy equals one if the respondent resides in IN/NE/PA/WA, zero otherwise, age is the respondent's age in years, education id the respondent's education in years.
[2] Full information maximum likelihood estimates with t-statistics for the null hypothesis that the parameter equals zero in parenthesis. Sample size is 864.
[3] Dependent variable of the natural logarithm of the wage rate. Sample was limited to employed persons. Sample size is 599. Regression R-square statistic is 0.238.

Table 2 --- Comparison of Mean Shadow Wage Estimates by Labor Group[1]

Employment Category	Proposed	Hedonic	Observed Wage
All	11.47 (17.78)	12.16 (3.97)	12.68 (70.10)
Employed	15.97 (19.61)	11.89 (3.50)	17.69 (83.30)
Over-Employed	15.95 (19.35)	11.47 (3.07)	14.98 (30.55)
Under-Employed	13.26 (11.93)	12.14 (3.72)	21.98 (36.66)
Flexible-Employed	18.86 (25.29)	12.01 (3.62)	15.72 (15.29)
Unemployed	1.00 (0.39)	12.80 (4.85)	0.00 (0.00)

[1] Standard deviations appear in parenthesis. Proposed shadow wage estimates are evaluated at observed hours of work.

Table 3 -- Random Utility Models of River Recreation[1]					
Parameter[2]	No value of time -- travel cost only	Value of time is 33% of the wage rate	Value of time is 100% of the wage rate	Value of time is 100% of the hedonic wage	Value of time is 100% of the shadow wage
Cost	-0.1309 (-90.21)	-0.0992 (90.00)	-0.0666 (-88.88)	-0.0778 (89.95)	-0.0816 (-88.47)
% Forest	-0.4750 (-5.20)	-0.4545 (4.99)	-0.4348 (-4.81)	-0.4890 (-5.35)	-0.4238 (-4.65)
% Private Own	-0.3142 (-4.54)	-0.3101 (-4.50)	-0.3048 (-2.23)	-0.3142 (-4.54)	-0.2865 (-4.18)
Erosion	-0.0111 (-1.76)	-0.0131 (-2.05)	-0.0144 (-2.23)	-0.0125 (-1.99)	-0.0118 (-1.81)
Ln(Size)	0.1142 (16.26)	0.1150 (16.43)	0.1150 (16.46)	0.1126 (15.95)	0.1112 (15.75)

[1] Estimated using a sample of 447 individuals averaging 10.8 river trips over the survey period. Most individuals visited more than one site over the survey period. The number of unique resident/location pairs is 772.
[2] Cost is round trip travel cost computed as $0.35/mile plus travel time times value of time. % Forest is the percentage of forested land. % Private Own is the percent of land privately owned. Erosion is the average soil erosion rate. Ln(size) is the natural logarithm of lake acres.t-statistics for the hypothesis that the parameter equals zero appear in parenthesis.

Table 4 --Double Hurdle Poisson Models of River Recreation: Participation Parameters[1]	
Parameter[2]	
Constant	-0.7567 (-4.36)
Family Income	0.0035 (1.49)
Age	-0.0186 (-6.05)
Gender	0.6567 (6.79)
College	0.0827 (0.76)

[1]These parameters are independent of variables used in the intensity portion of the doublehurdle model. Number of observations equal 1510.
[2]Constant is a constant term. Family Income is in $1000 units. Age is age in years. Gender equals one if the respondent is male; zero otherwise. College equals one if the respondent has a collegeeducation; zero otherwise. t-statistics for the hypothesis that the parameter equals zero appear in parenthesis.

Table 5 -- Double Hurdle Poisson Models of River Recreation: Intensity Parameters[1]					
Parameter[2]	No value of time -- travel cost only	Value of time is 33% of the wage rate	Value of time is 100% of the wage rate	Value of time is 100% of the hedonic wage	Value of time is 100% of the shadow wage
Constant	6.2326 (37.31)	6.2775 (37.10)	6.1734 (35.74)	6.2485 (37.83)	5.7854 (32.73)
E(Cost)	-0.1306 (-20.09)	-0.1044 (-20.65)	-0.0664 (-19.59)	-0.0804 (-20.96)	-0.0430 (-11.94)
E(% Forest)	0.8490 (12.79)	0.8618 (12.89)	0.8262 (12.29)	0.8671 (13.05)	0.6772 (10.32)
E(% Private Own)	1.1488 (8.35)	1.1476 (8.28)	0.9443 (6.90)	1.1175 (8.30)	-0.0052 (-0.40)
E(Erosion)	-0.0446 (-4.41)	-0.0309 (-2.99)	-0.0155 (-1.47)	-0.0369 (-3.71)	-0.0144 (-1.40)
E(Size)	-0.1938 (-16.37)	-0.1927 (-16.10)	-0.1841 (-15.13)	-0.1898 (-16.26)	-0.1603 (-13.20)
Family Income	-0.0058 (-10.12)	-0.0057 (-9.89)	-0.0053 (-9.33)	-0.0058 (-10.01)	-0.0056 (-9.87)
Average Consumer Surplus[3]	$41.71 (19.57)	$51.99 (24.41)	$81.51 (37.63)	$67.46 (31.98)	$124.20 (53.66)

