Valuing a Beach Day
Using a Repeated Nested Logit Model of Participation and Beach Choice[†]

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Abstract

Beach recreation values are often needed by policy-makers and resource managers to efficiently manage coastal resources, especially in popular coastal areas like Southern California. This paper presents welfare values derived from random utility maximization-based recreation demand models that explain an individual's decisions about whether or not to visit a beach and which beach to visit. The models are consistent with underlying time- and money-constrained choices and utilize labor market decisions to reveal each individual's opportunity cost of recreation time. The value of a beach day at San Diego County beaches is estimated to be between \$21 and \$26.

JEL Codes: Q26, J22, Q51

Introduction

What is a beach day worth? The value of a beach day is an important issue for a variety of reasons. In coastal areas around the country, beach recreation is a popular activity for many residents and for visitors. In southern coastal areas, such as Southern California, it is also a major cultural and economic activity. Consequently, efficiently managing coastal resources necessarily involves accounting for the value of beach recreation. Along these lines, economic values of beach use are needed to evaluate coastal projects and policies that may restrict or enhance beach recreation, such as beach closures resulting from sewage overflows or sand renourishment projects to widen beaches. Beach day values are also important in natural resource damage assessment (NRDA) cases where environmental accidents temporarily restrict recreation opportunities along the coastline, since lost or impaired recreation opportunities are an important component of the overall economic damages.

This paper presents beach day values for San Diego County in California, derived from random utility maximization-based recreation demand models that explain whether and where San Diego beach users choose to visit. These choice-based models are consistent with consumer choice subject to binding time and money constraints. Particular attention is given to the treatment of the time costs of recreation in these models. In contrast to the usually *ad hoc* ways of estimating the opportunity cost of time in recreation demand models, we estimate the shadow value of leisure time (SVLT) jointly with beach trips demand using information from beach users' labor market choices. Since the SVLT is a latent variable, it is treated as stochastic in the estimation. This is a natural way to generate correlated choices in a fixed parameter choice model; as a result, choice probabilities do not exhibit the well-known Independence of Irrelevant Alternatives (IIA) property symptomatic of standard multinomial logit models.

The beach demand model is a repeated nested logit model of beach recreation participation and site choice that explicitly accounts for unobserved opportunity costs of time using information from labor market choices. Using data collected from San Diego County residents, the model is used to estimate the economic value of a beach day. It presents both empirical and conceptual advances to the state of the art of estimating beach demand. Empirically, it provides new estimates of economic values for San Diego County beaches, which are among the most heavily used in the country. Conceptually, it advances the repeated nested logit recreation demand framework by rigorously incorporating time constraints to choice and jointly estimating a stochastic opportunity cost of time along with beach participation choices.

Economic Values of Beach Recreation

Since beach recreation is not traded in markets with explicit prices, its economic value is not easily observed. The primary methods used in the valuation of beach recreation are the travel cost model and contingent valuation method. Deacon and Kolstad (2000) review several studies that value saltwater beach recreation with values ranging from $0.41 to $13.00 per day (in 1990 dollars). Most past studies have focused on estimating recreational beach values for East Coast beaches. These include beaches in New Jersey (Silberman and Klock, 1988; Leeworthy and Wiley, 1991), Florida (Bell and Leeworthy, 1990), Rhode Island (McConnell, 1977), and Massachusetts (Hanemann, 1978; Binkley and Hanemann, 1978; McConnell, 1992).

The current supply of California beach recreational value information useful for policy purposes is limited. In the *American Trader* oil spill case, for instance, experts were unable to find suitable California beach values to assess beach recreation losses in Orange County in Southern California, instead using values for Florida beach recreation (Chapman and Hanemann, 2001). In fact, very few California beach value estimates exist, and even fewer provide estimates from theoretically-consistent models. For instance, Leeworthy and Wiley (1993)[1] reports several estimates of the value of beach recreation for three Southern California beach areas (Santa Monica, Leo Carillo, and Cabrillo-Long Beach) generated from recreation surveys conducted by the National Oceanic and Atmospheric Administration (NOAA). Beach values ranged from \$8.16 to \$146.97 per person per day (in 1989 dollars), and varied significantly over sites and over assumptions about the opportunity cost of travel time. However, estimates were generated from simple travel cost demand models that ignored substitute sites and income effects and consequently do not provide reliable beach value estimates.[2]

Lew and Larson (2005b) provide estimates of the value of a beach trip from a theoretically-consistent recreational choice model, but do not account for an important component of recreational choices—the decision of whether or not to visit a beach. Consequently, the reported values likely overestimate the value of a beach day.

The Role of Time in Recreational Choices: A Framework

This section explains the conceptual and empirical models that form the components of the joint model used to estimate the value of a beach day. First, the labor supply model under both equilibrium and disequilibrium conditions is introduced, then it is integrated into a model of whether and where to go to the beach.

[1] In addition, Leeworthy, Schruefer, and Wiley (1990) use contingent valuation to estimate willingness-to-pay for access to five California beaches. Also, a study of coastal beach recreation in five California counties (Los Angeles, Ventura, Orange, San Luis Obispo, and Santa Barbara) is currently being conducted by Professors Michael Hanemann and Michael Ward, and Mr. James Hilger, at UC Berkeley, Professor David Layton at University of Washington, and Professor Linwood Pendleton at UCLA.

[2] The authors note that due to widespread item non-response the demand specification excluded income.

The opportunity cost of time spent traveling to and from the beach is a real cost that must be accounted for as part of the price of going to the beach.[3] The time cost is the amount of time required for travel multiplied by its per-hour opportunity cost, which will vary depending on what alternative activity is foregone in lieu of going to the beach. This opportunity cost, or shadow value of leisure time (SVLT), is a measure of the value of a unit of time spent in non-work activities, and as a rule is not directly observable.[4] Often, the wage rate is used as a proxy for the SVLT, although this is problematic because it does not reflect the true opportunity cost of leisure time for workers facing fixed work schedules (Bockstael, Hanemann, and Strand, 1987).

