Estimating the aggregate value of forest recreation in a regional context

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Abstract

Public goods and services supplied by nature require active government intervention to ensure their provision. Nevertheless, prior to the implementation of any policy, planners should compare the costs and benefits caused by their decisions, a difficult task when policies and regulations are developed at a regional or national level, and their impacts spread out across a huge number of people and ecosystems. Although environmental economics has provided the necessary information for decision-making guidance related to site-specific interventions, little attention has been given to the information requirements of policies affecting large geographical areas, that is, to the estimation of an aggregate value for a specific region. The purpose of this paper is to improve current applications, inferring the recreational value of forests through the implementation of a discrete-count linked model including all the forest areas in the region of Mallorca (Spain).

Keywords: Travel Cost Method, aggregate value, discrete-count linked model, recreation demand, forests.

JEL Classification: C25, Q23, Q26, Q51.

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1 Introduction

Forests and woodlands are a multi-functional resource. Therefore, in addition to timber and wood-related products, they provide a wide range of goods and services such as recreation, biodiversity, landscape, and carbon sequestration (Willis et al., 2003; Slee et al., 2006). Unfortunately, despite growing awareness of the important contribution of these services to people’s wellbeing (Brown et al., 2006), their public good attributes preclude the development of well functioning markets (Bockstael and Freeman III, 2005). Given this situation, government intervention is required to correct market failure and ensure the provision of forest goods and services (Dixon et al., 1994; Bishop, 1998).

However, to guarantee an efficient use of society’s resources, the development of any public policy needs to be preceded by a sound evaluation of its social costs and benefits (Boardman et al., 2001; Pearce et al., 2006). For this reason, environmental valuation has increasingly been used by managers to assign monetary values to non-marketed benefits as a way of integrating them into benefit-cost analysis and cost effectiveness analysis (Brown et al., 2006; Christie et al., 2006). As a result, the past twenty to thirty years have seen the rapid development of the economic theory and techniques for measuring the demands for non-marketed goods and, hence, evaluating the impacts of new policies and regulations on the wellbeing of society (Yen and Adamowicz, 1994; Bockstael and Freeman III, 2005). In this context, although a wide range of environmental benefits has been evaluated (i.e. water quality, pollution absorption, biodiversity, landscape, visibility, carbon sequestration, health effects, etc.), recreation has been the subject of particular scrutiny, as demonstrated in an extensive body of relevant research (Kaval and Loomis, 2003; Selman and Powell, 2003; Loomis, 2005).

With time, Travel Cost Method (TCM) has become one of the most used methodologies to evaluate policies, programs and plans related to outdoor recreation (Bateman et al., 1999a; Ward and Beal, 2000). Nowadays, TCM is considered a robust methodology that produces acceptable estimates of nature-based recreation benefits (Ward and Loomis, 1986; Durden and Shogren, 1988; Smith, 1989; Smith and Kaoru, 1990; Smith, 1993). In addition to the consolidation of the method, important advances have taken place providing a consistent way of explaining the allocation of vis-
its among alternative sites (Cesario, 1973, 1976; Sutherland, 1982), valuing site-specific attributes (Bockstael et al., 1987; Morey et al., 1993; Yen and Adamowicz, 1994; Kaoru et al., 1995; Shaw and Shonkwiler, 2000; Scarpa et al., 2004) and evaluating the creation of additional sites (Burt and Brewer, 1971; Cicchetti et al., 1976; Hof and King, 1982).

However, from a policy perspective, a relevant issue is whether current estimates are adequate to make informed environmental management decisions. In this line, a review of recreational demand literature shows, beyond the concern about the valuation of specific sites and their attributes, little attention has been given to aggregate values, that is, those of large geographical areas (Lutz et al., 2000; Garber-Yonts, 2005). Consequently, in spite of the important policies implemented at a regional or national scale that affect many ecosystems simultaneously and generate important spillovers among several areas (i.e. fire and pest control policies included in national plans), current valuation studies are not comprehensive enough to provide all the information needed for their evaluation. In such cases, single-site (or small area) valuation studies have limited relevance for decision making (Hill and Courtney, 2006) and, therefore, the measurement of the aggregate value of the impact generated across all affected areas is required (Heal et al., 2005).