[1] Estimated using a sample of 1510 individuals.
[2] E(Cost) is the expected round trip travel cost computed as $0.35/mile plus travel time times value of time. E(% Forest) is the expected percentage of forested land. E(% Private Own) is the expected percent of land privately owned. E(Erosion) is the expected average soil erosion rate. E(size) is the expected natural logarithm of lake acres.t-statistics for the hypothesis that the parameter equals zero appear in parenthesis.
[3]Average annual consumer surplus in one dollar units. Standard deviations appear in parenthesis.

Figure 1 --- Interior Solution

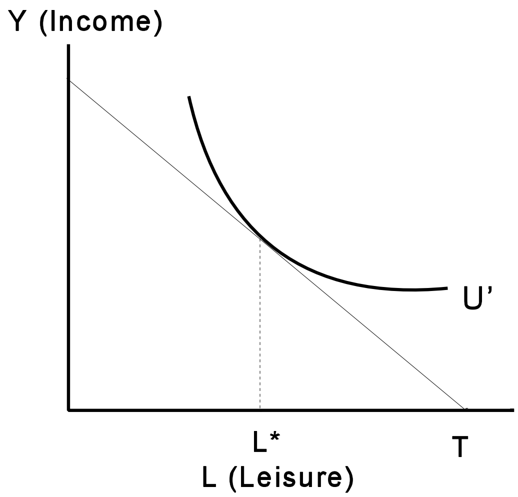


Figure 2 --- Corner Solution

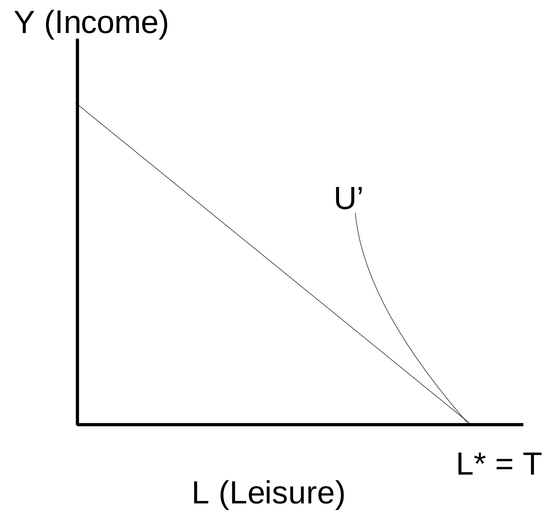


Figure 3 --- Over Employment

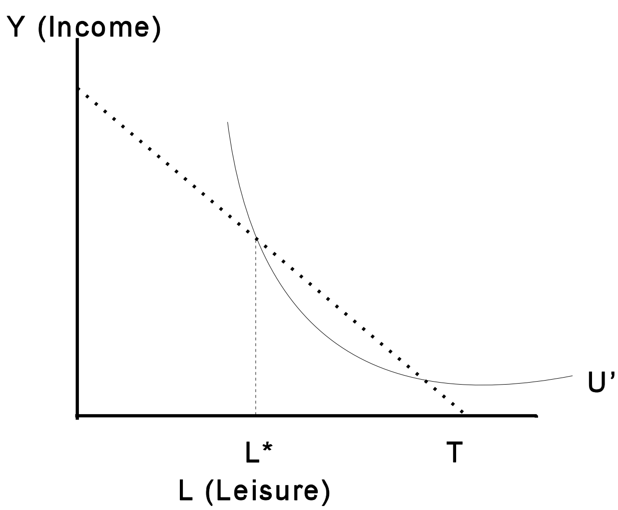
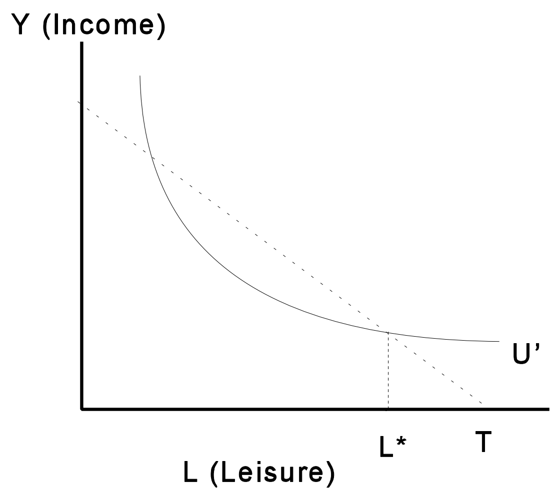


Figure 4 --- Under Employment



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