In recent years, economists have recognized that people's observed decisions in the face of both time and money costs, made in the labor market and elsewhere, can be used to more accurately measure the SVLT than simple appeals to wage information. Feather and Shaw (2000) extended the labor supply model of Heckman (1974) to estimate a SVLT for both non-workers and workers, including those with fixed work schedules. This modified Heckman model provides a more accurate measure of the SVLT since it accounts for both non-workers and constraints on workers who are unable to work flexible hours and hence trade recreation time for work time. We employ a version of this model using a specification for the SVLT function that is consistent with the underlying theoretical model (Larson and Shaikh, 2001).

Following Feather and Shaw, labor market participants can fall into one of four categories: workers with flexible work schedules, non-workers, overemployed workers, and underemployed workers. Flexible-schedule workers are able to adjust their work schedules to permit more time for either work or leisure. Non-workers include students, homemakers, and

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[3] Failure to account for time costs in economic models of recreation behavior has been shown to lead to biased economic values (Cesario and Knetsch, 1970).
[4] The appropriate SVLT to use in recreation decision models has been a matter of contention in the literature (McConnell and Strand, 1981; Bockstael, Strand, and Hanemann, 1987; Shaw, 1992) and is discussed in more detail in Lew (2002).

other unemployed persons. Overemployed and underemployed workers have fixed work weeks, with overemployed individuals working more hours than they would optimally choose and underemployed individuals working fewer.

In the labor supply model, each type of individual is viewed as making a tradeoff between the SVLT, which in general depends on hours worked and other demographics, and the market wage, which is a function of labor market conditions and demographics. Under the maintained assumption that work time does not yield utility, the SVLT for flexible schedule workers is their wage, since they are able to adjust hours worked to balance the benefits of leisure with the benefit of another hour worked. Those who are unemployed must have a SVLT that exceeds the available wage rate; for if this was not true, the individual would prefer to work. The SVLT of overemployed workers is greater than the wage; since they would prefer more leisure time, its value at the margin is higher. The opposite is true for underemployed workers: their SVLT is less than the wage at the current number of hours worked.

To see how the SVLT enters recreation decisions, consider the following model of recreation choice. When time is an important determinant of choice, the consumer is presumed to maximize utility subject to both money income and time constraints.[5] To focus attention on both discrete recreation site choices and labor supply, assume first that the individual has chosen to visit the jth site alternative available and let h be hours worked. Working pays a marginal wage w, while beach alternative j has a money cost of p_j and a time price t_j. Other activities chosen during the same period, $\boldsymbol{x} = [x_1, \ldots, x_m]$, have money costs $\boldsymbol{p} = [p_1, \ldots, p_m]$ and time costs $\boldsymbol{t} =$

[5] Similar money and time-constrained recreation demand models were explored by Bockstael, Strand, and Hanemann (1987), Smith (1986), McConnell (1992), Larson (1993), and Larson and Shaikh (2001).

$[t_1, \ldots, t_m]$.[6] The consumer wishes to maximize the conditional utility function $U_j(\boldsymbol{x})$ by choosing activities $\boldsymbol{x}$ along with labor supply (h).. This can be represented by the Lagrangian

$$L_j \equiv \max_{\boldsymbol{\alpha}} \; U_j(\boldsymbol{x}) + \lambda_j\,[A + w \cdot h - p_j - \boldsymbol{p} \cdot \boldsymbol{x}] + \mu_j\,[T' - h - t_j - \boldsymbol{t} \cdot \boldsymbol{x}], \qquad (1)$$

where A is non-wage income, T' is the total time allotment, and $\boldsymbol{\alpha} \equiv [\mathbf{x}, \mathrm{h}]$ for flexible-schedule workers who can choose the hours they work and $\boldsymbol{\alpha} \equiv [\mathbf{x}]$ for all others. A key issue for specifying the beach choice model is whether the consumer is in equilibrium in the labor market, as this determines how the opportunity cost of time is handled.

Labor Market Equilibrium

When hours (h) are chosen freely, the first-order conditions that solve equation (1) reveal that the SVLT (ρ_j) equals the discretionary wage, and other goods $\boldsymbol{x}$ are chosen so that their marginal values equal their full marginal costs. Since the wage rate does not vary across recreation site alternatives for each individual, the value of the function ρ_j is constant across choices, though the form of the functions need not be the same.

The first-order conditions can be solved for the optimized values of the choice variables $x_j(\boldsymbol{p}, \boldsymbol{t}, A, T')$ and the SVLT, $\rho_j(\boldsymbol{p}, \boldsymbol{t}, A, T') \equiv \mu_j/\lambda_j$, which is in general a function of all parameters of the problem. Bockstael, Strand, and Hanemann (1987) have noted that because hours are

[6] It is assumed that the vector $\mathbf{x}$ includes both a time and money numeraire good to ensure that the budget constraints bind. The time numeraire good is time costly, but not money costly, while the converse is true of the money numeraire good.

chosen freely and the SVLT equals the discretionary wage w, the optimal demands are functions of the form

$$\boldsymbol{x}_j(\boldsymbol{p}, \boldsymbol{t}, A, T') = \boldsymbol{x}_j(\boldsymbol{p} + w \cdot \boldsymbol{t}, A + w \cdot T'); \tag{2}$$

that is, they are functions of the full prices $\boldsymbol{p} + w \cdot \boldsymbol{t}$ and full income $A + w \cdot T'$, with the market wage w as the terms of trade between time and money. Substituting the optimal demands (2) into the utility function yields the conditional indirect utility functions $V_j(\boldsymbol{p} + w \cdot \boldsymbol{t}, A + w \cdot T')$ that give the maximum utility if the jth beach is chosen.