Unfortunately, given the lack of aggregate benefit valuations, managers have usually made use of somewhat crude assessments to deal with this shortage. In this way, some ad hoc procedures such as the aggregation of single-site valuations, the multiplication of the average per-trip value by total trips within a season (Knoche and Lupi, 2007), or the transference of an arrival function to all areas in the region (Brainard et al., 2001; Selman and Powell, 2003) have been implemented. Nevertheless, the use of such simple procedures entails important restrictions and limitations concerning the consideration of the substitution and complementary effects among available sites (Freeman III, 1979; Bockstael et al., 1986; Caulkins et al., 1986), the varying costs across the region under study (Lutz et al., 2000) and the impact of site-attributes and socioeconomic characteristics of the population (Bateman et al., 1999b).

In this context, the desire for more accuracy in revealing regional non-marketed values has led researchers toward the estimation of aggregate demand functions. As a result, several TCM approaches such as the varying parameter model (Russell and Vaughan, 1982; Vaughan and Russell, 1982;
Vaughan et al., 1982; Hesseln et al., 2003), the discrete-count linked model for site selection and frequentation (Bockstael et al., 1986; Bockstael et al., 1987; Siderelis and Moore, 1998), the repeated nested logit model (Morey et al., 1993; Morey and Waldman, 1995; Grijalva et al., 2002), and the Kuhn-Tucker model (Hanemann, 1978; Wales and Woodland, 1983; Phaneuf, 1999; Von Haefen et al., 2004) have been developed to achieve the goal of aggregate benefit valuation.

At present, although none of these approaches is entirely satisfactory to address the shortcoming of aggregate valuation, the linked model has become a practical and popular method to achieve regional valuations of non-marketed goods (Herriges et al., 1999; Haab and McConnell, 2002; Bockstael and McConnell, 2007). However, in spite of the ability of the linked model to handle a large number of sites without having to resort to site aggregation, an important issue remain unsolved in the literature concerning the number of sites that has to be included in the valuation exercise. In this line, Bockstael et al. (1986) and Kaoru et al. (1995) state that all available alternatives within the region (or country) should be considered to get accurate estimations of the aggregate Hicksian consumer surplus. Unfortunately, current applications have only used a subset of the available alternatives. For instance, Hutchinson et al. (2003) evaluate the recreational benefits of forest ecosystems in the Northern Ireland region, considering a set of 14 sites.

In this context, this paper aims to fill the gap existent in current literature valuing the recreational services provided by natural areas within large regions, not specific sites. The analysis focuses on the demand for outdoor recreation in forest ecosystems in Mallorca (Spain). For this reason, all recreational areas within the 153,115 hectares of Mediterranean forests around the island have been identified and included in the empirical application. The remainder of the paper is organized as follows. In the next section the TCM approach know as discrete-count linked model for site selection and frequentation is presented. Section three describes the data used in the estimation of the model. Finally, results and conclusions are presented in sections four and five, respectively.
2 Model specifications

Random Utility Models (RUM) are well structured to address the choice among a set of mutually exclusive alternatives within a limited time horizon (Phaneuf and Smith, 2005). Consequently, they provide a convenient way to explain the individual’s selection of which site to visit on a given choice occasion (Revelt and Train, 1998; Train, 1998). However, as RUM alone cannot predict total recreational trips taken in a season, they are an incomplete representation of recreational demand (Feather et al., 1995; Johnstone and Markandya, 2006). Given this situation, a continuous component to model the number of trips has to be added to the discrete component of the model to achieve seasonal valuations (Herriges et al., 1999; Parsons et al., 1999).

In this context, since the seminal work by Bockstael et al. (1986; 1987), the linked model has been suggested to estimate the participation and site-choice decisions by means of two different components (Cropper, 2000; Hutchinson et al., 2003). In the first one, the individual decides how to allocate the trips across sites on the basis of site-specific travel cost and quality attributes. In the second one, the individual chooses whether or not to participate and, if positive, how many times a year. Although different methods have been developed to link both components, Parsons et al. (1999) find little practical difference between these linking functions. However, the variant of Hausman et al. (1995), which is equivalent to the traditional variant developed by Bockstael et al. (1987), is usually preferred for its attractive interpretation as the monetized utility per-trip, that is, the consumer surplus that corresponds to one recreational trip (Herriges et al., 1999). First, we turn to modelling the site selection component of the overall model.

