Hors-série spécial 50 ans du BETA

DOCUMENTS DE TRAVAIL

« Spatial preference heterogeneity in forest recreation »

Auteurs

Jens Abildtrup, Serge Garcia, Søren Bøye Olsen, Anne Stenger

Document de Travail – Hors-série n°2022-06

Mai 2022

Notice introductive : **Jette Bredahl Jacobsen**

BETA
Bureau d'économie théorique et appliquée

Site : https://beta-economics.fr
@beta_economics

Contact :
jaoulgrammare@beta-cnrs.unistra.fr

Abildtrup, Jens; Garcia, Serge; Olsen, Søren Bøye; Stenger, Anne, 2013. Spatial preference heterogeneity in forest recreation. Ecological Economics 92, 67-77

Introduction written by Jette Bredahl Jacobsen, University of Copenhagen

Forests constitute major sites for outdoor recreation, and their value is increasingly being acknowledged, not least during the covid19 pandemic, where several countries have experienced a boom in outdoor recreation as it provided recreational opportunities with safe distance to other people. With increasing urbanization throughout Europe, it also becomes evident that *where* forest recreational options exist is of importance relative to where people live. It is therefore with good reason that BETA chose a paper focusing on forest recreation and spatial heterogeneity as a key paper for their 50 years anniversary.

The paper "Spatial preference heterogeneity in forest recreation" is based on a choice experiment investigating recreational preferences of people living in Lorraine. A second layer is added to the analysis by investigating, ex post, determinants for these preferences.

The paper is heavily cited (85 citations on scopus as of April 2022), and continues to be so with more than 10 citations per year.

The many citations over a long period reflects that the paper contributes to several aspects. First is its application: in 2013 not many studies existed on recreational preferences, and in particular, not many choice experiments addressing key management attributes like facilities and hiking paths. Thus it adds to the literature on valuing outdoor recreation and has also directly relevance for forest managers providing recreational facilities.

Second, it was one of the first to try to explain spatial heterogeneity as more than simple distance decays or observing that preferences differ between sites or people. It includes in a second stage both characteristics of a site, the respondent, and endowment of forest in the surroundings of the respondent as explanatory variables for the marginal willingness to pay. Endowment is particularly important as it explores the Achille's heal of many valuation studies applying travel cost or stated preference methods: the endogeneity arising from people's selection of where to live. In the paper Abildtrup and colleagues show that such a pattern is indeed present. Thereby they point at an important aspect which has been elaborated since in both the revealed and stated preference literature. This is also evident from the citations which covers both fields. Looking at the citation patterns it is also interesting to note that there are hardly any self-citations, and that the citing authors are many different from many different places in the world. This shows the wide impact the paper has had.

While more advanced statistical methods are typically used today for such questions, mainly with efficiency gains, the simple, yet novel approach at the time, is still valid and provide robust results. I believe this is an important quality to look for in the environmental valuation literature – a thorough thinking of the problem in hand leading to novel approaches of analyses. Such results are likely to hold despite econometric development.

With the paper Abildtrup and colleagues formed the basis for putting BETA on the European map of the very good environmental valuation scientists. Since this paper, several more has followed, many following the pattern of investigating spatial heterogeneity. And always with solid data collection and analyses behind.

Spatial preference heterogeneity in forest recreation

Jens Abildtrup, INRA, UMR356 LEF, 54000 Nancy, France

Serge Garcia INRA, UMR356 LEF, 54000 Nancy, France

Søren Bøye Olsen, University of Copenhagen, 1958 Frederiksberg C, Denmark

Anne Stenger INRA, UMR356 LEF, 54000 Nancy, France

Abstract:

In this study, we analyze the preferences for recreational use of forests in Lorraine (Northeastern France), applying stated preference data. Our approach allows us to estimate individual-specific preferences for recreational use of different forest types. These estimates are used in a second stage of the analysis where we test whether preferences depend on access to recreation sites. We find that there is significant preference heterogeneity with respect to most forest attributes. The spatial analysis shows that preferences for forests with parking and picnic facilities are correlated with having access to such forests while for the other attributes considered (dominant tree species, trekking paths and presence of lake and rivers) we find no correlation between stated preferences and accessibility. This implies that the problem of endogenous distances in the travel cost method (Parsons 1991) may be present in the estimation of welfare economic values for parking and picnic facilities in the analyzed model. The results underline the importance of considering spatial heterogeneity of preferences carrying out economic valuation of spatial-delineated environmental goods and that the spatial variation in willingness to pay for such goods is not only explained by the users' transport costs of accessing the sites.

Keywords: Forest recreation; forest attributes; spatial heterogeneity; choice experiment; error-component model.

Acknowledgements:

The authors would like to thank Vincent Perez, Christian Piedallu and Erwin Thirion from LERFoB for their contribution to the establishment of a GIS database with characteristics of forests in Lorraine, and Max Bruciamacchie and Jean-Marc Rousselle, Laboratoire d'Economie Forestière, for their contribution to the development of the questionnaire and its Web implementation. We also want to thank Office National des Forêts in Lorraine and the Fédération Française de Randonnée Pédestre for provision of data for the analysis. This work was supported by funding from the French Ministry of Agriculture (DGER, FABELOR).

1. Introduction

This paper analyzes the preferences for forest recreation, with a focus on spatial preference heterogeneity. Spatial factors get increasing attention in environmental valuation. For example, distance decay functions are included in the economic valuation of spatially delineated ecosystem services and are especially important when aggregating individual values and carrying out benefit transfer (e.g., Bateman et al. 2006). Distance decay functions are not necessarily associated with spatial preference heterogeneity but, in the case of use values, reflect variations in transport costs and availability of substitute sites (Schaafsma et al., 2011). Other environmental valuation studies have addressed spatial preference heterogeneity on a rather coarse scale by, for example, including regional dummies in the estimated choice model or estimating separate models for different locations (e.g., Bergmann et al., 2008; Broch et al. 2012; Brouwer et al., 2010).

The main objectives of this study are: (1) to estimate recreational users' preferences for forest attributes; and (2) to estimate the determinants of the preference heterogeneity. Spatially heterogeneous preferences may be a result of spatial sorting where individuals select their location of residence according to their preferences for recreation opportunities. If access to forest recreation is correlated with the preferences, it is important to consider the endogeneity of travel distance in the application of the travel cost method (Parsons, 1991; Randall, 1994). Furthermore, if recreation opportunities influence the choice of residence location welfare effects of changes in access to recreation sites may differ in the short-term and long-term due to changed composition of the local population over time (see e.g. Klaiber and Phaneuf, 2009).

In this study, we estimate the preferences for forest recreation applying a Choice Experiment (CE) where respondents are asked to choose between the forest they usually go to and two hypothetical forests. Asking the respondents to make hypothetical choices allow us to account for potential endogeneity of site attributes (e.g., travel distance) and thus reduce the potential estimation bias in applications based on revealed preferences. We model forest choice by applying a random parameter error component model that allows us to account for preference heterogeneity as well as for the repeated choice panel structure of the data. Due to the repeated choices made by each respondent, we are able to estimate individual-specific utility model coefficients. These estimates are used in a second-stage analysis where we estimate the potential spatial determinants of the preferences for forest recreation. To our knowledge, this has not been previously attempted in the environmental valuation literature. Individual-specific willingness-to-pay estimates for rural landscape improvements have been derived from a mixed logit model and spatially analyzed in Campbell et al. (2008, 2009). Their spatial analysis is mainly explorative and does not attempt to estimate spatial determinants of preferences. An explorative analysis of spatial distribution of preferences was also carried out by Baerenklau (2010) who applied a latent class approach to the estimation of backcountry hiker preferences in southern California. Compared to previous studies (Birol et al., 2006; Campbell, 2007; Campbell et al., 2008, 2009; Baerenklau, 2010; Brouwer et al., 2010) on preference heterogeneity, we include variables representing the spatial proximity to recreation sites with different site attributes. Our study uses empirical data from a CE with recreational attributes of forests in Lorraine. Lorraine is a heavily forested region. Forest covers nearly 850,000 ha, representing more than 35% of the territory (this rate is 29% at the national level). A previous survey conducted in 1997 (Despres and Normandin, 1998; Normandin, 1998) on ecological and recreational services of forests in Lorraine reveals that Lorraine forests are heavily visited, with an average of 40 visits/family/year and only 4% of households that never visit forest sites[1]. For this study, we carried out a Web-based survey by sending the questionnaire to an Internet panel of residents in Lorraine.

We find significant heterogeneity in the preferences for different forest attributes, describing the forest structure and the presence of recreational facilities. In a spatial analysis of the individual preferences, we find some evidence of a link between the strength of preferences and access to

[1] In the survey they did not ask the number of individuals from the households going together at a visit, implying that the number of visits per person cannot be calculated.

forests, i.e. forests with picnic and parking facilities. The next section briefly reviews the economic literature concerning spatial aspects and feedback effects in the valuation of recreational sites and amenities. In the third section we describe our empirical approach for estimating forest recreation values, addressing spatial issues explicitly. Next, we describe the data used, followed by the estimation results. Finally, we conclude the paper with a discussion of the results and the implications of spatial preference heterogeneity for recreational modeling and forest policy.