Labor Market Disequilibrium

When individuals are not working or have fixed rigid work schedules, they do not choose the number of hours they work per week. The key difference is that the SVLT is no longer equal to the discretionary wage rate, but instead they have the following relationships:

(unemployed)	$w < \rho_j$	if $h^* = 0$	(3)
(overemployed)	$w < \rho_j$	if $h^* < h'$	(4)
(underemployed)	$w > \rho_j$	if $h^* > h'$	(5)

where h^* is the number of work hours the individual would have optimally chosen. The over- and underemployed cases in equations (4) and (5) represent the extension by Feather and Shaw of the Heckman labor supply model.

Larson and Shaikh (2001) studied the implications of the two-constraint consumer choice problem for the specification of demands and the SVLT. They showed that even though the SVLT is an endogenous function of the parameters of the problem under labor market disequilibrium, when the conditional demand and indirect utilities are functions of the full prices and full budgets, i.e.,

$$\boldsymbol{x}_j(\boldsymbol{p}, \boldsymbol{t}, M, T) = \boldsymbol{x}_j(\boldsymbol{p} + \rho \cdot \boldsymbol{t}, M + \rho \cdot T); \tag{6}$$

and

$$V_j = V_j(\boldsymbol{p} + \rho \cdot \boldsymbol{t}, M + \rho \cdot T), \tag{7}$$

the restrictions implied by two binding constraints are satisfied.[7] In equations (6) and (7), the SVLT, ρ, must satisfy symmetry conditions, M is money income ($A + w \cdot h'$), and T is discretionary leisure time ($T' - h'$). These results provide a basis for specifying the SVLT function when the labor supply choice is in disequilibrium, and permits it to be estimated jointly with the choice probabilities in a discrete choice model.

The SVLT for the ith individual is specified as

$$\rho_i = \rho(M, T, s_1) = \rho(w \cdot h + A, T' - h, s_1)$$

$$= \frac{w \cdot h_i + A_i}{T_i' - h_i} \cdot \exp(\beta' s_{1i}) + \varepsilon_i, \qquad \forall i = 1, \ldots, \mathrm{N}, \tag{8}$$

[7] Two binding resource constraints imply two forms of Roy's Identity, which impose additional structure on preferences.

where $\mathbf{s}_{1i}$ is the individual's SVLT shifters and ε_i is a normally distributed disturbance term. This SVLT specification is consistent with the underlying two-constraint choice problem. The function is positive-valued and increasing at an increasing rate in hours worked, indicating that the marginal value of non-work time increases as the individual works more. Several recent studies provide evidence that the SVLT is conditional on demographic variables such as gender and household size (Larson and Shaikh, 2004; Larson, Shaikh, and Layton, 2004; Lew, 2002).

The Heckman-Feather-Shaw labor supply model estimates both a market wage function and a shadow value of leisure time function for four classes of people: workers who can vary hours, the overemployed, the underemployed, and non-workers. Following the Heckman motivation of the labor supply choice, let the market wage function be $W(\boldsymbol{s}_2)$, where $\boldsymbol{s}_2$ is a vector of exogenous variables. At equilibrium, the observed wage (w) equals the market wage rate, $w = W(\boldsymbol{s}_2)$. The equilibrium conditions for the four classes of workers are then

(flexible hours) $$w = W(\boldsymbol{s}_2) = \rho(w \cdot h + A, T' - h, \boldsymbol{s}_1) \quad (9)$$

(unemployed) $$W(\boldsymbol{s}_2) \le \rho(A, T', \boldsymbol{s}_1) \quad (10)$$

(overemployed) $$\rho(A, T', \boldsymbol{s}_1) < \mathrm{w} = W(\boldsymbol{s}_2) < \rho(A + W(\boldsymbol{s}_2) \cdot h, T' - h, \boldsymbol{s}_1) \quad (11)$$

(underemployed) $$\rho(A + W(\boldsymbol{s}_2) \cdot h, T' - h, \boldsymbol{s}_1) \le w = W(\boldsymbol{s}_2) \quad (12)$$

The market wage equation for the ith individual is specified as

$$W_i = \exp(\boldsymbol{\alpha}' \boldsymbol{s}_{2i}) + e_i \qquad \forall i = 1, \ldots, N, \quad (13)$$

where α is a vector of parameters and e_i is a normally distributed disturbance term. Empirical studies suggest the market wage is positively influenced by labor market participants' education and experience (Mincer, 1974). Additionally, numerous studies have found that wages differ by gender (e.g., Gunderson [1989]), with males earning higher wages than females, *ceteris paribus*. Thus, the variables assumed to shift the market wage are age (serving as a proxy for experience), education, and gender.

The errors, e_i and ε_i, are assumed to be bivariate normal distributed disturbances each with zero means and standard deviations, σ_e and σ_ε, respectively, and a correlation coefficient r. Given the stochastic assumptions and equilibrium conditions in the labor market, the probability of observing a flexible schedule worker (L_1), non-worker (L_2), overemployed worker (L_3), or underemployed worker (L_4) can be calculated, and are presented in Table 1. With the exception of L_1, the probabilities are written in terms of the standard normal cumulative distribution function (Φ) and probability density function (ϕ). The component of the log-likelihood function associated with the labor supply model is

$$LL^{HFS} = \sum_{i=1}^{N} \sum_{k=1}^{4} D_{ki} \cdot \ln L_{ki}), \tag{14}$$

where D_{ki} is 1 if the ith individual is in the kth labor class and 0 otherwise, where $k = 1, 2, 3, 4$, corresponding to flexible hours, non-workers, overemployed, and underemployed, respectively.

A Repeated Nested Logit Model of Participation and Site Choice

Beach users' values for recreation are revealed through two choices made in each choice occasion: whether or not to visit a beach (the participation decision) and which beach to visit (site choice decision). These decisions depend upon the (time and money) costs of visiting each beach, the features of the beaches that are important to their recreation experience, and the non-beach recreation opportunities available. This two-stage decision process can be modeled over the season using a repeated nested multinomial logit (RL) model (Morey, Rowe, and Watson, 1993). This is an extension of the commonly-used nested multinomial logit model (NMNL) (e.g., Morey [1999]).