2.1 Trip allocation

Different RUM approaches, such as the conditional or the nested logit, have been used to model the destination choice decision (Train, 2003). However, a generalization of the standard logit model known as the mixed or random parameter logit (RPL), has become very common within the recreational demand literature to bring into consideration the heterogeneous preferences of consumers in recreational choice settings (Boxall and Adamowicz, 2002;
Following McFadden (1974), the utility $U_{ni}$ that an individual $n$ receives from choosing to visit site $i$ on a given choice occasion, when a choice set of $i = 1, ..., I$ exists, is assumed to take the form of the conditional indirect utility function which, following a lineal specification, can be expressed as:

$$U_{ni} = \beta_n' x_{ni} + \varepsilon_{ni}$$  \hspace{1cm} (1)

where $\beta_n' x_{ni}$ is the nonstochastic portion of the indirect utility received during choice occasion if site $i$ is visited. Therefore, $x_{ni}$ are observed site-attributes related to alternatives faced by individuals and $\beta_n$ is the vector of estimated coefficients for individual $n$ representing that individuals tastes. Finally, the error term $\varepsilon_{ni}$ captures the variation in preferences among individuals in the population. As the individual is assumed to visit the recreation site that yields the greatest utility, the probability $\pi_{ni}$ of choosing the $i_{th}$ alternative is:

$$\pi_{ni} = \Pr (\beta_n' x_{ni} + \varepsilon_{ni} > \beta_n' x_{nj} + \varepsilon_{nj}) \forall j \neq i$$  \hspace{1cm} (2)

In addition, as it is usually assumed that the error term $\varepsilon_{ni}$ is independent and identically distributed extreme value type I, the site-selection probability in equation (2) can be expressed as (McFadden, 1974; McFadden, 1978; Train, 2003):

$$\pi_{ni} = \frac{e^{\beta_n' x_{ni}}}{\sum_{j=1}^{I} e^{\beta_n' x_{nj}}}$$  \hspace{1cm} (3)

As $\beta_n$ is unknown by the researcher, a probability function for the coefficient vector has to be specified and the parameters of such distribution have to be estimated. Although more complex distributions can be used, it is quite common to specify it as a normal $\beta \sim N(b, W)$ with parameters $b$ and $W$ (Revelt and Train, 1998; Train, 1998, 1999; McFadden and Train, 2000). Whichever distribution is used, the choice probability for individual $n$ visiting site $i$ becomes the integral of expression (3), consequently:
Finally, the log likelihood function for a given value of the parameter vector $\beta$ takes the form:

$$LL(\beta) = \sum_{n=1}^{N} \sum_{i=1}^{I} y_{ni} \ln (\pi_{ni}(\beta))$$ (5)

where $N$ represents the number of individuals in the sample, $\pi_{ni}(\beta)$ are the choice probabilities from equation (4) and $y_{ni}$ equals one when the $n_{th}$ individual chooses alternative $i$ and 0 otherwise. As the solution to expression (5) involves the evaluation of a multiple-dimensional integral which does not have a closed-form, the estimation of such model requires the use of simulation methods such as, for instance, the simulated maximum likelihood estimation (Bhat, 1998; Revelt and Train, 1998).

Following McFadden (1978) and Hanemann (1982), the expected maximum utility from site characteristics on any given choice occasion can be defined as:

$$IV_n = \ln \left( \sum_{i=1}^{I} e^{\beta'_n x_{ni}} \right)$$ (6)

This expression, usually referred to as inclusive value ($IV$), has been used within recreational demand literature to link site selection and trip frequency since the works of Bockstael et al. (1986; 1987). The inclusion of this measure in the second component of the model brings into consideration the fact that not only changes in travel costs, but also changes in site attributes can alter trip demand and, therefore, the seasonal value of the evaluated region.

More recently, Hausman et al. (1995) have suggested normalizing the inclusive value by the estimated coefficient of the travel cost variable $\beta_{tc}$ from the site-choice component. In this way, this new measure can be used as a price index and, under the logit assumption, can be interpreted as the expected consumer surplus associated with the available alternatives in a given choice occasion (Train, 2003). Supposing that the utility is linear in income, the expression of the expected consumer surplus per-trip $s_n$ becomes
\( s_n = \frac{1}{\beta_{ke}} \ln \left( \sum_{i=1}^{I} e^{\beta'_{n} x_{ni}} \right) \)  \hspace{1cm} (7)

### 2.2 Trip demand

Once the per-trip consumer surplus brings together data from travel costs and site-specific attributes, the individual-related socioeconomic data can be incorporated in the study. In this way, income, age, profession, household composition and place of birth, among others variables, are used to explain the seasonal demand for recreation. As the number of trips undertaken by an individual to all recreational sites is an integer value greater than or equal to zero, a count data model has to be used to fit the recreational demand estimation (Maddala, 1983; Hausman et al., 1984; Hellerstein and Mendelsohn, 1993; Haab and McConnell, 1996; Shrestha et al., 2007).

