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Providing preference-based support for forest ecosystem service management

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ABSTRACT

The paper examines people's preferences for changes in selected ecosystem services resulting from new management strategies of forest areas in Poland. This study applies a generalized multinomial logit model to interpret the results of a discrete choice experiment administered to a representative sample of 1001 Poles. The questionnaire included three physical attributes: protecting the most ecologically valuable forest ecosystems, reducing litter in forests, and improving recreation infrastructure. The selection of these attributes was motivated by extensive qualitative research regarding to what indicators of biodiversity, nature protection and recreation possibilities people are most sensitive. The fourth attribute was monetary, that is, additional costs associated with the new programs that would have to be financed out of increased taxes. The results allowed for an estimation of implicit prices regarding the choice attributes and calculating welfare measures of specific forest management scenarios. The study revealed interesting connections between respondents' current forest recreation patterns and the importance they place on the various attributes of forests. The paper particularly focuses on respondents' unobserved and observed preference heterogeneity, as well as scale heterogeneity, and the study demonstrates how heterogeneity can improve the models and provide insight into how users and non-users of forests may benefit from introducing a particular policy.

1. Introduction

A better understanding of human attitudes toward the environment is an essential element for obtaining public support for environmental protection programs and for improving decision-making processes by framing environmental goals in an efficient way under limited public financial sources. One of the key problems associated with conservation policy decisions is that because environmental benefits are often not directly reflected in market prices, conservation is mostly perceived as a cost burden, rather than an investment in social values. Economic sciences, however, have developed methods that estimate the economic value provided by non-market goods and services by using either revealed or stated preferences of individuals. Recommendations concerning the use of the results of non-market valuation studies in designing and implementing conservation policies have recently been made by the Millennium Ecosystem Assessment (MEA, 2005) and The Economics of Ecosystems and Biodiversity initiative (Sukhdev et al., 2010).

While non-market valuation techniques and stated preference methods have been applied to value forest externalities for several decades, most of the available studies have focused on estimating recreational benefits (see Giergiczny (2009) for a comprehensive review). A considerable number of empirical studies were devoted to public preferences for different types of forests and the attributes that characterize them (e.g., Yarrow, 1966; Daniel et al., 1976; Arthur, 1977; Zube et al., 1982; Jensen and Koch, 2000; Lee, 2001; Blasco et al., 2009; Edwards et al., 2012). The main goal of these studies was to provide information to forest managers on the types and features of forests that are likely to improve the recreational and aesthetic values of the land. However, as the majority of them relied on images of forest stands that were scored by respondents, they did not necessarily provide monetary estimates associated with the changes, and only a handful focused on the valuation of the benefits associated with changes in forest management practices (e.g., Mattsson and Li, 1994; Horne et al., 2005; Mill et al., 2007; Nielsen et al., 2007).

Giergiczny (2009) identified 140 non-market valuation studies concerning changes in forest management conducted across Europe. These studies provided 280 estimates of different non-timber benefits offered by forests. The studies were conducted in Central and Eastern Europe (CEE), and the relevant work published in peer reviewed journals is limited to Czajkowski and Hanley (2009) and Bartczak et al. (2012).[1] These studies reveal different forest recreation and valuation patterns in Poland than in the other

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[1] We also identify some gray literature and conference presentations referencing additional studies conducted in the CEE region (Šišák et al., 1997; Melichar, 2001; Nagypal, 2005; Melichar, 2007).

European countries. Somewhat surprisingly, both trip frequency and per-trip recreational benefits are substantially higher in CEE than in the Western Europe. However, a better understanding of how it influences the associated welfare measures requires further investigation.

Our study adds to the literature by investigating individual preferences for changes in forest management strategies in Poland. To do this, we applied a discrete choice experiment (DCE) to a representative sample of adult Poles. This allowed us to formally model their preferences and provide implicit prices of the attributes that were used to describe the new management strategies as well as the welfare changes associated with possible policy scenarios. From the policy perspective, our study demonstrates how non-market valuation methods can be used to design new forest management strategies in such a way that they directly draw from social preferences rather than maximize revenues from logging or combine logging with reaching additional environmental goals. For this purpose, we utilized extensive qualitative analysis to identify the forest attributes that people most want changed.[2]

With respect to the methodological aspects of this study, to the authors' best knowledge, it is one of the first applications of a generalized multinomial logit (G-MNL) model that takes into account personal preference and scale heterogeneity in the environmental context. We demonstrate that this can lead to substantial improvement in model fit and can potentially avoid bias.

Finally, our study also adds to the literature devoted to researching observed heterogeneity of respondents' preferences with respect to the different characteristics of the forests (e.g., Mattsson and Li, 1994; Scarpa et al., 2000; Horne et al., 2005; Mill et al., 2007; Nielsen et al., 2007). We investigate the differences in preferences toward forest management based on respondents' recreation patterns. The results from previous studies have not been unequivocal in this respect.[3] In this study, we investigate to what extent (1) the frequency of forest recreation trips and (2) the number of different locations visited correlate with respondents' preferences, and we find that these two indicators have significant impact on respondents' implied willingness to pay (WTP).