In contrast to previous NMNL models of recreational participation and site choice, in this application the SVLT is treated as stochastic in the recreation decision. Lew and Larson (2005a) showed that ignoring the stochastic nature of unobserved opportunity costs of time in discrete-choice recreation demand models leads to biased parameter estimates, and hence biased welfare estimates. In this paper, labor market information and recreational choice decisions are combined to estimate stochastic SVLT value functions.

The season is divided into T choice occasions. In each choice occasion, the individual can choose to participate and visit one of J beach sites, or not participate. In the participation decision, we specify the conditional utility for the ith individual not going to any beach in the tth choice occasion as U_{i0t}.[8] This utility is assumed to be the sum of a deterministic component, $V_{i0t} = \alpha_0 + \boldsymbol{\delta} \cdot z_{it}$,[9] which is a function of a vector of observable individual-specific characteristics (z_{it}), and a disturbance term, ξ_{i0t}, that represents the variation in utility that is unobservable to the researcher, but known to the individual. The decision about whether or not to participate in

[8] U_{it0} is a reference level of utility for the individual, which does not vary across beach choices. It does, however, vary over individuals, and possibly time, which is why it is modeled as a function of individual characteristics.
[9] The assumption of linear-in-parameters conditional indirect utility is widespread in the literature.

beach recreation on a given occasion depends both on U_{i0t} and on the satisfaction of visiting beaches. We define the conditional indirect utility for the ith individual visiting the jth beach site on the tth choice occasion as

$$U_{ijt} = U_{ijt}(c_{ijt}, \mathbf{q}_{jt}; u_{ijt}) = V_{ijt}(c_{ijt}, \mathbf{q}_{jt}) + \xi_{ijt} = \theta \cdot c_{ijt} + \boldsymbol{\gamma} \cdot \mathbf{q}_{jt} + \xi_{ijt} \qquad (15)$$

where θ and $\boldsymbol{\gamma}$ are parameters to be estimated, c_{ijt} is the "full price" of visiting the jth beach (j = 1,…,J) by the ith individual (i = 1,…,N) on the tth choice occasion ($t = 1, ..., T$) $\mathbf{q}_{jt}$ is a vector of site attributes for the jth site at time t, and ξ_{ijt} is the econometric error. The full price of a visit to the beach properly includes both the time cost and the out-of-pocket money costs, and is written as $c_{ijt} = p_{ijt} + \rho_{it} \cdot t_{ijt}$, where p_{ijt} is the money costs of visiting beach j by individual i, t_{ijt} is the time required to visit site j by the ith individual at time t, and ρ_{it} is the money cost of the time spent for the ith individual in time t, i.e., his or her SVLT.[10]

For this two-level nested choice, the error associated with the ith individual's conditional indirect utility of the jth beach if choosing to visit a beach in time t, ξ_{ijt}, is assumed to follow a generalized extreme value (GEV) distribution.[11] For any individual and choice occasion (and

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[10] Although not explicitly shown in (15), a full budget (total monetary value of available time plus money budget) argument is implied, with a coefficient equal to -θ. This is because choice probabilities depend on utility differences and variables in this linear specification that do not vary across choice alternatives cancel out in the probabilities. So long as θ is non-negative, equation (15) satisfies the usual theoretical restrictions imposed by consumer theory (Lew, 2002).

[11] To derive the choice probabilities of the NMNL model for a two-level nested structure, assume the CDF is a special case of the generalized extreme value distribution (GEV) defined as:

$$F(\varepsilon_i) = \exp\left(-\exp(-\xi_0) - \left[\sum_{j=1}^{J} \exp(-d^{-1} \cdot \xi_j)\right]^d\right), \qquad \forall i = 0,\ldots,J,$$

where d is the dispersion parameter. When $0 \le d \le 1$, this CDF is globally well-defined and thus is consistent with stochastic utility maximization (McFadden, 1978).

dropping the individual and time notation, *i* and *t*, to simplify the exposition), the probability of choosing the *j*th beach is

$$\Pr(\text{choose site j} \mid \text{visit beach}) = \pi_j = \frac{\exp\left(\frac{V_j}{d}\right)\cdot\left[\sum_{i=1}^{J}\exp\left(\frac{V_i}{d}\right)\right]^{d-1}}{\exp(V_0)+\left[\sum_{i=1}^{J}\exp\left(\frac{V_i}{d}\right)\right]^{d}} \tag{16}$$

and the probability of not visiting a beach is

$$\Pr(\text{do not visit beach}) = \pi_0 = \frac{\exp(V_0)}{\exp(V_0)+\left[\sum_{i=1}^{J}\exp\left(\frac{V_i}{d}\right)\right]^{d}}, \tag{17}$$

where *d* is the dispersion parameter of the distribution. The parameter *d* is also known as the inclusive value parameter and measures the degree of substitutability between the non-participation and site choice decisions. It is the presence of these inclusive value parameters that relaxes the restrictive Independence from Irrelevant Alternatives (IIA) property of the MNL model across nests. Note that if $d = 1$, the NMNL model reduces to the MNL model.

Our estimation approach uses the additional information provided by labor market decisions to estimate the SVLT jointly with the recreation site choice decision by explicitly recognizing that the SVLT is observed with error in both the labor market and recreational choice decisions.

A principal concern with the NMNL approach is that it implies no correlation among choices within a nest such that, in this case, the site choice probabilities exhibit the IIA property.

A common way of relaxing this restrictive property in conditional logit models is to let the parameters of the model be random (e.g., Train, 1998). Explicitly modeling the stochastic SVLT in the beach choice model and jointly estimating it with the labor supply choice is another way of introducing random parameters, so that the choice probabilities do not suffer from IIA.