2. Spatial heterogeneity and preferences for amenities

The economic analysis of changes in access to recreational sites or changes in quality of environmental sites is inherently spatial (Baerenklau et al., 2010). First, a recreational site has a specific spatial location. The distance between the site and the potential visitor influences the costs of a visit and, accordingly, the probability that the site will be visited. Consequently, the aggregate demand for recreational use of a given site strongly depends on its distance from population centers. However, alternative sites that may serve as substitutes or complementary sites (Troy and Wilson, 2006; Termansen et al., 2008) also influence the demand for recreational use of a given site. This implies that the spatial configuration of the recreational sites is important for the economic value. Therefore, consideration of the distance effect on the demand side and the spatial configuration of the recreational sites must be included in the valuation of recreation sites. The spatial configuration of recreational sites does not only concern the spatial distribution of sites but also the recreational quality of the individual sites and of their substitutes.

Secondly, an additional source of spatial heterogeneity of the economic value of recreation sites is preference heterogeneity. Benefit estimations of recreation have revealed significant variation in preferences for forest recreation and for different forest site characteristics (Brey et al., 2007; Christie et al., 2007; Termansen et al., 2008). Spatial preference heterogeneity is theoretically consistent with the sorting models inspired by Tiebout (1956) and has been confirmed in empirical analyses based on Roback's (1982) hedonic model framework. This framework assumes that house prices and wages depend, in part, on access to natural amenities and reflect peoples' amenity-dependent residential location choices (e.g., Schmidt and Courant 2006). Workers prefer to be in areas with access to amenities which implies a high demand for housing (higher rents) and a high supply of labour in such areas (lower wages)[2]. In an empirical study of the amenity value of forests in Arizona and New Mexico, Hand et al. (2008) found that increasing forest density in a region implies higher rents and lower wages in that region. Spatial heterogeneity in preferences for environmental amenities has been confirmed in empirical studies. Schläpfer and Hanley (2003) reported that attitudes to landscape protection are strongly associated with the local landscape. The presence of distance decay functions in valuation studies may also reflect spatial preference heterogeneity (Bateman et al., 2006). For example, Birol et al. (2006) found that the utility of wetland management attributes depends on the distance from the location of residence to the wetlands considered, and Brouwer et al. (2010) found that water quality improvement in a river system depends on the location of the respondents. Campbell et al. (2009) reported significant regional differences in the preferences over rural landscape improvements in Ireland.

Thirdly, if households choose their residential location according to their preferences for environmental quality, e.g., access to forests, we would consequently expect that preferences for environmental quality are spatially heterogeneous and may depend on the spatial configuration of the environmental quality. Furthermore, if preferences for forest recreation depend on income and other socio-demographic factors and these factors influence the residential location choice, we also expect to find spatial heterogeneity in preferences for forest recreation (Kuminoff 2009; Baerenklau, 2010). However, another effect leading to spatially heterogeneous preferences is what Nielsen et al. (2007) refer to as an accustomisation effect, i.e. people develop preferences for what is close to

[2] Note that it is unclear whether amenities have an positive or negative impact on wages if amenities also affect firm productivity (Roback 1982)

them. While the neoclassical concept of *Homo Economicus* entails an assumption of stable preferences which would preclude such an effect, what has been known for centuries in psychology is by now also more or less agreed upon in behavioral and experimental economics; people do not in general have stable preferences over time, rather their preferences develop and evolve over time (Norton et al., 1998). Empirically, it is extremely difficult to disentangle the spatial sorting effect , i.e. individual choose location according to preferences, from the accustomisation effect, i.e. individuals develop preferences according to the location where they have decided to live.[3]

Spatial sorting due to heterogeneity in preferences and in the access to recreation sites has implications for the welfare economic analysis of policies that influence access to and quality of recreation sites[4]. As mentioned in the introduction, the travel distance between a visitor and the recreation site cannot be considered exogenous if spatial sorting occurs. Instrumental variables have typically been used to cope with endogenous quality attributes (travel distance, congestion, among others) in applications of the travel cost method (Parsons, 1991; Murdock, 2006; Timmins and Murdock, 2007) and property characteristics (local open space, among others) in the hedonic pricing model (Irwin et al., 2001, Irwin, 2002, Cavailhès et al., 2009). In welfare economic analysis of situations with potential sorting a general equilibrium framework has been applied to model the sorting mechanisms explicitly (e.g. Sieg et al. 2004, Smith et al. 2004, Wu et al. 2004, Walsh 2007, and Klaiber and Phaneuf 2010). For example, Smith et al. (2004) find that the estimated welfare effects of reductions in ozone concentrations in the Los Angeles area between 2000 and 2010 using a general equilibrium approach, where relocation and price changes are modelled explicitly, differ significantly from the welfare effects applying a partial equilibrium approach. Ignoring feedback effects may not only lead to wrong welfare estimates but may also lead us to overlook important

[3] We thank one reviewer for pointing out that this can be thought of as a "chicken or egg" conundrum: Do people choose to live in an area because they have preferences for recreational opportunities in that area, or do their preferences for recreation develop to reflect the recreational opportunities in the area they live in? We agree with the reviewer that it is most likely a combination of the two.

[4] Here we consider spatial sorting as the determinant of spatial heterogeneity. However, presence of accustomisation would also complicate welfare economic analysis as preferences also in this case would be endogenous to changes in environmental quality.

distributional effects of environmental quality changes (Smith et al., 2004; Klaiber and Phaneuf, 2009). Explicit modeling of feedback mechanisms in travel cost models have been attempted in Leplat and Le Goffe (2009). They show how the optimal regulation of recreational visits in the case of congestion should address the regulation induced reallocation of visits between sites.

To sum up, the combination of (1) preference heterogeneity, (2) spatial heterogeneity in environmental resources, and (3) potential feedback effects should be considered in environmental valuation. Otherwise, the welfare impacts of a non-marginal improvement in spatially delineated environmental resources may be over- or underestimated and important distributional impacts may be neglected. In the economic valuation of recreational site quality, it is important to address the endogeneity of site attributes as well as the preferences of the local population. In our empirical approach, we take the potential endogeneity of site attributes into account, applying an experimental survey design, i.e., a CE. However, the objective of the present study is not to establish a general equilibrium model in which we will be able to explicitly account for relocation of households as a function of changes in access to forest recreation. Our contribution is to assess empirically the heterogeneity of forest recreation, and in particular to test if preferences are dependent on access to forests. To our knowledge, this is the first study to investigate this link explicitly. If the results show spatial heterogeneity in preferences for forest recreation, it would be an indication of residential sorting that should be considered in future valuation of access to forest recreation. It should also be noted that a potential correlation between preferences for forest recreation and access to forest could also be explained by the impact of local access to forest on preferences, i.e. the accustomisation effect.

3. Methodology

3.1. Choice modeling

We apply the familiar random utility model (RUM, McFadden 1974) that has become popular in the valuation of recreational site quality since the study by Bockstael et al. (1987). Basically, we process information about the trade-offs individuals make between travel costs and site attributes in order to value the latter. Such results can, for example, be used in assessing the welfare economic consequences of policies affecting the quality of the sites or the changes in the cost of accessing the sites. Most studies are based on revealed choices, i.e., observed choices of recreational sites. However, we estimate the RUM model using stated preference data obtained from a discrete CE (Adamowicz et al., 1994; Hanley et al., 1998; Hanley et al., 2002; Christie et al., 2007). The advantages of using stated preference methods include avoidance of multicollinearity in the attribute levels. Multicollinearity may be a problem because forests may be rather similar due to, for example, similar climatic conditions for the forest in an individual's choice set. In studies based on stated preferences the choice alternatives can be designed to avoid multicollinearity between attribute levels (see next section). Another advantage of stated preference approaches is the possibility of *ex ante* modeling of new recreational opportunities not presently available, i.e., recreation site attribute levels outside the range of current levels. Furthermore, the problem of endogenous attribute levels can be avoided (Hanley et al., 2002; von Haefen and Phaneuf, 2008; Whitehead et al., 2008). If people choose their residential location based on their preferences for forest recreation, among others, the travel distance attribute will be endogenous (Parsons, 1991). Recreational equipment (parking places, picnic areas, marked hiking paths) in the forest may also be endogenous since forest managers may install these types of facilities in forests with many visitors.

3.2 Survey design

The CE that is used to elicit preferences for forest recreation attributes involved an iterative process of design and testing. A starting point for identifying relevant forest attributes and development of the questionnaire was meetings with state forest managers and previous studies on the recreational use of forests in Lorraine (Normandin, 1998; Peyron et al., 2001) as well as at the national level (Peyron et al., 2002). Based on expert judgement, previous forest preference surveys, focus group interviews and a pilot test, five attributes describing forests were identified for use in the survey (see Table 1).