This paper is organized as follows. Section 2 provides the methodological background and introduces the econometric approach. Section 3 describes the case study area, the scenarios and design of the discrete choices, the sampling procedure and the survey administration. Section 4 presents the results, and Section 5 offers the conclusions.

2. Methods

2.1. Econometric framework

The discrete choice experiment is a popular method to elicit preferences and monetary values associated with non-market goods and the attributes that comprise such goods (Carson and Czajkowski, forthcoming). Respondents are usually asked to state which of the several alternatives they most prefer. A standard practice is to pool choice data from individuals and estimate a population model. Because respondents are likely to have heterogeneous preferences and differ in error variances (scales), it is crucial to account for these preferences and scale heterogeneity in a modeling approach.

There have been many attempts to allow for heterogeneous tastes in discrete choice modeling. The state-of-practice method to account for systematic and unobserved taste heterogeneity is the random parameters logit model (RPL, Revelt and Train, 1998; McFadden and Train, 2000), which extends the standard multinomial logit model by making the utility function parameters random variables that follow an a priori specified type of distribution. The parameters for these distributions are estimated using maximum likelihood methods.

Formalizing this model, let the random utility of an individual i associated with choosing alternative j at choice situation t be:

$$U_{itj} = \sigma\boldsymbol{\beta}_i'\mathbf{x}_{itj} + \varepsilon_{itj}. \quad (1)$$

In the RPL model, the parameters of utility functions are respondent-specific. It is assumed that they follow distributions specified by a modeler such that $\boldsymbol{\beta}_i \sim f(\mathbf{b} + \Delta'\mathbf{z}_i, \boldsymbol{\Sigma}_i)$, with means $\mathbf{b}$ and variance–covariance matrix $\boldsymbol{\Sigma}$.[4]

In the above model specification, the parameter σ represents the utility function scale (error term variance) that has been implicitly normalized to allow for identification. This allows for otherwise homogeneous utility weights to be proportionally scaled up or down, making the deterministic part of the utility function larger or smaller in relation to its non-observable random part.

It has recently been proposed to extend the state-of-practice taste-heterogeneity approach by allowing the scale parameter to be random, which simultaneously accounts for consumers' preference and scale heterogeneity. In this paper, we employ this state-of-the-art method by applying the generalized multinomial logit model (G-MNL, Fiebig et al., 2010).

In the G-MNL model, the random utility expression is:

$$U_{itj} = [\sigma_i\mathbf{b} + \gamma\boldsymbol{\eta}_i + (1-\gamma)\sigma_i\boldsymbol{\eta}_i]'\mathbf{x}_{itj} + \omega_{itj}. \quad (2)$$

The utility associated with each alternative is, as in the case of the RPL model, a function of observed attributes $\mathbf{x}_{ij}$ and accompanying individual-specific (random) parameters, $\boldsymbol{\beta}_i = \mathbf{b} + \boldsymbol{\eta}_i$, where $\mathbf{b}$ is a vector of population means of these parameters and $\boldsymbol{\eta}_i$ is a vector of random errors with zero means and a specified variance–covariance matrix over the population (usually following multivariate normal distribution). By introducing the error term ω_{itj}, the modeler assumes utility levels to be random variables, as it is otherwise impossible to explain why apparently equal individuals (equal in all observable attributes) may choose different options. This error term can further be disaggregated to $\omega_{itj} = \mathbf{Y}'_{itj}\boldsymbol{\Omega}_{itj} + \varepsilon_{itj}$, where $\boldsymbol{\Omega}_{itj}$ is a vector of stochastic components of utility function, which follows an identical and independent distribution specified by a modeler, and $\mathbf{Y}_{itj}$ is a vector of loadings that map the error component according to the desired structure and, hence, allows for generic correlations. This specification of the random term of the utility function allows for the inclusion of numerous error structures and hence allows for the accounting of heteroskedascity, correlation, cross-correlation, and autoregression of error components (Hensher and Greene, 2003; Greene and Hensher, 2007; Train, 2009).

[2] The vast majority of forests in Poland (more than 80%) are state owned and administrated by the State Forest Enterprise (SFE). Polish law allows and encourages society to participate in public goods management including the national forest management. We used this information to our advantage, constructing the contingent scenario and our survey in such a way that it was perceived as potentially consequential. This satisfies one of the necessary conditions for incentive compatibility of a stated preference study – the consequentiality of the survey (Carson and Groves, 2007), which has been empirically shown to be of great importance (Vossler et al., 2012).

[3] For example, Hanley et al. (1998) show that non-users have lower valuations for landscape improvements than users; on the other hand, Kniivilä (2006) found no difference between the user and non-user groups in their willingness to support sustained conservation.

[4] In addition, it is possible to make the means and variances of the distributions a function of observable respondent or choice-specific characteristics $\mathbf{z}$.