In this joint estimation model, the recreational choice probabilities are conditional upon the realized SVLT value for each individual. Thus, to estimate it, the probabilities must be evaluated over the distribution of SVLT values, resulting in a form of the mixed logit model (Brownstone and Train, 1996; Train, 1998). The individual-specific probabilities to be estimated for each choice occasion thus take the form:

$$\pi_j^s = \int \frac{\exp\left(\frac{V_j(\rho)}{d}\right)\cdot\left[\sum_{k=1}^{J}\exp\left(\frac{V_k(\rho)}{d}\right)\right]^{d-1}}{\exp(V_0)+\left[\sum_{k=1}^{J}\exp\left(\frac{V_k(\rho)}{d}\right)\right]^{d}}\cdot f(\rho\mid\Omega)d\rho \qquad \forall j=1,\ldots,\mathrm{J} \tag{18}$$

$$\pi_0^s = \int \frac{\exp(V_0)}{\exp(V_0)+\left[\sum_{k=1}^{J}\exp\left(\frac{V_k(\rho)}{d}\right)\right]^{d}}\cdot f(\rho\mid\Omega)d\rho\,, \tag{19}$$

where the conditional indirect utilities are functions of each individual's stochastic SVLT, and $f(\rho \mid \Omega)$ is the probability density function of the SVLT function with parameters Ω. The beach choice model can be estimated using simulated maximum likelihood to maximize the simulated log-likelihood function:

$$LL^s = \sum_{n=1}^{N}\sum_{t=1}^{T}\left(d_{nt0} \cdot \ln(\pi_{nt0}^s) + \sum_{j=1}^{J} d_{ntj} \cdot \ln(\pi_{ntj}^s) \right) \tag{20}$$

where d_{ntj} equals 1 when the nth individual chooses the jth beach in time t and 0 otherwise, d_{nt0} equals 1 when the *nth* individual chooses not to visit a beach in the tth time period and 0 otherwise.

Data

A telephone-mail-telephone survey was conducted on a sample of randomly chosen households in San Diego County during the period from January 2000 through March 2001. A preliminary phone interview was used to identify beach users who had gone recently (in the most recent two weeks) or were planning to go to the beach in the upcoming two weeks from the time of the interview. This one-month window of time was chosen to improve the respondents' recall about their recent beach experiences. Persons satisfying this requirement were asked whether they would participate in a follow-up interview that collected detailed information on recent beach experiences. Those who agreed were mailed a booklet that contained questions and information to prepare them for the follow-up phone interview.

Out of the 3,740 initial interviews completed[12], 1,105 were qualified beach users, who had visited a San Diego beach or were planning an upcoming trip within the one-month window. Only 8 percent of those initially interviewed were non-users who had not visited a San Diego County beach, or were not planning a future beach visit. Of the qualified beach users, 74 percent

[12] In total, 3,740 screener interviews were completed, 2,296 refused, and the remaining cases could not be contacted for a variety of reasons (e.g., phone number no longer in service). Given that 83 partial interviews were completed, the total number of individuals successfully contacted was 6,119. Since 3,740 completed the preliminary screening interview to identify qualified beach users, the cooperation rate was 61 percent.

agreed to participate in the follow-up interview. Unless reached before then, these individuals were called at least fifteen times (and up to 20 times) at varying times of the day for the follow-up interview after being sent the booklet. A total of 607 follow-up interviews were completed from this group. Of the 428 who did not complete follow-up interviews, there were 83 refusals and 2 partial interviews, and the remainder could not be contacted for a variety of reasons (e.g., invalid numbers).[13] Of the 607 beach users completing the follow-up interview, 494 provided sufficient information to be used to estimate the economic model. Table 2 provides a summary of several important characteristics of the sample.

The data set contains information on each respondent's trip visits to San Diego County bay or coastal beaches over the two-month period. The 31 San Diego County beach areas used for the analysis are listed in Table 3, which also shows the number of trips taken to each beach area. Pacific, Mission, and Ocean Beaches, all in the City of San Diego, were the most popular, accounting for about 37% of all beach trips in the sample.

Both the distances traveled and the time required to visit each beach were calculated for each individual using geographic information systems (GIS). Across the sample, the mean round-trip travel time for the most recent trip taken was 0.79 hours, or about 47 minutes. The monetary travel costs depended upon the mode of travel and the distance traveled. For those who drove to the beach (~85%), the cost per mile for vehicle travel calculated by the Southern California branch of the American Automobile Association of $0.146 was used (Automobile Club of Southern California, 2001).[14] The money costs per mile for non-automotive modes of travel are assumed to be zero, except for travel by boat (<1%), which is assumed to have the same cost per mile as driving. Those who walk (~12%) or bike (~2%) to the beach accrue time

[13] The cooperation rate, defined as the number of completed interviews (607) over the total number of cases successfully contacted (692), is 88%.
[14] The AAA cost per mile estimate accounts for gas and oil, maintenance, and tires.

costs of travel, but are assumed to have no out-of-pocket expenses. The travel costs were calculated for each beach area for each beach user.

Respondents were asked about their labor status, for use in modeling their labor market choices. Almost three-quarters of the sample were full- or part-time workers. Together with self-employed workers, about 80 percent of the sample indicated they worked, with the majority being full-time workers. The remaining 99 people, who categorized themselves as temporarily unemployed, students, homemakers, retired, or disabled and unable to work, are non-workers. With respect to the labor categories used in the empirical labor supply model, over a third (167 or 33.81 percent) of the sample had flexible work schedules. Almost half of all respondents (228 or 46.15 percent) faced fixed work schedules and were thus classified as either overemployed (95 or 19.23 percent) or underemployed (133 or 26.92 percent).

Results

Previous authors have reported on the sensitivity of welfare estimates to choice set considerations, particularly aggregation of smaller sites into larger sites (Parsons and Needleman, 1992; Feather, 1994). This is potentially an important issue in modeling beach recreation in areas like Southern California, where beach areas are often contiguous and multiple beach sites may be accessible on a single beach trip. To assess the effect of aggregating beach sites, two models were estimated that differ in the definition of the beach choice set. The *full sites model* uses all 31 beach sites enumerated in Table 3, and the *aggregate sites model* uses a smaller set of aggregate sites that combines contiguous beach areas into aggregate beaches, resulting in a choice set of 16 beach areas. Beaches lying within the city limits of the following municipalities were aggregated: Carlsbad, Encinitas, Solana Beach, Del Mar, La Jolla,[15] and San Diego.