However, although count data model applications have been traditionally implemented through Poisson specifications, given the restrictive assumptions of this model concerning the equality of the conditional mean and variance, using more flexible specifications such as the Negative Binomial Model (NBM) is suggested. More precisely, the NBM is a generalization of Poisson models where an unobserved random effect \( \varphi_n \) is introduced into the distribution of the conditional mean \( \mu_n \) defined as (Cameron and Trivedi, 1986; Greene, 2003):

\[ \mu_n = e^{\gamma s_n + z_n \delta + \varphi_n} = \lambda_n u_n \hspace{1cm} \text{where} \hspace{1cm} \lambda_n = e^{\gamma s_n + z_n \delta} \]  \hspace{1cm} (8)

where \( s_n \) is the per-trip consumer surplus, \( z_n \) are the considered variables, \( \gamma \) is the per-trip consumer surplus coefficient, \( \delta \) is the vector of coefficients estimates, \( \lambda_n \) is the conditional mean in the original Poisson model and \( u_n \) the unobserved effects from inter-person heterogeneity. In this way, the distribution of the number of trips \( t \) for individual \( n \) conditioned on the explicative variables and the unobserved effects remains Poisson (Long, 1997):

\[ Pr \left( t_n \mid s_n, x_n, u_n \right) = \frac{e^{-\lambda_n u_n} (\lambda_n u_n)^{t_n}}{t_n!} \]  \hspace{1cm} (9)

However, the conditional distribution of the number of trips cannot be computed since \( u_n \) is unknown. Instead, the unconditional distribution can
be computed using a probability density function for $u_n$ to estimate the integral of expression (9). Following most common assumptions, a gamma distribution $\Gamma(.)$ with parameter $\theta_n$ will be considered obtaining the equation below (Shrestha et al., 2007):

$$Pr\left(t_n | s_n, x_n\right) = \frac{\Gamma(\theta_n + t_n)}{\Gamma(t_n + 1) \Gamma(\theta_n)} \frac{r_n^t_n}{r_n^n} (1 - r_n)^\theta \quad \text{where} \quad r_n = \frac{\lambda_n}{\lambda_n + \theta} \quad (10)$$

Concerning the estimation of the NBM, numerical methods can be used to maximize the log likelihood equation:

$$LL(\gamma, \delta | t_n, s_n, x_n) = \sum_{n=1}^{N} Pr\left(t_n | s_n, x_n\right) \quad (11)$$

Following Hausman et al. (1995), the aggregate recreational value can be measured in the same way as the value of more traditional commodities are defined and measured, that is, through consumer surplus. In this way, assuming small income effects, the Hicksian demand function for trips is approximately equal to the Marshallian demand function and, consequently, the consumer surplus can be calculated without incurring in important biases. For this reason, the integral under the recreational demand function can be used to calculate the individual consumer surplus $S_n$ for outdoor recreation in the whole region of study. Again, the unobserved individual effect is included through the parameter $\varphi_n$.

$$S_n = \int_0^{s_n} e^{\gamma s_n + z_n \delta + \varphi_n} ds = \frac{1}{\gamma} e^{\gamma s_n} (e^{\gamma s_n} - 1) \quad (12)$$

3 Data collection

Two types of data have to be used to estimate the discrete-count linked model and to compute the aggregate recreational value. On the one hand, information on the environmental characteristics of all recreational sites is needed. On the other hand, data regarding the recreational activities undertaken by individuals in forests is also required. The former has been collected from existing datasets and fieldwork inventory and has been assembled in a Geographical Information System (GIS) using ArcGIS 9.2 software. The latter has been gathered from an outdoor recreation survey specially imple-
mented for the study of Mallorcan forests.

3.1 The Geographical Information System

The 153,115 hectares of Mediterranean forestland, covering 42% of the surface of the island of Mallorca (Spain), have been chosen as the study area for this application. Highly disaggregated site definitions have been used in the study in order to identify all available alternatives and, hence, to correctly capture the substitution patterns among sites. In this way, 59 forest areas have been identified and considered suitable for outdoor recreation including a wide range of activities such as hiking, picnicking, going for a walk, camping, adventure sports (biking, climbing, etc.) and observing the flora and fauna.

The environmental quality of the forests, as well as the recreational facilities that they provide to Mallorcan residents, have been represented in a large dataset from different sources. In this way, the Balearic Islands topographic map at scale 1:25,000, data from the National Institute of Meteorology and a land use map from the National Forest Inventory at scale 1:50,000 have been combined in the GIS and complemented with analogical cartography, aerial photography and fieldwork inventory. Table 1 lists all GIS-based variables considered in this application concerning forest composition (broad-leaved, mixed, etc.), land use (agricultural and urban areas), landscape quality and visibility, land fragmentation (total edge, coefficient of patches variation, etc.), recreational facilities (picnic sites, playgrounds, parking, etc.) and infrastructures (roads, reservoirs, etc.).