The first attribute, dominant tree species, is related to forest management, i.e., the choice of tree species and management system. Three levels are used to depict this attribute: forests dominated by coniferous species (more than 70% of trees are coniferous), forests dominated by broadleaf species (more than 70% of trees are broadleaf), and mixed species forests (neither coniferous nor broadleaf species represent more than 70% of the forests). A priori, based on the focus group interviews and expert judgement, we would expect that mixed species forests are preferred to broadleaf forests and broadleaf forests are preferred to coniferous stands. The second and third attributes are related to recreational facilities, i.e., marked hiking paths and parking and picnic facilities. Once again, we have three levels where the first level has no facility, the second level has one hiking path and one facility (picnicking or parking), and the third level has more than one hiking path and both parking and picnic facilities. The fourth attribute, the absence or presence of lakes or rivers in the forest is included because it is considered that the recreational value of a forest increases with water bodies in the forests. It is explained that fishing, sailing and canoeing on the lakes or rivers is not allowed. The final attribute is the distance between the residence and the forest, measured in kilometres.

Even after reducing the number of attributes to five, the possible combinations of attributes and levels were still very high with the full factorial design comprising 324 alternatives. Consequently, we apply a fractional factorial design, implying that potential interaction effects between attributes cannot be estimated – only the main effects. The orthogonal fractional design includes 18 pair-wise comparisons of alternative forests. They are allocated into three blocks, each with six choice sets, since this was found to be a suitable number of choice sets per respondent in the focus group interviews. Each choice task consists of a status quo alternative and two experimentally designed alternatives. Before they are given the choice tasks, respondents are asked to characterize the forest they have visited the most often over the past 12 months according to the same attributes and levels used in the experimental design and this is then used as the status quo definition. Focus group interviews suggested that this way of asking respondents to describe the forest visited, in line with the pre-defined list of attributes and levels, is an effective way of informing them about the attributes and preparing them for the subsequent choice tasks. A pilot test was carried out based on 79 respondents. On the basis of results from this pilot test, an experimental design with an informative Bayesian update to improve design efficiency was constructed using NGENE software (Scarpa et al., 2007a).

[insert table 1]

3.3 Econometric specification

Econometric modeling is carried out in a two-stage estimation procedure. We first estimate a choice model based on the responses to the CE questions, and we use this model to estimate respondent-specific marginal WTP for the forest attributes. These estimates are carried on to the second stage where we estimate a random effect model, applying procedures used for panel data.

Estimation of choice model and respondent-specific marginal utilities

The model applied in the parametric analysis of responses is a mixed logit model that can be derived in a number of different ways (Hensher and Greene, 2003; Train, 2003). In the present case, a model formulation that incorporates random parameters as well as an error component was found suitable. This model specification avoids major limitations of the multinomial logit model. Importantly, it explicitly accommodates repeated choices as well as unobserved taste heterogeneity, i.e., random taste variations across respondents but not across observations from the same respondent, and it is not restricted by the Independence of the Irrelevant Alternatives (IIA) property (Revelt and Train, 1998; Hensher and Greene, 2003; Train, 2003). Furthermore, it is a computationally practical and flexible model that can approximate any random utility model (McFadden and Train, 2000).

Following Scarpa et al. (2005) an Alternative Specific Constant (ASC) is specified for the status quo alternative (SQ) in order to capture the systematic component of a potential status quo effect.

Furthermore, an error component in addition to the usual Gumbel-distributed error term is incorporated into the model to capture any remaining status quo effects in the stochastic part of the utility. The error component, which is implemented as a zero-mean normally distributed random parameter, is exclusively assigned to the two non-status quo alternatives. By specifying a common error component across these two alternatives, correlation patterns in the utility over these alternatives are induced. It therefore captures any additional variance associated with the cognitive effort of evaluating experimentally-designed hypothetical alternatives (Greene and Hensher 2007; Scarpa et al. 2007b; Scarpa et al. 2008). This results in the following general utility structure:

$$U_{ntj} = \begin{cases} V(x_{ntj}, \tilde{\beta}_n, \mu_n) + \varepsilon_{ntj}, & j = 1,2; \\ V(ASC, x_{ntj}, \tilde{\beta}_n) + \varepsilon_{ntj}, & j = \mathrm{SQ} \end{cases} \tag{1}$$

where the indirect utility, V, is a function of the vector of explanatory variables, x_{ntj}, as well as the vectors of individual-specific random parameters, $\tilde{\beta}_n$. For the two experimentally-designed policy alternatives, the common individual-specific error component μ_n enters the indirect utility function, while it is replaced by the ASC for the status quo alternative. The unobserved error term ε_{ntj} is assumed to be Gumbel-distributed. The individuals are referred to as n, while j is the alternative and t is the choice set. $\tilde{\beta}_n$ varies over individuals in the population with density $f(\beta | \theta)$, where θ is a vector of the true parameters of the taste variation, e.g., representing the mean and standard deviation of the β's in the population. Assumptions concerning the distribution of each of the random parameters, i.e., the density function $f(\beta | \theta)$, are necessary. The true distribution is unknown, so, in principle, any distribution could be applied (Carlsson et al., 2003; Hensher and Greene, 2003). The normal is the most easily applied distribution (Train and Sonnier, 2005).

In the present paper, we assume that the parameters associated with all forest attributes, except the distance attribute, are normally distributed random parameters. This allows for both negative and positive preferences that could be expected on the basis of focus group interviews and a pilot test. Typically, in valuation studies, the variable representing the marginal utility of income (which is similar to our distance attribute in the sense that distance can be viewed as a cost) is kept fixed in order to avoid a number of severe problems associated with specifying a random price parameter (Train, 2001; Hensher and Greene, 2003; 2003; Hensher et al., 2005; Hess et al., 2005; Train and Sonnier, 2005; Train and Weeks, 2005; Campbell et al., 2006; Meijer and Rouwendal, 2006; Rigby and Burton, 2006). We believe that it may be important in the current case to let the distance be specified as a random variable because the costs associated with a certain travel distance may significantly depend on each individual's means of transport (car, bike or walking) and the alternative costs of time[5].

One important advantage of the specified random parameter error component model that we use in this paper is the ability to calculate estimates of individual-specific preferences by deriving the conditional distribution based (within sample) on their known sequence of choices (Train, 2003; Hensher et al., 2006). It should be mentioned that these conditional parameter estimates are strictly same-choice-specific in the sense that they are the mean of the parameters of the subpopulation that would have made the same choices when faced with the same choice situation. Hence, it is, strictly speaking, not a unique set of estimates for the individual but rather a mean and standard deviation estimate of the subpopulation that makes the same choices (Hensher et al., 2006). The estimates of individual-specific parameters are obtained using Bayes' theorem under which the conditional density for the random parameters is given by the following equation:

[5] We have chosen to use distance directly as payment vehicle because we do not have information on the mode of transport chosen if the respondent choose one of the hypothetical forests presented for them.

$$p(\beta_n|Y_n,X_n,\theta) = \frac{L(Y_n|\beta_n,X_n,\theta)f(\beta_n|\theta)}{\int_{\beta_n} L(Y_n|\beta_n,X_n,\theta)f(\beta_n|\theta)d\beta_n} \qquad (2)$$

where Y_n denotes the respondents' chosen alternatives in their sequence of choices over the T_n choice occasions, X_n denotes all elements of x_{ntj} for all t and j, and where the elements of θ are the underlying parameters of the distribution of β_n. The first term in the numerator is the likelihood of an individual's sequence of choices given that they had this particular β_n. The second term in the numerator is the distribution in the population of the β_ns. The denominator is the unconditional choice probability for the individual respondent. Since the integrals in the probabilities in Equation 2 have no closed form solution, estimation is undertaken through simulation to obtain maximum likelihood estimates. In this paper, we estimate the log-likelihood functions using 1000 Halton draws which was found to be a sufficient number of draws for results to stabilize. Estimation of the above-described model was done using Nlogit 4.0 software.

Spatial determinants of marginal WTP

In a second stage, we use an approach similar to the approach used in Campbell (2007) to analyze the individual-attribute parameters estimated above. Campbell (2007) estimated the determinants of the willingness to pay for improvement of rural landscapes in Ireland, applying procedures adapted to panel data. He found that socio-demographic variables as well as variables representing possible violations of rational preference may influence the willingness to pay. He also found a significant effect of the location of the respondent, i.e., the region of residence and the community type (urban or rural district). Our study deviates from Campbell's because a key issue for us is to explore the potential link between local access to forests and the preference for forest recreation.