The models were estimated using simulated maximum likelihood in GAUSS. The conditional indirect utility associated with site choices is assumed to depend upon the full price of travel to each beach and the length of each beach, while the factors assumed to affect participation decisions are the individual's gender, age, educational level, and household size. Table 4 presents the parameter estimates and associated asymptotic t-values for each model.

The estimated conditional utility parameters of the recreational choices (site choice and participation) are similar for both models. In the conditional site utility function, the price coefficient is negative and statistically different from zero, as expected, suggesting the probability of visiting a site diminishes with increased travel costs. The length coefficients are significant and of opposite sign, implying that the size of the beach matters: utility increases with length at a decreasing rate, all else being equal. The inclusive value index in both models is positive, significantly different from both zero and one, and in the range of values for which the model is consistent with stochastic utility maximization.

In the indirect utility function for non-participation, the constant, education, and household size are statistically different from zero at the 5% level in both models. The signs of these coefficients suggest that, *ceteris paribus*, individuals with less education or larger families are more likely to not visit the beach in any given choice occasion. In the full sites model, age is positive and statistically significant at the 10% level, indicating that older persons are less likely to visit the beach, while age is not statistically significant in the aggregate sites model. Gender is not significant in either model.

[15] Although part of San Diego proper, La Jolla was treated as a distinct area due to the physical separation of La Jolla beaches from other San Diego beaches.

The results for the labor supply model component are qualitatively the same across the models. In both models, the standard deviation in the SVLT function is statistically different from zero at conventional levels of significance. In the aggregate sites model, the constant and gender coefficient are also significantly different from zero, although household size is insignificant. The negative sign on gender implies that males have lower SVLT values compared to females, holding everything else constant. In the full sites model, the constant, gender, and household size coefficients are not statistically different from zero.

In both models, only the constants and standard deviations are statistically significant in the market wage function. Gender, age, and education do not seem to be statistically related to the market wage. The correlation coefficient, *r*, however, is statistically different from both zero and one in both models (0.41 in the full sites model and 0.23 in the aggregate sites model). This suggests that the SVLT and market wage errors are positively correlated, although not perfectly.

Although both models predict the same signs and similar magnitudes for all statistically significant coefficients, the model results are not identical. Several parameters that are not significant in the full sites model are significant in the aggregate sites model, and the Likelihood Ratio Index (LRI), which measures goodness-of-fit, associated with the aggregate sites model (0.624) exceeds the LRI for the full sites model (0.609).

Welfare Estimates

A goal of this paper is to estimate the value of a beach day using the model of repeated beach participation and site choice decisions. To this end, define $V(\boldsymbol{c}, \boldsymbol{q})$ as the individual's expected utility in a given time period for a given vector of costs and quality attributes. In the NMNL model, this is

$$V(\boldsymbol{c}, \boldsymbol{q}) = \ln\left[\exp(V_0) + \left[\sum_{i=1}^{J} \exp\left(\frac{V_i(c,q)}{d}\right)\right]^d\right] + 0.5772, \tag{21}$$

where 0.5772 is Euler's constant. The expected per-choice occasion compensating variation (*ECV*) associated with a change from price and quality levels ($\boldsymbol{c}^0$, $\boldsymbol{q}^0$) to new levels ($\boldsymbol{c}^1$, $\boldsymbol{q}^1$) is defined implicitly by the identity $V(\boldsymbol{c}^0, \boldsymbol{q}^0) \equiv V(\boldsymbol{c}^1 - ECV, \boldsymbol{q}^1)$. This measure of the value of a beach day accounts for the fact that an individual has the choice not to visit the beach on a given choice occasion. The seasonal expected compensating variation is calculated by summing the *ECV* over the *T* time periods making up the season. When income effects are present, *ECV* must be calculated numerically since it has no closed-form solution.

For the linear conditional indirect utility specification, there are no income effects and *ECV* has a closed-form solution, which reduces to

$$ECV = -\frac{1}{\theta} \cdot \left\{ \ln\left[\exp(V_0) + \left[\sum_{i=1}^{J} \exp\left(\frac{V_i(c_i^1, q_i^1)}{d}\right)\right]^d\right] - \ln\left[\exp(V_0) + \left[\sum_{i=1}^{J} \exp\left(\frac{V_i(c_i^0, q_i^0)}{d}\right)\right]^d\right]\right\}. \tag{22}$$

To evaluate the value of a beach choice occasion specifically, the change of interest is from ($\boldsymbol{c}^0$, $\boldsymbol{q}^0$) to (∞, $\boldsymbol{q}^0$); that is, we wish to evaluate the expected compensating variation associated with a change from the present trip prices to the prices that would choke demand to zero at all beaches. This leads to the following *ECV*:

$$ECV^{day} = -\frac{1}{\theta} \cdot \left\{ V_0 - \ln\left[\exp(V_0) + \left[\sum_{i=1}^{J} \exp\left(\frac{V_i(c_i^0, q_i^0)}{d}\right)\right]^d\right]\right\}. \tag{23}$$

Note, however, that these welfare measures do not account for the fact that SVLT is stochastic. To calculate welfare measures consistent with our empirical model, equation (23) must be evaluated over the distribution of SVLT values, i.e.,

$$ECV^{day} = \int -\frac{1}{\theta} \cdot \left\{ V_0 - \ln\left[\exp(V_0) + \left[\sum_{i=1}^{J} \exp\left(\frac{V_i(c_i^0, q_i^0 \mid \rho)}{d} \right) \right]^d \right] \right\} f(\rho \mid \Omega) d\rho, \quad (23')$$

which can be calculated numerically using equation (24):

$$ECV^{day} = R^{-1} \cdot \sum_{r=1}^{R} -\frac{1}{\theta} \cdot \left\{ V_0 - \ln\left[\exp(V_0) + \left[\sum_{i=1}^{J} \exp\left(\frac{V_i(c_i^0, q_i^0 \mid \rho^r)}{d} \right) \right]^d \right] \right\}. \quad (24)$$

where ρ^r is the rth draw from the SVLT distribution. The ECV^{day} calculated from equation (24) for each model are reported in Table 5, summarized across the sample of 494 beach users. The mean and median ECV^{day} across the sample using the full sites model estimates are \$20.99 and \$20.60, respectively, and for the aggregate sites model, are \$25.83 and \$25.42. Confidence intervals for the mean ECV^{day} for each model are estimated from simulated distributions following Krinsky and Robb (1986). These confidence intervals clearly show the means have skewed distributions, and also that they are not statistically different for the two models.