3.2 The outdoor recreation survey

The regional-wide survey on outdoor recreation was aimed to collect data concerning recreational trips taken by Mallorcan residents to forests throughout the last year.\(^1\) For this reason, the survey sample was drawn from all residents, not just those participating in recreation, avoiding on-site sampling problems. The questionnaire was developed and tested in a pilot survey and the final version was administered from April to July 2006 to 1043 Mallorcan residents. It was divided in different sections where data concerning site frequentation (number of trips, visited sites and activities undertaken) as

\(^1\)Consequently, the season considered in the application is one year.
Table 1: Site-choice model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel cost</td>
<td>Total travel cost in euros</td>
</tr>
<tr>
<td>Picnic site</td>
<td>= 1 if a picnic site is present at the area and the visitors is a picnicker; = 0 otherwise</td>
</tr>
<tr>
<td>Playground</td>
<td>= 1 if the site has a playground for children; = 0 otherwise</td>
</tr>
<tr>
<td>Parking</td>
<td>= 1 if a car parking is available for visitors; = 0 otherwise</td>
</tr>
<tr>
<td>Camping area</td>
<td>= 1 if a camping area is present at the site; = 0 otherwise</td>
</tr>
<tr>
<td>Hiking trails</td>
<td>Kilometres of marked trails for hiking when the visitor is a hiker; = 0 otherwise</td>
</tr>
<tr>
<td>Climbing area</td>
<td>= 1 if the site has a climbing area and the visitor undertakes adventure sports; = 0 otherwise</td>
</tr>
<tr>
<td>Kilometres of roads</td>
<td>Kilometres of roads accessible to cars</td>
</tr>
<tr>
<td>Distance to coast</td>
<td>Euclidean distance from the site to the nearest coastline</td>
</tr>
<tr>
<td>Reservoir</td>
<td>= 1 if a reservoir is present at the site; = 0 otherwise</td>
</tr>
<tr>
<td>Citrus-farming area</td>
<td>Size of the citrus-farming area</td>
</tr>
<tr>
<td>Scrubland</td>
<td>Size of the scrubland</td>
</tr>
<tr>
<td>Broad-leaved forests</td>
<td>Size of the broad-leaved forests</td>
</tr>
<tr>
<td>Mixed forests</td>
<td>Size of the mixed forests</td>
</tr>
<tr>
<td>Juniperus area</td>
<td>Size of the Juniperus Phoenicia area</td>
</tr>
<tr>
<td>Burned area</td>
<td>Size of the burned area</td>
</tr>
<tr>
<td>Urban area</td>
<td>Size of the urban area</td>
</tr>
<tr>
<td>Cliffs</td>
<td>Length of cliffs</td>
</tr>
<tr>
<td>Total edge</td>
<td>Total perimeter of patches (landscape fragmentation measure)</td>
</tr>
<tr>
<td>Patches variation</td>
<td>Coefficient of patches variation (landscape fragmentation measure)</td>
</tr>
<tr>
<td>Visibility index</td>
<td>Size of the visible area from the highest point of the site</td>
</tr>
<tr>
<td>Landscape quality</td>
<td>Landscape quality index capturing the attractiveness of land for recreation</td>
</tr>
</tbody>
</table>

Source: own elaboration.

well as socioeconomic information about the respondent (place and year of birth, attained level of studies, occupation, household composition, income, etc.) was collected.

At the same time, data on means of transport, party size, on-site time and costs associated with the visit as well as the travel time and distance from each trip origin to the 59 available recreational sites have been gathered and used to compute the travel cost variable. Travel time and distance have been calculated from the Mallorcan road map at scale 1:25,000 and Teleatlas digital data. When more than one route was available for a specific
individual, it has been assumed that the shortest one was chosen. The mileage cost and the opportunity cost of driving time have been jointly considered to estimate the travel cost.\footnote{The mileage cost has been set to 0.19 per kilometre following the official cost per kilometre dictated by the Spanish Government.} Regarding the opportunity cost of driving time, the traditional lower bound proposed by recreation literature has been used, consisting of one-third of the individuals wage (Englin and Shonkwiler, 1995; Phaneuf and Smith, 2005).