Let $MWTP_{na}$ be the marginal willingness to pay for forest attribute/level *a* (where a={broadleaf tree species, mixed tree species, one hiking path, more than one hiking path, parking or picnic, parking and picnic, lake or river}) for respondent *n,* i.e. $MWTP_{na} = -\frac{\beta_{na}}{\beta_{np}}$ where β_{np} is the parameter of the distance variable in (1). To take account for differences in unobserved local differences in the access to outdoor recreational sites we include a cluster specific fixed effect where the clusters are defined by the *arrondissement*[6] *m* (*m*=1,…*16*) where the respondent has residence. We observe many individuals per cluster and few clusters. In this case of large clusters, there are only a few parameters φ_m to estimate and the incidental parameters problems do not arise (Cameron and Trivedi, 2005). The regression of $MWTP_{na}$ can be written as an error component model:

$$MWTP_{nma} = \beta_0 + \lambda_a + \varphi_m + \pi \quad h_{na} + \gamma_a ac_{na} + \delta z_n + \varepsilon_{nma} \quad (3)$$

where: $\varepsilon_{nma} = \alpha_n + e_{nma}$

In this model, the error term is composed of a random and unobservable individual-specific effect α_n, a random and a remainder disturbance e_{nma}. In the case of a random effects model, $\alpha_n \sim IID(0, \sigma_\alpha^2)$, $e_{nma} \sim IID(0, \sigma_e^2)$ and the α_n are independent of the e_{nma}. Furthermore, the λ_a and φ_m are assumed to be fixed parameters specific to the attribute and the spatial cluster, respectively, and β_0 is the constant term. h_{na} is a vector of variables characterizing the respondent n with respect to forest attribute a, z_n are the characteristics of respondent n (independent of the forest attribute a), ac_{na} is an index representing the proximity of forests where the attribute/level *a* is present, i.e;

$$ac_{na} = \sum_j^K s_{aj}\delta_{nj}, \quad \text{where } \delta_{nj} = 1 \text{ if } d_{nj} < \phi, \text{ otherwise } \delta_{nj} = 0,$$

where s_{aj} is equal to one if the attribute and level a is present in forest j and zero otherwise, d_{nj} is the distance between the residence of visitor n and forest j, and ϕ is a parameter defined by the

[6] An *arrondissement* is a spatial contiguous grouping of communes. There are 19 *arrondissements* in Lorraine. The survey did not include respondents from three *arrondissements* which had a low population density.

analyst ($\emptyset$ = 10 is used in this paper). π , γ_a and δ are the associated parameters to be estimated[7]. The index, ac_{na}, is relatively high when the respondent's residence is relatively close to forests with the considered attribute (s_{aj}=1). Compared to Campbell (2007), model (3) includes the variables ac_{na} that allow us to estimate and test if preferences for forest recreation are independent of access to forest recreation. Also, our model is more flexible since we have included attribute-fixed effects as well as attribute-specific parameters, reflecting that characteristics of the individual and local access to forests may not have the same effect on the marginal utility for all attributes. Furthermore, compared to Campbell et al. (2008, 2009) who analyze the spatial distribution of preferences in an explorative way, our model includes spatial explanatory variables (obtained from GIS maps).

4. Survey and data

The administration of our questionnaire was Web-based, a survey mode that has gained popularity in CE surveys (Olsen, 2009). An e-mail with a link to the server with the questionnaire was sent to an Internet panel of inhabitants in Lorraine. A response rate of only two percent was projected by the company maintaining the applied panel. Thus, in the main survey, 53,000 people were sent an e-mail that briefly described the survey and with a link to the questionnaire on the Web. If the respondents gave their e-mail address and completed the questionnaire, they would be able to participate in a lottery with the chance to win one of 50 USB memory keys. E-mail reminders were sent after two and four weeks. In all, 1837 respondents began to answer the online questionnaire (3.5%), and out of these, 1144 actually completed the questionnaire (2.2%). A total of 1061 (2.0%) respondents who had completed the questionnaire had visited a forest during the past 12 months and were asked to complete the CE. Seven questionnaires were excluded because there was a large difference between the distance given by the respondent and the distance calculated between the residence and the forest visited. The distance could be calculated because the respondents were also asked to identify

[7] Notice that γ_a is a parameter specific to attribute and attribute level.

on a map the forest visited most often during the last 12 months (the status quo forest in the CE). Compared to other surveys using the same panel, the response rate was relatively high, although compared to other stated preference surveys in general, the response rate was relatively low.

In Table 2, the main demographic and socioeconomic characteristics of the effective sample (1054 respondents) used to estimate the choice model are presented and compared with the total population in Lorraine. The share of female respondents is lower in the sample than in the population and the 40-60-year-old respondents are overrepresented in the sample. The sample exhibits an overrepresentation of people in high income classes. The relatively high rates of middle-aged people and high-income groups in the sample are not unusual for Internet and mail surveys (Olsen, 2009). Thus, even though the response rate might raise some concerns regarding the representativeness of the sample, the skewness of the sample for central socio-demographic characteristics does not seem to be much worse than similar surveys with much higher response rates. It should also be noted that the purpose of the present study is not to estimate aggregate welfare measures for Lorraine but to analysis preference heterogeneity. In this case, external validity is less of a concern.

[insert table 2]

The majority of the respondents (96%) have visited a forest more than once during the past 12 months, whereas 77% have visited different forests during the period. Forest visitors have visited a forest 27 times during the past year on average. In the study on forest recreation in Lorraine by Despres and Normandin (op cit) in 1997, it was estimated that a household visited a forest 40 times during a year on average. A study carried out at the national level in France in the year 2000 (Peyron et al., 2002) estimated the average forest visits per household in France to be only nine times per year, though this only included car-borne visits and was done just after the major windthrows in

1999. The latter study also showed that the percentage of respondents who went to the forest was 44%. This relatively low percentage at the national level may also be due to less accessibility to forests in other regions in France and only considering car-borne visits.

The second-stage analysis uses only the respondents with primary residences in Lorraine and who had visited a forest in Lorraine during the past 12 months[8]. The respondents from the *departement* (county) Les Vosges who are located in the Southern part of Lorraine are excluded. Les Vosges is a mountain area which around 50% of land cover is forest and natural vegetation. In Table 3, the variables representing potential determinants of preference heterogeneity are defined. These include socio-demographic characteristics (age, employment status, income, recreational habits and attitude to environment) of the respondents obtained from the questionnaire. As in Campbell (2007), the effect of non-attendance of an attribute in the respondents' trade-offs is estimated. After having carried out the CE, the respondents are asked if they have ignored attributes when they made their choices of forest. Of the 464 respondents analyzed in the second stage, 20% replied that they have not used the species attribute when making the choice (Table 4). The non-attendance rate is at about the same level for trekking path and the lake and river attribute. The non-attendance rate is 31% in the case of facilities.

The variable representing accessibility to forests with a given attribute is calculated using a recently established GIS database with data characterizing forests in Lorraine (Thirion, 2010) and a GIS road map. Variables describing tree species composition of the forest are obtained from the French National Forest Inventory (IFN). Data describing the presence of hiking paths are obtained from the French Hiking Association (Fédération Française de Randonnée Pédestre), while data concerning the presence of recreational facilities, lakes and rivers in forests are obtained from the French National Geographic Institute (IGN). The definition of forest is the one used by Thirion (2010)[9]. Basically,

[8] 410 of the respondents who participated in the CE were, according to their own information provided in the questionnaire, not living in Lorraine or had not visited a forest in Lorraine during the past 12 months.
[9] The definition of forest units in Thiron (2010) did originally not include forest smaller than 100 ha, if there was no recreational facility. The dataset used in the present study include all forest larger than five hectare.

forests are continuous land with forest cover. If a forest is very large (typically, greater than 1,000 hectares), it is divided into two or more forest units that are considered to be a unity in our analysis. The division of forests into units is, among other things, determined by existing structures in the forest, e.g., roads or rivers. The first 7 lines in Table 4 give the distribution of attribute levels in the 5567 forests in Lorraine. Forests dominated by broadleaves are the most frequent type in Lorraine. Eight percent of the forests have one marked hiking path, while only 3 percent have more than one marked hiking path. A total of 95% of the forests have no recreation facilities (parking and picnic places), while four percent have either a picnic or a parking place and only one percent have both types of facilities. A total of 47% of the forests have access to water, i.e., lakes and/or rivers.

The distance between a respondent and a given forest is the road distance between the town hall of the municipality (*commune*) where the respondent had his/her residence and the nearest entry point of the forest. In the empirical results presented in Section 5, the accessibility index is the number of forests within in a road distance of 10 km from the residence.

Table 4 describes both an average attribute accessibility index and attribute-specific index. As expected, forests characterized by the most frequent attributes (e.g., broadleaves) are also the most accessible ones according to our accessibility index.