Previous work presented estimates of the value of a beach *trip* to beaches in San Diego County of approximately \$28 (Lew and Larson, 2005b). This individual beach day value differs from the more comprehensive measure of value presented in the present paper in that it is conditional on the individual having *chosen* to visit a beach (and thus involves solely modeling the choice between sites). To better compare them, an adjustment for the probability of not going to the beach (π^0) must be made. When the estimated (mean) probability of staying home of $\pi^0 = 0.7097$ is included, the previous study's estimate of the per-day value of beach access is approximately $0.29 \times \$28/\text{trip} \approx \$8$ per day, which is roughly one-third the magnitude of the estimates in the present study ($21-26 per day). The discrepancy between the $8 and $21-26 per day estimates can be explained by the fact that the $8 per day estimate does not incorporate the choice of not going to the beach in calculating the beach value, which has been shown to be statistically important in the results presented above. Neglecting the non-participation decision altogether consequently overestimates the value of a beach choice occasion (i.e., a day as defined for this model), and in our case, correcting for this omission after the fact leads to a significant underestimate of beach values.

Conclusions

This paper has developed and implemented a beach recreation model that jointly determines participation, site choices, and the shadow value of leisure time (SVLT). It is an extension of the repeated nested multinomial logit model that includes an endogenous function for the value of time. The structure of two-constraint optimization models provides guidance for how to specify and incorporate the SVLT within the repeated NMNL consistent with the requirements of theory. Allowing for error in specification of the SVLT generates a random parameters logit which induces correlation among the alternatives within nests, so the model does not suffer from the IIA property. To our knowledge, this is the first such application of the random parameters framework to a repeated nested logit model.

The model was estimated using data collected from households in San Diego County on their use of county beaches during 2000-2001. Two levels of aggregation are considered: a model with each of the 31 area beaches as a choice alternative, and a 16-beach model which aggregates nearby and contiguous beaches. Both models are highly significant with correct signs and significance on the key economic variables. Aggregation appears to help somewhat in the identification of the shadow wage equation, though not evidently in the market wage equation. It does not appear to impart a bias to welfare estimation, as the welfare estimates produced by the two models are not significantly different from one another.

The presence of a non-beach alternative in the model allows for the calculation of the per-day value of access to area beaches for county beach users. The compensating variation measure of this value is $21-$26 per day. This is a value per choice occasion (which is assumed to occur daily in this model, as the sample included beach users who went daily), which contrasts with previous estimates of the value of individual beaches that when expressed on comparable terms is approximately $8 per day. The difference between these two estimates is explained by departures in the way the participation decision is handled.

While this paper extends the repeated NMNL framework to better account for and jointly estimate the opportunity cost of time devoted to recreation, it has some of the same limitations. For example, the number of choice occasions is specified arbitrarily (though in a way to be consistent with the observed patterns of beach visits), and it is assumed that there is no correlation between choice occasions. While this model focused on how measurement error in the latent shadow value of leisure time can generate the more flexible random parameters version of the MNL model, it should be possible to allow more key economic parameters such as the marginal utility of income to be random as well.

Table 1. Probabilities of Observing Types of Labor Classes

Labor Classification	*Probability*

Flexible schedule worker

$$L_{1i} = \frac{1}{2\pi} \cdot \left|\det(\Sigma)\right|^{-1/2} \cdot \exp\left(-\frac{1}{2} \cdot \boldsymbol{D} \cdot \Sigma^{-1} \cdot \boldsymbol{D}' \right),$$

where $\boldsymbol{D}' =$

$$\left[\left(\frac{\exp(\boldsymbol{\acute{a}}'\boldsymbol{s}_{2i}) \cdot h_i + A_i}{T_i' - h_i} \cdot \exp(\beta'\boldsymbol{s}_{1i}) - \boldsymbol{\acute{a}}'\boldsymbol{s}_{2i} \right) , \boldsymbol{w}_i - \exp(\boldsymbol{\acute{a}}' \cdot \boldsymbol{s}_{2i}) \right],$$

$$\Sigma = \begin{bmatrix} B_i^2 \cdot \sigma_e^2 + \sigma_\varepsilon^2 - 2 \cdot B_i \cdot r \cdot \sigma_\varepsilon \cdot \sigma_e & B_i \cdot \sigma_e^2 - r \cdot \sigma_\varepsilon \cdot \sigma_e \\ B_i \cdot \sigma_e^2 - r \cdot \sigma_\varepsilon \cdot \sigma_e & \sigma_e^2 \end{bmatrix}, \text{ and}$$

$$B_i = \left[1 - \frac{h_i \cdot \exp(\beta' s_{1i})}{T_i' - h_i} \right]$$

Non-worker

$$L_{2i} = \Phi\left(\frac{\frac{A_i}{T_i'} \cdot \exp(\beta \cdot \boldsymbol{s}_{1i}) - \alpha'\boldsymbol{s}_{2i}}{\sqrt{\sigma_e^2 + \sigma_\varepsilon^2 - 2 \cdot r \cdot \sigma_e \cdot \sigma_\varepsilon}} \right)$$