Concerning the main characteristics of the sample, 841 residents stated validly that they had taken one or more trips to forests in the last 12 months (80.63% of the sample) and respondents who had visited forests took an average of 10 trips each. With regards to the purpose of the trip, the survey indicated that going for a walk was the most popular activity in forests (40.90%), followed by hiking (24.85%), picnicking (22.95%), adventure sports (6.66%) and other activities (4.64%). In addition, the mean age in the sample was 44 and the average monthly income of respondents was 950 euros. 92.43% of sampled residents were Spanish and 48.21% men. 35.57% of surveyed people had finished primary studies, 37.87% secondary studies and 26.56% tertiary studies. Regarding the occupation, 63.57% were employed, 4.03% were unemployed, 10.45% were housewife or househusband, 15.44% were retired and, lastly, 6.51% were students.

4 Model estimation and empirical results

The two components of the linked model described in section two have been implemented to assess the aggregate regional value of forest recreation in Mallorca. Both models have been estimated using NLOGIT Econometric Software. On the one hand, Table 2 shows the coefficient estimates for the RPL model, related to the destination choice decision, which has been estimated using 1000 replications per observation. On the other hand, the parameter estimates of the NBM, regarding the trip demand, are given in Table 3. Although more variables were initially considered, only statistically significant attributes have been reported in the final models.

Concerning the specification of the RPL, although all variables except the travel cost have been initially considered as random coefficients, only three of them have become statistically significant in the final estimation.
In this way, the standard deviations of the variables ‘citrus-farming area’, ‘urban area’ and ‘visibility index’ are highly significant, indicating that there is random variation in tastes with respect to these attributes. At the same time, three interactions have been included to capture the preferences of individuals for specific facilities especially oriented to the recreational activity that they undertake. In this way, the variable ‘picnic site’ equals one when a picnic area is available at the site and the individual is a picnicker, and zero otherwise. Likewise, the variable ‘hiking trails’ shows the kilometres of specially marked tracks existent in the site when the respondent is a hiker. Finally, ‘climbing area’ equals one when this facility is available in the site and the individual takes on adventure sports.

Overall, the goodness of fit of the model is up to standard with a McFadden-$R^2$ around 13.26% and an adjusted McFadden-$R^2$ around 13.21%.\(^3\) In addition, the signs and statistical significance of the estimated coefficients are consistent with economic theory and past recreation site-choice studies. In this way, all variables related to recreational facilities (‘picnic site’, ‘playground’, ‘parking’, ‘hiking trails’, ‘camping area’ and ‘climbing area’) and accessibility to the site (‘roads’) have a positive coefficient. Consequently, the presence of any of these attributes in a recreational site increases its probability of being chosen among all available alternatives. However, other variables concerning the proximity of dangerous or non-attractive features (‘cliffs’ and ‘burned areas’), disturbing land uses (‘urban areas’ and ‘citrus-farming’) and travel cost have a negative impact on visitation probabilities.

With regard to forest composition, individuals try to avoid ‘scrubland’ as well as they prefer more peculiar and unusual species (‘Juniperus Phoenicia’) and ‘broad-leaved’ compositions rather than the most common ‘mixed’ forests. In addition, individuals show their preference for more heterogeneous sites with higher landscape fragmentation (‘total edge’ and ‘coefficient of patches variation’), a higher ‘visibility index’ and a greater ‘landscape quality index’.

Following the NBM specification presented in section two, the recreation demand function has been estimated considering the individuals socioeconomic characteristics and the per-trip consumer surplus defined in equation...