[insert table 3]

[insert table 4]

5. Results

5.1. Results from the first-stage analysis

The parameter estimates obtained from the random parameter error component model are reported in Table 5. With a McFadden's pseudo-R^2 of 0.229, the specified model fits the data quite well. All parameters have the expected sign and are significantly different from zero. The utility of visiting a broadleaf forest or a mixed species forest is higher than visiting a forest dominated by conifers. Visitors generally prefer a forest with one marked hiking path to a forest without a marked hiking path, and they prefer to have more hiking paths rather than just one. However, in the case of picnic and parking facilities, only one of the facilities is preferred. On average, the respondents obtain less utility when both parking and picnic facilities are present than when only one of these two are present. This may be because the two facilities are not seen as complementary but instead as potentially conflicting facilities due to different uses. It is possible that people consider that a picnic place is less attractive if there is a parking lot close to the picnic place or that a parking place will make the picnic place more crowded. It is also important here to consider the significant standard deviation of the random parameter of the picnic and parking attribute level. Combining this evidence of preference heterogeneity with the mean parameter estimate indicates that a rather large percentage (41%) of the respondents experience a negative utility when both facilities are present[10]. The respondents prefer visiting forests with lakes or rivers and forests that are close to their residential location. Not surprisingly, we found significant preference heterogeneity for all parameters except for the parameter for broadleaf forest and one recreation facility (parking or picnic place). The positive parameter estimate for the ASC captures a systematic status quo effect. All other things being equal, respondents prefer the status quo alternative, i.e., the forest they have visited most often in the past 12 months. In other words, respondents show an affinity for this alternative beyond what the specific attribute levels for this alternative relative to the two other alternatives would predict. The significant error component further adds a stochastic element to the status quo effect. As this parameter estimate is common to the two experimentally designed alternatives, it also implies significantly differing covariance structures across the utilities of these two alternatives and those of the status quo alternative (Scarpa et al. 2005, 2008).

[10] The 41% is calculated as the Φ[-(mean parameter estimate/ random parameter standard deviation)]= the Φ[-(0.150/ 0.641)] where Φ[x] is the cumulative standard normal distribution.

[insert table 5]

5.2. Results from the second-stage analysis

Table 6 presents the estimates of the model outlined in Equation 3 obtained by the GLS method on the random effect model. The second stage approach takes the conditional marginal WTP estimates from the first stage as given. However, it should be noted that the conditional individual-specific estimates used are not known with certainty as they are the means of the underlying individual-specific distributions. Hence, taking these estimates as given essentially disregards the fact that they also come from a distribution. For this reason caution in the interpretation of the significance levels obtained is necessary since they are potentially not efficient even though they are consistent. While this is of course an important limitation to bear in mind, following e.g. Train (2003), Greene et al. (2005), Campbell et al. (2008; 2009), Hess (2010) and Hess and Hensher (2010) we believe there is a nevertheless considerable merit in using these conditional estimates for the purpose at hand. The first six estimates in Table 6 are the dummy variables representing the different attribute levels. The lake or river attribute is excluded to avoid the dummy trap problem, i.e. avoiding perfect multicollinearity between attribute dummies. This implies that the estimates represent the marginal utility in addition to the marginal utility of having a lake or a river in the forest visited. One of the objectives of this study is to test for spatial sorting. A significant impact on the marginal WTP of accessibility to forest (access) with the respective attribute is interpreted as evidence of spatial sorting. If a positive parameter on the accessibility variable is found, it may be because people choose their location of residence close to forests with attributes that they have strong preferences for (Baerenklau, 2010). We find only a significant effect of accessibility to forest on the marginal WTP for the picnic and parking attribute (at the 5% level). As described in Section 4, the variable representing accessibility to forest ac_{na} is the number of forests within a distance of 10 kilometers from the residence. The model is also estimated using different assumptions about the maximum distance of forest considered in the respondent's neighborhood. The results are generally robust to such changes. We find a weakly significant correlation in all cases between forests with parking and picnic places and the preferences for this attribute. For the variables characterizing the respondents, only variables which have statistically significant parameters are kept in the final model which is presented in table 6. The coefficients of the attendance variable (natt) is positive as expected but only significant for the mixed species forest and the lake or river attributes. Income has a significant negative impact on the marginal WTP of visiting forests with mixed tree species but positive WTP for visiting forests with presence of a lake or a river attribute. The marginal WTP for the mixed forest increases with age while the WTP for visiting forest with lakes and rivers decreases with age. Six percent of the respondents stated that they are hunters and eight percent that they are members of a hiking club. It could be expected that preferences for different forest attributes may depend on the recreation activities of the respondent (Hanley et al., 1998; Christie et al., 2007). However, we find no significance of hiking club membership and the model is re-estimated without the hiking club membership dummy. Nevertheless, being a hunter has a strong negative impact on the preference for lake and river. Other socio-economic and attitudinal characteristics of the respondent indicate workers (employed but not in a managerial position), and frequent buyers of fair trade products have a higher WTP while frequent user of museums and respondents sorting their trash regularly have a lower WTP. Gender and variables representing education level did not have a significant impact on the willingness to pay. Furthermore, dummy variables representing the three blocks of choice sets were included in the initial estimations but were not significant. These block dummies were included to account for the fact that the individual-specific WTPs are choice specific. The variable z20_25km is a dummy representing municipalities close to the border of Lorraine. We do not have access to data on characteristics of forest outside Lorraine. Therefore, the variable representing access to forests will not represent the forests located outside Lorraine but which are still in the neighborhood of the respondent. Dummies for different zones were defined but only the dummy representing municipalities in a zone of 20-25 kilometers from the border is significant. The estimated fixed cluster effects are not reported but have been tested by performing a *F*-test. The statistic *F*(15, 3206) is equal to 2.79 and is greater than the critical value at a 1% level. We also performed a *F*-test for fixed attribute-specific effects. The statistic F(6, 3206) is equal to 162.79, a value much larger than the critical value at a 1% level. In both cases, the best specification of the model is to introduce the fixed effects.

The test results for appropriateness of using the random-effects model included the Lagrange multiplier test of the hypothesis that σ_α^2 is equal to zero, developed by Breusch and Pagan (1980). The value of the $\chi^2(1)$ is 257.55, implying that the null is largely rejected. This indicates that there were (random) individual-specific effects and that our use of panel data procedures increased estimation efficiency. Moreover, a Hausman test is used to test the hypothesis that the random individual effects are independent of the explanatory variables. The value of the statistic is 13.83 (with a *p*-value of 0.74) and is below the $\chi^2(18)$ critical value at the 1% level. The hypothesis of exogeneity of explanatory variables can not be rejected and thus justifies the use of the GLS estimation method on the random effect model.

[insert table 6]

6. Discussion

We present a study on forest visitors' preferences for recreational attributes of forests, applying a two-stage procedure model. In the first stage, we estimated individual-specific marginal willingness to pay for forest attributes, applying a random parameter error component logit model and, in the second stage, we analyzed the estimated individual-attribute WTPs and their determinants. The results from the first stage show strong evidence of preference heterogeneity. Consequently, our results confirm the results of other studies that have found preference heterogeneity for recreation (e.g., Christie et al., 2007; Termansen et al., 2008; Baerenklau, 2010, Bestard and Font, 2010) and environmental services (e.g., Campbell et al., 2007; Brouwer et al., 2010). For example, the mean marginal utility of having access to a forest with both picnic and parking places is lower than the marginal utility of a forest with only one of these facilities. Our results also show that some respondents obtain a positive utility from these facilities when visiting a forest, while others, on the contrary, obtain a negative utility. A related result is obtained in the survey in 1997 by Despres and Normandin (1998). They did find that 32% and 27% of the respondents replied that there were too many parking places and picnic places, respectively, in the forests in Lorraine. This heterogeneity in preferences may influence the optimal spatial configuration of forests as well the optimal distribution of forest types. Termansen and McClean (2005) find in an analysis of the optimal spatial distribution of recreation areas in Denmark is influenced by demand factors (e.g. population density) and substitution and complementarities between different sites (forest and non-forest sites). Ando and Shah (2010) use theoretical models of linear abstract landscapes to explore the impact of demand-side factors on optimal land conservation choice. They find that the population distribution and spatial value decay have an impact on the optimal conservation site selection. However, results are sensitive to assumptions about the specification of the model (e.g. degree of spatial value decay, agglomeration effects etc.). However, these studies do not address the impact of preference heterogeneity on optimal location choices. This should be addressed in future research, including integrated analyses of conservation selection and spatial configuration of outdoor recreation sites.

Generally speaking, forests dominated by broadleaf and mixed tree species seem to be preferred to forests dominated by coniferous tree species, which is consistent with the results reported by Scarpa et al. (2000) and Nielsen et al. (2007). However, Termansen et al. (2008) found some preference for coniferous forests, contrary to their expectations. Positive utility of hiking paths has also been found by Christie et al. (2007) and Bestard and Font (2010). The presence of water bodies in forests also reveals a positive impact on the utility of a visit, as was also reported by Termansen et al. (2004). Finally, respondents prefer forests close to their residence (i.e., a negative marginal utility of distance), as expected. The second-stage analysis shows that visitor's age, income and being a hunter, employment status, number of visits at museums, and frequency of buying fair trade products and waste sorting have an impact on the marginal WTP of forest attributes, while there are no significant effect of being member of a hiking club (variable not in table 6 because it was not significant). Income is also found to be a significant determinant of preferences in Campbell (2007). However, we find that the income effect is attribute-dependent". As expected, we find a significantly negative impact of non-attendance of an attribute in the choice tasks (Campbell, 2007).