Overemployed $L_{3i} =$

$$\Phi\left(\frac{\frac{\exp(\alpha'\boldsymbol{s}_{2i}) \cdot h_i + A_i}{T_i' - h_i} \cdot \exp(\beta \cdot \boldsymbol{s}_{1i}) - \alpha'\boldsymbol{s}_{2i}}{\sqrt{B_i^2 \cdot \sigma_e^2 + \sigma_\varepsilon^2 - 2 \cdot B_i \cdot r \cdot \sigma_e \cdot \sigma_\varepsilon}} \right) - \Phi\left(\frac{\frac{A_i}{T_i'} \cdot \exp(\beta \cdot \boldsymbol{s}_{1i}) - \alpha'\boldsymbol{s}_{2i}}{\sqrt{\sigma_e^2 + \sigma_\varepsilon^2 - 2 \cdot r \cdot \sigma_e \cdot \sigma_\varepsilon}} \right) \times \phi\left(\frac{w_i - \exp(\alpha' s_{2i})}{\sigma_e} \right)$$

Underemployed

$$L_{4i} = \left[1 - \Phi\left(\frac{\frac{\alpha'\boldsymbol{s}_{2i} \cdot h_i + A_i}{T_i' - h_i} \cdot \exp(\beta \cdot \boldsymbol{s}_{1i}) - \alpha'\boldsymbol{s}_{2i}}{\sqrt{B_i^2 \cdot \sigma_e^2 + \sigma_\varepsilon^2 - 2 \cdot B_i \cdot r \cdot \sigma_e \cdot \sigma_\varepsilon}} \right) \right] \times \phi\left(\frac{w_i - \exp(\alpha' s_{2i})}{\sigma_e} \right)$$

Table 2. Descriptive Statistics for San Diego Beach Users Sample (N = 494)

Variable	Units	Mean	Standard Deviation	Minimum	Maximum
Income	$/year	$62,698	$41,761	$2,500	$200,000
Average hourly income	$/hour	$18.38	$22.48	$0.00	$291.67
Educational attainment	Years completed	14.91	2.35	3.5	18
Gender	1 = male, 0 = female	0.51	0.50	0	1
Household size	Persons	2.82	1.43	1	8
Hours	Hours per week worked	32.32	19.12	0	100
Age	Years	39.58	13.38	18	88

Table 3. San Diego County Beach Sites and Sample Visitation (J = 31 beaches)

Beach Name	Number beach visits	Percent of total trips
San Onofre State- Camp Pendleton Beaches	97	1.10%
Oceanside Beaches	714	8.07%
Carlsbad Beaches	491	5.55%
South Carlsbad State Beach	169	1.91%
Ponto Beach	52	0.59%
North Encinitas Beaches	215	2.43%
Moonlight Beach	237	2.68%
Boneyard Beach	21	0.24%
Swami's Beach	136	1.54%
San Elijo State Beach	112	1.27%
Cardiff State Beach	137	1.55%
Tide Beach Park	18	0.20%
Fletcher Cove Park	48	0.54%
Seascape Surf - Del Mar Shores Beaches	183	2.07%
Del Mar City Beach	204	2.30%
Torrey Pines State Beach	398	4.50%
Black's Beach	187	2.11%
La Jolla Shores Beach	618	6.98%
Scripps Park Beaches	232	2.62%
Marine Street Beach	68	0.77%
Windansea Beach	121	1.37%
Pacific Beach	1265	14.29%
Mission Beach	1178	13.31%
Ocean Beach	842	9.51%
Coronado Beach	457	5.16%
Silver Strand State Beach	132	1.49%
Imperial Beach	230	2.60%
Border Field State Beach	13	0.15%
Mission Bay	170	1.92%
San Diego Bay	16	0.18%
Sunset Cliffs - Point Loma Beaches	92	1.04%
Total trips	8853	100%

Table 4. Model Estimates.[a]

Parameter	Full sites model Estimate	Aggregate sites model Estimate
Price	-0.01666**	-0.01287**
	(-2.242)	(-2.132)
Length	0.01572**	0.07882**
	(2.131)	(2.260)
Length squared	-0.00108**	-0.00407**
	(-2.169)	(-2.286)
Constant	1.66308**	1.90878**
	(3.565)	(3.978)
Gender	-0.22729	-0.21563
	(-1.560)	(-1.577)
Age	0.00930*	0.00848
	(1.696)	(1.607)
Education	-0.08175**	-0.08488**
	(-3.046)	(-3.212)
Household size	0.17602**	0.15715**
	(3.347)	(3.173)
Inclusive value (d)	0.13731**	0.13203**
	(2.859)	(2.475)
SVLT - Constant	0.56238	0.89578**
	(1.470)	(4.364)
SVLT - Gender	-0.44662	-0.40052**
	(-1.295)	(-2.307)
SVLT - Household size	-0.03649	-0.08569
	(-0.276)	(-1.110)
SVLT - Std error	6.13659**	6.28306**
	(11.435)	(13.050)
Wage - Constant	2.85787**	2.21861**
	(4.212)	(3.754)
Wage - Gender	-0.07789	-0.02074
	(-0.192)	(-0.117)
Wage - Age	-0.00130	0.00177
	(-0.184)	(0.365)
Wage - Education	-0.00363	0.04431
	(-0.073)	(1.094)
Wage - Std error	11.43138**	11.42830**
	(15.277)	(17.933)
Correlation	0.41159**	0.23274*
	(3.092)	(1.850)
Sample size	494	494
Mean simulated log-likelihood	-96.808	-78.2359
LRI	0.6091	0.6238

[a] Asymptotic t-values in parentheses.
**Statistically different from zero at the 5% level.
* Statistically different from zero at the 10% level.

Table 5. Per-Day Values of Beach Access (ECV^{day})

	Full sites model	**Aggregate sites model**
Sample mean ECV^{day}	\$20.99	\$25.83
Sample median ECV^{day}	\$20.60	\$25.42
Krinsky-Robb 90% Conf. Interval[a]	(\$11.71, \$64.77)	(\$16.51, \$94.58)
Krinsky-Robb 95% Conf. Interval[a]	(\$10.44, \$98.01)	(\$14.51, \$165.94)

[a]Based on 4000 draws from the empirical distribution of the mean ECV^{day}.

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