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\(^3\)The so-called McFadden-$R^2$ or Pseudo-$R^2$ is a measure of goodness of fit defined by McFadden (1974). The adjusted McFadden-$R^2$ is a variation of the McFadden-$R^2$ that bring into consideration the number of parameters included in the model and was suggested by Ben-Akiva and Lerman (1985).
Table 2: Site-choice model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>b/St.Er.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel cost</td>
<td>-0.2363</td>
<td>-19.850</td>
</tr>
<tr>
<td>Picnic site</td>
<td>0.0345</td>
<td>3.051</td>
</tr>
<tr>
<td>Playground</td>
<td>0.0801</td>
<td>5.348</td>
</tr>
<tr>
<td>Parking</td>
<td>0.0391</td>
<td>2.669</td>
</tr>
<tr>
<td>Camping area</td>
<td>1.0012</td>
<td>3.939</td>
</tr>
<tr>
<td>Hiking trails</td>
<td>0.0322</td>
<td>7.545</td>
</tr>
<tr>
<td>Climbing area</td>
<td>0.0040(*)</td>
<td>2.191</td>
</tr>
<tr>
<td>Kilometers of roads</td>
<td>0.3047</td>
<td>13.876</td>
</tr>
<tr>
<td>Distance to coast</td>
<td>-0.0195(*)</td>
<td>-2.218</td>
</tr>
<tr>
<td>Reservoir</td>
<td>0.0007(*)</td>
<td>2.235</td>
</tr>
<tr>
<td>Citrus-farming area</td>
<td>-0.0462</td>
<td>-3.742</td>
</tr>
<tr>
<td>Scrubland</td>
<td>-0.0009</td>
<td>-7.046</td>
</tr>
<tr>
<td>Broad-leaved forests</td>
<td>0.0003</td>
<td>4.438</td>
</tr>
<tr>
<td>Mixed forests</td>
<td>-0.0003</td>
<td>-5.580</td>
</tr>
<tr>
<td>Juniperus Phoenicia area</td>
<td>0.0017</td>
<td>5.613</td>
</tr>
<tr>
<td>Burned area</td>
<td>-0.0099</td>
<td>-3.045</td>
</tr>
<tr>
<td>Urban area</td>
<td>-0.0068</td>
<td>-3.674</td>
</tr>
<tr>
<td>Cliffs</td>
<td>-0.3388</td>
<td>-2.998</td>
</tr>
<tr>
<td>Total edge</td>
<td>0.0005</td>
<td>5.291</td>
</tr>
<tr>
<td>Coefficient of patches variation</td>
<td>0.4179</td>
<td>7.740</td>
</tr>
<tr>
<td>Visibility index</td>
<td>0.1222</td>
<td>4.530</td>
</tr>
<tr>
<td>Landscape quality index</td>
<td>0.4083</td>
<td>8.307</td>
</tr>
</tbody>
</table>

Standard deviations

- Citrus-farming area: 0.0250 (3.315)
- Urban area: 0.0047 (3.804)
- Visibility index: 0.1585 (3.091)

Log likelihood function: -2.974.628
Restricted log likelihood: -3.429.209
McFadden-$R^2$: 0.1326
Adjusted McFadden-$R^2$: 0.1321

All estimated coefficients are statistically significant at a 1% level except those denoted by (*) which are significant at a 5% level.
Source: own elaboration.

(7). As a result, thirteen variables and a constant have become statistically significant in the final model, which has achieved a McFadden Pseudo-$R^2$ value of 59.27%. In addition, the parameter alpha is also statistically different from zero giving evidence of the over dispersion present in the sample.4

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4The ancillary parameter alpha measures the dispersion of the gamma distribution of the NBM and is equivalent to $\alpha = 1/\theta$
Consequently, the use of the NBM instead of the more restrictive Poisson specification is reasonable.

Table 3: Trip demand model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>b/St.Er.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-2.2595</td>
<td>-12.301</td>
</tr>
<tr>
<td>Per-trip consumer surplus</td>
<td>0.1359</td>
<td>23.223</td>
</tr>
<tr>
<td>Income</td>
<td>0.0003</td>
<td>5.095</td>
</tr>
<tr>
<td>Children</td>
<td>0.4092</td>
<td>5.131</td>
</tr>
<tr>
<td>Secondary studies</td>
<td>0.3427</td>
<td>3.908</td>
</tr>
<tr>
<td>Tertiary studies</td>
<td>0.7527</td>
<td>8.418</td>
</tr>
<tr>
<td>Unemployed</td>
<td>0.3683(*)</td>
<td>2.210</td>
</tr>
<tr>
<td>Homemaker</td>
<td>-0.1957(**)</td>
<td>1.757</td>
</tr>
<tr>
<td>Non-European country</td>
<td>-0.3064(*)</td>
<td>-1.254</td>
</tr>
<tr>
<td>Preference for outdoor leisure</td>
<td>0.4488</td>
<td>7.157</td>
</tr>
<tr>
<td>Enrolled in a sports club</td>
<td>0.1375(*)</td>
<td>2.075</td>
</tr>
<tr>
<td>Preference for organic products</td>
<td>0.1690</td>
<td>2.680</td>
</tr>
<tr>
<td>Involved in some NGO</td>
<td>0.2065</td>
<td>2.869</td>
</tr>
<tr>
<td>Resident in Palma</td>
<td>0.2037</td>
<td>3.305</td>
</tr>
<tr>
<td>Alpha</td>
<td>10.626</td>
<td>16.666</td>
</tr>
</tbody>
</table>

Log likelihood function: \(-2.929.059\)
Restricted log likelihood: \(-7.190.771\)
McFadden-\(R^2\): 0.5927

All estimated coefficients are statistically significant at a 1% level except those denoted by (*) and (**) which are significant at a 5% and 10% level, respectively.