Heterogeneity is present among forest visitors as well as forests in Lorraine are heterogeneous both in terms of their ecological components and their facilities. With significant preference heterogeneity and variability in the access to forests, i.e., presence of forests with the demanded quality (attribute levels) in the respondent's proximity, and given that individuals include accessibility to forests in their choice of residence location, we would expect spatial sorting to occur. This would imply that preferences for forest attributes would be correlated with the accessibility to forests with these attributes. In the second-stage analysis we included a variable representing the proximity or access to the forest with a given attribute. This variable is found to be insignificant in accounting for preference heterogeneity, except for the forest with picnic and parking facilities. Due to this weak link between access and preferences (only significant with respect to one attribute), we cannot conclude that there is strong empirical evidence of spatial sorting due to preferences for forest recreation[11]. The positive correlation between marginal WTP for visiting forests with picnic and

[11] A high correlation between WTP and access to forest would not necessarily be a result of spatial sorting in the choice of residence location but could also be explained by people living close to forest over time get a higher willingness to pay for forest recreation, i.e. the accustomization effect (cf. Section 2). In an initial estimation we included an interaction term between access to forest variable and number of years the respondent had residence in the same municipality. The interaction variables were not significant.

parking places and the access to such forests indicate, however, that potential endogeneity of travel distance should be considered in applications of the travel cost method based on revealed preference data (Parsons 1991). Several explanations could be proposed to account for not finding a correlation between access to forest recreation and preference for all the forest attributes considered. The most obvious one is that Lorraine is relatively densely forested and the residents are therefore always relatively close to a forest corresponding to their preferences, implying relatively little variation in data. The distance to the closest forest is on average 396 meters (minimum distance is 32 meters and maximum distance is 3,478 meters). This, in combination with rather imprecise residence location data (information only about the commune but no specific addresses) necessarily makes estimates less precise and weakens the link in our data between heterogeneous preferences and location of forests with different attributes. The reason that we find no evidence of spatial sorting could also be that individuals do not choose a location according to their preferences for recreational uses in forests but according to preferences for other uses or benefits provided by forests such as green views or open spaces (Baerenklau, 2010). This may also be due in large part to unobserved factors (school quality, sport facilities, etc.) that also influence the location choice. The preferences for these unobserved factors may be positive correlated with preferences for forest access but their spatial distribution may be negative correlated with access to forests and therefore blur the correlation between forest access and preferences for forest recreation. An alternative and more direct approach to analyze spatial preference heterogeneity and spatial sorting would be to model location choice explicitly and include other types of amenities important for the choice of residence location (see Klaiber and Phaneuf, 2010). Future research should also address whether different subgroups are more or less prone to spatial sorting (Epple et al, 2010). Such groups could, for example, be defined by different moving costs. One of the reasons for not finding a correlation between respondents' marginal attribute utility and accessibility to the forest could be an imperfect housing market where transaction costs exceed the gains of relocating according to preferences for forest recreation. Even though we didn't find strong evidence of correlation between WTP and access to forests we found significant spatial heterogeneity in preferences for forests. Based on our cluster model specification the hypothesis of homogeneous WTP between *arrondissements* was rejected. Since we have controlled for the impact of income and other characteristics of the respondents on WTP this indicates the presence of unobserved spatial factors having an impact on WTP (Johnston et al. 2011), including preferences for other amenities, which have a heterogeneous spatial distribution.

References

Adamowicz, W.L., Louviere, J., Williams, M., 1994. Combining revealed and stated preference methods for valuing environmental amenities. Journal of Environmental Economics and Management 26, 271-392.

Ando, A.W., Shah, P., 2010. Demand-side factors in optimal land conservation choice. Resource and Energy Economics, 32, 203-221.

Baerenklau, K.A., 2010. A latent class approach to modeling endogenous spatial sorting in zonal recreation demand models. Land Economics 86 (4), 800-816.

Baerenklau, K.A., Conzález-Cabán, A., Paez, C., Chavez, E., 2010. Spatial allocation of forest recreation value. Journal of Forest Economics 16 (2), 113-126.

Bateman, I.J., Day, B.H., Georgiou, S., Lake, I., 2006. The aggregation of environmental benefit values: Welfare measures, distance decay and total WTP. Ecological Economics 60, 450-460.

Bergmann, A., Colombo, S., Hanley, N., 2008. Rural versus urban preferences for renewable energy developments. Ecological Economics 65 (3), 616-625.

Bestard, A.B., Font, A.F., 2010. Estimating the aggregate value of forest recreation in a regional context. Journal of Forest Economics 16, 205-216.

Birol, E., Karousakis, K., Koundouri, P., 2006. Using a choice experiment to account for preference heterogeneity in wetland attributes: The case of Cheimaditida wetland in Greece. Ecological Economics 60, 145-156

Bockstael, N.E., Hanneman, M., Kling, C.L., 1987. Estimating the value of water quality improvements in a recreational demand framework. Water Resources Research, 23 (5), 951-960.

Breusch, T.S. Pagan, A.R. 1980. The Lagrange multiplier test and its application to model specifications in econometrics. Review of Economic Studies 47, 239–253.

Brey, R., Riera, P., Mogas, J. 2007. Estimation of forest values using choice modeling: An application to Spanish forests. Ecological Economics 64, 305-312

Broch, S.W., Strange, N., Jacobsen, J.B., Wilson, K.A. 2012. Farmers' willingness to provide ecosystem services and effects of their spatial distribution. Ecological Economics (Forthcoming).

Brouwer, R., Martin-Ortega, J., Berbel, J., 2010. Spatial preference heterogeneity: A choice experiment. Land Economics 86 (3), 552-568.

Carlsson, F., Frykblom, P., Liljenstolpe, C., 2003. Valuing wetland attributes: an application of choice experiments Ecol Econ 47(1):95-103

Cavailhès, J., Brossard, T., Foltête, J., Hilal, M., Joly, D., Tourneux, F., Tritz, C., Wavresky, P.,2009. GIS-based hedonic pricing of landscape. Environmental and Resource Economics, 44 (4), 571-590.

Campbell, D., 2007. Willingness to pay for rural landscape improvements: Combining mixed logit and random-effects models. Journal of Agricultural Economics, 58 (3), 467-483.

Campbell, D., Hutchinson, W.G, Scarpa, R., 2006. Using mixed logit models to derive individual-specific WTP estimates for landscape improvements under agri-environmental schemes: evidence from the Rural Environment Protection Scheme in Ireland. In: Koundouri, P., Birol, E. (eds). Choice experiments informing European environmental policy. Edward Elgar, 58-81.

Campbell, D., Hutchinson, G., Scarpa, R., 2009. Using choice experiments to explore the spatial distribution of willingness to pay for rural landscape improvements. Environment and Planning 41, 97-112.

Campbell, D., Scarpa, R., Hutchinson, W.G., 2008. Assessing the spatial dependence of welfare estimates obtained from discrete choice experiments. Letters in Spatial and Resource Sciences 1 (2-3), 117-126.

Christie, M., Hanley, N., Hynes, S., 2007. Valuing enhancements to forest recreation using choice experiment and contingent behaviour methods. Journal of Forest Economics 13 (2-3), 75-102.

Despres, A., Normandin, D., 1998. Demande et évaluation des services écologiques et récréatifs des forêts en Lorraine. Document de Recherche, ENGREF, Nancy.

Epple, D., Peress, M., Sieg, H., 2010. Identification and semiparametric estimation of equilibrium models of local jurisdictions. American Economic Journal: Microeconomics 2, 195-220.

Greene, W. H., Hensher, D. A., Rose, J. M., 2005. Using classical simulation-based estimators to estimate individual WTP values. In: Scarpa, R., Alberini, A., (eds.). Applications of simulation methods in environmental and resource economics. The economics of non-market goods and resources, vol. 6. Springer, Dordrecht, The Netherlands, 17-33.

Greene, W.H., Hensher, D.A., 2007. Heteroscedastic control for random coefficients and error components in mixed logit. Transportation Research. Part E, Logistics & Transportation Review 43 (5), 610-623.

von Haefen, R.H., Phaneuf, D.J., 2008. Identifying demand parameters in the presence of unobservables: A combined revealed and stated preference approach. Journal of Environmental Economics and Management 56 (1), 19-32.

Hand, M.S., Thacher, J.A., McCollum, D.W., Berrens, R.P., 2008. Intra-Regional Amenities, Wages, and Home Prices: The Role of Forests in the Southwest. Land Economics 84(4), 635-651.

Hanley, N., Macmillan, D.C., Wright, R.E., Bullock, C., Simpson, I., Parsisson, D., Crabtree, B., 1998. ontingent valuation versus choice experiments: Estimating the benefits of environmentally Sensitive Areas in Scotland. Journal of Agricultural Economics 89 (1), 1-15.

Hanley, N., Wright, R.E., Koop, G., 2002. Modelling recreation demand using choice experiments: Climbing in Scotland. Environmental and Resource Economics, 22, 449-466.

Hensher, D.A., Greene, W.H., 2003. The mixed logit model: The state of practice. Transportation 30, 133-176.