Source: own elaboration.

The coefficient of the linking variable, that is, the per-trip consumer surplus, is positive and statistically significant showing that visitors take more trips when the utility per-trip is higher. In the same line, the results indicate that higher ‘income’ and higher attained education (‘secondary’ and ‘tertiary studies’) have a positive influence on trip demand. Likewise, individuals with ‘children’ in their household, ‘unemployed’ workers, and individuals with ‘preference for outdoor leisure’, ‘enrolled in a sports club’ or with ‘preference for organic products’ will undertake more recreational trips to forests. In the same line, urban residents (‘resident in Palma’) are more likely to participate in recreational activities. However, those individuals who are undertaking domestic chores (‘homemaker’) or who were born in a ‘non-European country’ will tend to take fewer trips to forests.

Finally, the individual consumer surplus for forest recreation in Mallorca
has been calculated according to equation (12). Table 4 summarises the
distribution of such measure across the entire sample. In this way, the
average consumer surplus per season is 68.60 euros. Likewise, the more
conservative measure of the median shows a lower value of 55.90 euros. In
addition, the 95% confidence interval has been estimated for inferring the
population value of the consumer surplus. Accordingly, the lower bound of
such interval (55.76 euros) has been added up over the whole population of
the area of study (619,917 inhabitants) showing an annual consumer surplus
for recreational forests of 34.57 millions of euros.

<table>
<thead>
<tr>
<th>Estimate</th>
<th>Per-person value (in euros)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>68.60</td>
</tr>
<tr>
<td>Median</td>
<td>55.90</td>
</tr>
<tr>
<td>Median’s 95% confidence interval</td>
<td>55.76 - 56.04</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>2.32</td>
</tr>
<tr>
<td>Minimum</td>
<td>0</td>
</tr>
<tr>
<td>Maximum</td>
<td>478.25</td>
</tr>
</tbody>
</table>

Source: own elaboration.

5 Conclusion

Information resources available to policy makers (i.e. forest managers) have
increased and improved over time (Garber-Yonts, 2005), especially dur-
ding the last 30 years, when environmental economics has made significant
progress in developing methods for valuing environmental benefits (Turner
et al., 2003). However, while a large number of valuation studies have been
conducted on a small scale focusing on the implications of management
changes at particular sites, the evaluation of policies affecting large geo-
graphical areas has been overlooked (Lutz et al., 2000; Garber-Yonts, 2005).

In this context, this paper has presented an application of the discrete-
count linked model to forest recreation in Mallorca (Spain), as a way of
addressing the gap existent in the literature concerning the measurement
of aggregate benefits at a regional or national scale. This model, initially
developed by Bockstael et al. (1986; 1987) and modified by Hausman et al.
(1995), provides a comprehensive approach for estimating the total demand
for the annual counts of recreation trips at the same time as predicting the trip allocation among substitute sites (Siderelis and Moore, 1998). Consequently, in addition to the assessment of aggregate benefits, the linked model provides a better understanding of the determinants of site-choice and trip demand, becoming an ideal tool for supporting policy decision-making.

A large household survey on outdoor recreation has been implemented to gather detailed information on residents visitation levels and patterns of use regarding a wide set of recreational activities (including picnicking, hiking, going for a walk, camping, adventure sports, observing the flora and the fauna, etc.). In addition, a GIS has been used to collect data describing the environmental characteristics of forest in terms of recreational facilities (picnic sites, camping areas, parking, marked trails, etc.) and environmental attributes (forest composition, land use, landscape quality, visibility, land fragmentation, etc.).

Firstly, GIS-based data has been used to estimate the site selection component through a RPL model obtaining the per-trip consumer surplus. Secondly, this measure of the individual utility, as well as a set of socioeconomic variables (income, household composition, education, occupation, etc.), have been included in the second component of the model, the annual demand of recreational trips that has been estimated through a NBM. Finally, the individual consumer surplus per season has been calculated, integrating the aggregate recreation demand.

Overall, the aggregate consumer surplus of Mallorcan residents for forest outdoor recreation is around 34.57 millions of euros per year. Such welfare estimate provides insight that will allow planners to make informed decisions concerning the provision of forest goods and services. However, although the methodology implemented in this paper supposes an improvement over traditional ad hoc methods for aggregate welfare measurements, a utility-consistent methodology is required to assess environmental benefits in the context of large geographical areas where a huge number of sites has to be considered.

6 References


The impact of measurement assumptions upon individual travel cost