Hensher, D.A., Rose, J.M., Greene, W.H., 2005. Applied choice analysis: a primer. Cambridge University Press, Cambridge, UK.

Hensher, D.A., Greene, W.H., Rose, J.M., 2006. Deriving willingness-to-pay estimates of travel-time savings from individual-based parameters. Environment and Planning A 38 (12), 2365 – 2376.

Hess, S., Bierlaire, M., Polak, J., 2005. Estimation of value of travel-time savings using Mixed Logit models. Transportation Research Part A: Policy and Practice 39 (3), 221-236

Hess, S. (2010), Conditional parameter estimates from Mixed Logit models: distributional assumptions and a free software tool, Journal of Choice Modelling 3 (2), 134-152

Hess, S., Hensher, D. A., 2008. Using conditioning on observed choices to retrieve individual-specific attribute processing strategies. Transportation Research Part B: Methodological 44 (6), 781-790

Irwin, E.G., 2002. The effects of open space on residential property values. Land Economics 78 (4), 465-480.

Irwin, E.G., Bockstael, N.E., 2001. The problem of identifying land use spillovers: Measuring the effects of open space on residential property values. American Journal of Agricultural Economics, 83 (3), 698-704.

Klaiber, H.A., Phaneuf, D.J., 2009. Do sorting and heterogeneity matter for open space policy analysis? An empirical comparison of hedonic and sorting models. American Journal of Agricultural Economics 91 (5), 1312-1318.

Klaiber, A.H., Phaneuf, D.J., 2010. Valuing open space in a residential sorting model of the Twin Cities. Journal of Environmental Economics and Management 60 (2), 57-77.

Kuminoff, N.V., 2009. Decomposing the structural identification of non-market values. Journal of Environmental Economics and Management 57 (2), 123-139.

Leplat, M., Le Goffe, P., 2009. Faut-il réguler l'encombrement des sites récréatifs? Un modèle de choix discret avec participation. Revue d'Etudes en Agriculture et Environnement 90 (1), 51-77.

McFadden, D., 1974. Conditional logit analysis of qualitative choice behaviour. In: Zarembka, P., (Ed.). Frontiers Econometrics. New York: Academic Press, 105-142.

McFadden, D., Train, K.E., 2000. Mixed MNL models for discrete response. Journal of Applied Econometrics 15 (5), 447-470.

Meijer, E., Rouwendal, J., 2006. Measuring welfare effects in models with random coefficients. Journal of Applied Econometrics 21 (2), 227-244.

Murdock, J., 2006. Handling unobserved site characteristics in random utility models of recreation demand. Journal of Environmental Economics and Management 51 (1), 1-25.

Nielsen, A.B., Olsen, S.,B., Lundhede, T., 2007. An economic valuation of the recreational benefits associated with nature-based forest management practices. Landscape and Urban Planning 80, 63-71.

Normandin, D., 1998. Une évaluation de la demande sociale de services environnementaux de la forêt. INRA Sciences Sociales, Recherches en Économie et Sociologies Rurales N° 2 -juin 1998, 1-4.

Norton, B., Costanza, R., Bishop, R.C. 1998. The evolution of preferencesWhy 'sovereign' preferences may not lead to sustainable policies and what to do about it. Ecological Economics 24, 193-211.

Olsen, S.B., 2009. Choosing between internet and mail survey modes for choice experiment surveys considering non-market goods. Environmental and Resource Economics 44 (4), 591-610.

Parsons, G.R., 1991. A note on choice of location in residential travel cost demand models. Land Economics 67 (3), 360-364.

Peyron, J.-L., Bakouma, J., Berthier, A., Colnard, O., Normandin, D., Stenger, A., Tessier, A., 2001. Première évaluation économique globale des dégâts forestiers dus aux tempêtes de décembre 1999. Research report, Laboratoire d'Economie Forestière, pp42.

Peyron, J-L, Harou, P., Niedzwiedz, A., Stenger, S., 2002. National survey on demand for recreation in French forests. Research Report. Laboratoire d'Economie Forestière, INRA, Nancy, pp44.

Randall, A., 1994. A Difficulty with the travel cost method. Land Economics 70 (1), 88-96.

Revelt, D., Train, K. E. 1998. Mixed logit with repeated choices: households' choices of appliance efficiency level. Review of Economics and Statistics 80 (4), 647-657.

Rigby, D., Burton, M., 2006. Modeling disinterest and dislike: A bounded bayesian mixed logit model of the UK market for GM food. Environmental and Resource Economics 33(4),485-509.

Roback, J., 1982. Wages, rents, and quality of life. The Journal of Political Economy 90, 1257-1278.

Scarpa, R., Campbell, D., Hutchinson, W.G., 2007a. Benefit estimates for landscape improvements : Sequential Bayesian design and respondents ' rationality in a choice experiment. Land Economics 83 (4), 619-634.

Scarpa, R., Ferrini, S., Willis, K., 2005. Performance of error component models for status-quo effects in choice experiments. In: Scarpa, R., Alberini, A., (eds.). Applications of simulation methods in environmental and resource economics. The economics of non-market goods and resources, vol. 6. Springer, Dordrecht, The Netherlands, pp247-273

Scarpa, R., Hutchinson, W.G., Chilton, S.M., Buongiorno, J., 2000. Importance of forest attributes in the willingness to pay for recreation: a contingent valuation study of Irish forests. Forest Policy and Economics 1, 315-329.

Scarpa, R., Thiene, M., Marangon, F., 2008. Using flexible taste distributions to value collective reputation for environmentally friendly production methods. Canadian Journal of Agricultural Economics 56 (2), 145-162.

Scarpa, R., Willis, K., Acutt, M. 2007b. Valuing externalities from water supply: status quo, choice complexity, and individual random effects in panel kernel logit analysis of choice experiments. Journal of Environmental Planning and Management 50 (4), 449-466.

Schaafsma, M., Brouwer, R., Rose, J. M. 2011. Directional heterogeneity in WTP-space models for environmental valuation. Paper presented at the 18th Annual Conference of the European Association of Environmental and Resource Economists, June 29 –July 2 2011, Rome.

Schläpfer, F., Hanley, N., 2003. Do local landscape patterns affect the demand for landscape amenities protection? Journal of Agricultural Economics 54 (1), 21-34.

Schmidt, L., Courant, P.N., 2006. Sometimes close is good enough: The value of nearby environmental amenities. Journal of Regional Science 46, 931-951.

Sieg, H., Smith, V.K., Banzhaf, H.S., Walsh, R., 2004. Estimating the general equilibrium benefits of large changes in spatially delineated public goods. International Economic Review 45 (4), 1047-1077.

Smith, V.K., Sieg, H., Banzhaf, H.S., Walsh, R.P., 2004. General equilibrium benefits for environmental improvements: projected ozone reductions under EPA's prospective analysis for the Los Angeles air basin. Journal of Environmental Economics and Management 47, 559-584.

Termansen, M., McClean, C. 2005. Optimal spatial allocation of reafforestation areas. Paper presented at The European Association of Environmental and Resource Economics Conference. 14th Annual Conference, Bremen, Germany 23 - 26 June 2005.

Termansen, M., Skov-Petersen, H. McClean, C.J. 2004. Recreational site choice modelling using high-resolution spatial data. Environmental and Planning A 36, 1085-1099.

Termansen, M., Zandersen, M., Mcclean, C., 2008. Spatial substitution patterns in forest recreation. Regional Science and Urban Economics 38 (1), 81-97.

Thirion, E., 2010. Utilisation d'un Système d'Informations Géographiques pour caractériser l'usage récreatif des forêts de Lorraine. AgroParisTech, Engref. Nancy.

Tiebout, C., 1956. A pure theory of local expenditures. Journal of Political Economy 64, 416–424.

Timmins, C., Murdock, J., 2007. A revealed preference approach to the measurement of congestion in travel cost models. Journal of Environmental Economics and Management 53, 230-249.

Train, K.E., 2001. A comparison of hierarchical Bayes and maximum simulated likelihood for mixed logit. Working paper. Department of Economics, University of California, Berkeley, USA.

Train; K.E., 2003. Discrete choice methods with simulation. Cambridge University Press, Cambridge, UK.

Train. K.E., Sonnier, G., 2005. Mixed logit with bounded distributions of correlated partworths. In: Scarpa, R., Alberini, A., (eds.). Applications of simulation methods in environmental and resource economics. The economics of non-market goods and resources, vol. 6. Springer, Dordrecht, The Netherlands, 117-134.

Train, K.E., Weeks, M., 2005. Discrete choice models in preference space and willingness-to-pay Space. In: Scarpa, R., Alberini, A., (eds.). Applications of simulation methods in environmental and resource economics. The economics of non-market goods and resources, vol. 6. Springer, Dordrecht, The Netherlands, 1-16.

Troy, A., Wilson, M., 2006. Mapping ecosystem services: Practical challenges and opportunities in linking GIS and value transfer. Ecological Economics 60 (2), 435-449.

Walsh, R., 2007. Endogenous open space amenities in a locational equilibrium. Journal of Urban Economics 61, 319-344.

Whitehead, J.C., Pattanayak, S.K., Van Houtven, G.L., Gelso, B.R., 2008. Combining revealed and stated preference data to estimate the nonmarket value of ecological services: An assessment of the state of the science. Journal of Economic Surveys 22 (5), 872-908.

Wu, J., Adams, R.M., Plantinga, A.J., 2004. Amenities in an urban equilibrium model: Residential development in Portland, Oregon. Land Economics 80 (1), 19-32.

Table 1. Attributes and attribute levels

Attributes	Levels
Dominant tree species	Conifers
	Broadleaves
	Mixed tree species
Hiking paths	No marked hiking paths
	One marked hiking path
	More than one hiking path
Facilities	No facilities
	Parking or picnic places
	Parking and picnic places
Access to water	No water body
	River or lake in the forest
Distance from your home	0.5, 2, 5, 10, 20, 50 km

Table 2. Sample and population characteristics

	Sample	Lorraine
Gender distribution (% women)	37	52
Age distribution (%)		
20 - 39 years	27	34
40 - 59 years	51	37
60 - 74 years	21	18
75- years	1	11
Household income		
€0 – 9,400	6	25
€9,401 – 13,150	5	14
€13,151 – 15,000	4	8
€15,001 – 18,750	5	13
€18,751 – 23,750	10	11
€23,751 – 28,750	13	8
€28,751 - 38,750	22	10
€38,751 – 48,750	15	5
> €48,750	21	6

Source: Age and gender: INSEE – *Population estimations;* Income: Taxable income 2008. www2.impots.gouv.fr/documentation/statistiques/ircom2007/region/region.htm

Table 3. Description of variables used in second-stage analysis

Variable	Variable explanation	model
$MWTP_{na}$	Marginal utility for individual *n* for attribute *a*	$MWTP_{na}$
sp_br	Is 1 if attribute *Dominant tree species* = *Broadleaves*; otherwise 0	
sp_mix	Is 1 if attribute *Dominant tree species* = *Mixed tree species*; otherwise 0	
pa_one	Is 1 if attribute *Hiking paths* = *One marked hiking path*; otherwise 0	
pa_more	Is 1 if attribute *Hiking paths* = M*ore than one marked hiking path*; otherwise 0	
fa_p	Is 1 if attribute *Facilities* = *Parking or picnic places* indicates presence of picnic or parking place; otherwise 0	
fa_pp	Is 1 if attribute *Facilities* = *Parking and picnic places* indicates presence of picnic or parking place; otherwise 0	
natt	Is 1 if attribute is used in trade-off in the CE, i.e., nonattendance of attribute if natt = 0	*h*
access	Accessibility for respondent *n* to forests with attribute *a*	ac_{na}
hunter	Is 1 if the respondent is a hunter; otherwise 0	*z*
museum	Number of visits in a museum during the last 12 months	*z*
age	Respondent's age	*z*
income	Annual income classes in €: 1: < 9,400, 2 : [9,401, – 13,150], 3: [13,151 – 15,000], 4: [15,001 – 18,750], 5: [18,751 – 23,750], 6 : [23,751– 28,750], 7: [28,751– 38,750], 8: [38,751 – 48,750], 9: > 48,750	*z*
profemp	Is 1 if working but does not hold a managerial position; otherwise 0	*z*
buyequal	Purchase of fair-trade products; 1,…,5 where 1 = never, 3 = sometimes 5 = often	*z*
trashso	Sorting the household waste; 1,…,5 where 1 = never, 3 = sometimes 5 = often	*z*
Z20_25km	Zoning dummy for commune close to Lorraine limit	

Table 4 Descriptive statistics: second-stage variables

Variable	Mean	Std. Dev.	Minimum	Maximum	Number of observations
s_{na}					
a=Broadleaf species	0.719	0.449	0	1	5567
a=Mixed tree species	0.237	0.425	0	1	5567
a=One hiking path	0.084	0.278	0	1	5567
a=More than one hiking path	0.026	0.158	0	1	5567
a=Parking or picnic	0.038	0.191	0	1	5567
a=Parking and picnic	0.011	0.102	0	1	5567
a=Lake or river	0.468	0.499	0	1	5567
ac_{na} (access)	12.9	16.1	0	76	3248
a=Broadleaf	42	12	0	76	3248
a=Mixed tree species	9.0	7.1	0	43	464
a=One hiking path	6.8	4.6	0	15	464
a=More than one hiking path	3.5	3.8	0	13	464
a=Parking or picnic	1.3	1.4	0	8	464
a=Parking and picnic	0.7	0.8	0	4	464
a=Lake or river	26.4	9.6	0	50	464
Marginal willingness to pay ($MWTP_{na}$)	13.43	9.21	-51.5	110	3248
$natt_a$ (attendance of attribute in choice task)	0.767	0.423	0	1	3248
a= Broadleaf *a*=Mixed tree species,	0.80	0.40	0	1	928
a= One hiking path *a*=More than one hiking path	0.81	0.39	0	1	928
a=Parking or picnic, *a*=Parking and picnic	0.69	0.46	0	1	928
a=lake or river	0.78	0.42	0	1	464
income	6.5	2.23	1	9	464
hunter	0.060	0.242	0	1	464
age	49.1	11.92	11	79	464
profemp	0.325	0.469	0	1	464
buyequal	2.950	0.954	1	5	464
museum	2.373	3.348	0	20	464
Z20_25KM	0.054	0.226	0	1	464
Trashso=2	0.017	0.130	0	1	464
Trashso=4	0.091	0.287	0	1	464

Table 5. Estimation results: The random parameter error component model

Attribute	Coefficient		St. error	z	P(z>|Z|)
Mean estimates					
Broadleaf	0.699	***	0.063	11.1	0.000
Mixed species	0.883	***	0.070	12.6	0.000
One hiking path	0.427	***	0.062	6.9	0.000
More hiking path	0.764	***	0.063	12.1	0.000
Parking or picnic	0.220	***	0.061	3.6	0.000
Parking and picnic	0.150	**	0.063	2.4	0.017
Lake or river	0.590	***	0.056	10.6	0.000
Distance	-0.041	***	0.002	16.9	0.000
ASC	0.502	***	0.082	6.1	0.000
Random parameter standard deviations					
Broadleaf	0.299		0.199	1.5	0.133
Mixed species	0.715	***	0.112	6.4	0.000
One hiking path	0.457	***	0.160	2.9	0.004
More hiking path	0.388	**	0.153	2.5	0.011
Parking or picnic	0.192		0.274	0.7	0.484
Parking and picnic	0.641	***	0.118	5.4	0.000
Lake or river	0.736	***	0.096	7.7	0.000
Distance	-0.041	***	0.002	16.9	0.000
Error component, μ	2.076	***	0.092	22.5	0.000
# respondents	1054				
# choice observations	6324				
McFadden's Pseudo-R2	0.229				
Log likelihood at convergence	-5357				

**p≤0.05, ***p≤0.01

Table 6 Estimation results from the second stage

Variable	Parameter		Standard error	*z*	P>|z|
sp_br	4.170	**	1.883	2.21	0.027
sp_mix	7.208	***	2.115	3.41	0.001
pa_one	-2.512		1.691	-1.49	0.137
pa_mor	5.221	***	1.659	3.15	0.002
fa_p	-8.520	***	1.672	-5.10	0.000
fa_pp	-10.917	***	1.666	-6.55	0.000
access*sp_br	-0.0074		0.023	-0.32	0.751
access*sp_mix	-0.017		0.041	-0.42	0.675
access *pa_one	-0.072		0.062	-1.16	0.246
access *pa_more	0.0095		0.078	0.12	0.903
access *fa_p	0.041		0.209	0.20	0.843
access*fa_pp	0.680	**	0.344	1.98	0.048
access*water	-0.0024		0.031	-0.08	0.938
Natt*mix	1.150		0.714	1.61	0.107
Natt*water	2.893	***	0.681	4.25	0.000
income *sp_mix	-0.279	**	0.129	-2.17	0.030
income *water	0.436	***	0.130	3.35	0.001
age*sp_mix	0.042	*	0.024	1.74	0.082
age*water	-0.097	***	0.024	-3.98	0.000
hunter *water	-4.388	***	1.191	-3.68	0.000
profemp	0.768	**	0.353	2.18	0.030
buyequal	0.416	**	0.177	2.35	0.019
museum	-0.081		0.051	-1.57	0.116
z20_25km	1.830	**	0.778	2.35	0.019
Trashso=2	2.972	**	1.274	2.33	0.020
Trashso=4	-1.173	**	0.577	-2.03	0.042
constant	13.443	***	1.861	7.23	0.000
N=464, a=7 (3248 observations)					
R^2 within = 0.60, R^2 overall = 0.52					
Breusch and Pagan test for random effects) (p-value)			257.55 (0.000)		
Hausman test (p-value)			13.83 (0.7402)		

* p≤0.10, ** p≤0.05, *** p≤0.01