WELFARE ANALYSIS WITH DISCRETE CHOICE MODELS – INVESTIGATING PUBLIC PREFERENCES FOR FOREST RECREATION ATTRIBUTES

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Abstract

Discrete choice model, which has its foundation in Lancaster's consumer theory and in the random utility modelling, is used to investigate the preferences and the willingness-to-pay of mountain recreationists in the Jizerske hory Mountains, Czech Republic, for different forest recreation attributes that represent various forest recreation sites in this landscape area. We model the probability of choosing one recreation alternative among others, which is regressed on four forest recreation attributes: type of forest stand visually displayed, surface type of hiking trail, crowdedness by hikers and travel distance to the recreation area. Visitors' preferences regarding to different forest recreation sites were gathered on-site during summer 2007 from visitors of the study area by administering a carefully designed questionnaire. The regression parameters for each forest recreation attribute were estimated by a conditional and nested logistic regression. The highest utility is achieved by visitor when the JH Mts. are not crowded, 218 CZK per person and trip. In opposite direction, there is a welfare loss 258 CZK. When the area is cover by broad-leaved trees or immature spruce forest, recreationists experience utility estimated at 44, respectively 40 CZK per trip. Dead and damaged forest is associated with a welfare loss of 216 CZK.

Key words: choice experiment, random utility theory, conditional logit, forest recreation

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Introduction

Nature-based recreation is an integral part of leisure-time activities. With growing pressure on recreation use of natural areas, it is becoming increasingly important to understand the value the visitors place on these natural resources. Especially forest ecosystems constitute a complex of possible recreation uses, which may be very sensitive to ecosystem quality as shown by previous research (Hesseln et al., 2003).

The majority of existing environmental valuation research on forests has either simply valued forest recreation in a generic sense (Bishop, 1992) or forest recreation as a single attribute of wider forest values (Hanley, 1989). However, there are only a few studies that actually examined the economic value of specific recreational activities (hiking, biking) and forest recreation attributes. Hanley et al. (1998) examined the public preferences of UK residents for forest attributes such as species diversity, the shape of plantations and how the forest was felled. Lehtonen et al. (2003) found in Finland that number of endangered species, conservation contracts and conservation areas affect individual utility. Horne et al. (2005) estimated recreational value of five forest municipal sites around Helsinki and found that specie richness is valued significantly across the sites.

Our study site Jizerske hory Mountains has experienced many changes in recreational and aesthetical value. It has been a Protected Landscape Area since 1968, but most of forest ecosystems were damaged and deforested since the 70´s, mainly due to air pollution, insect infestation and changes in forestry compositions. Nowadays 68% of the spruce wood is defoliated and damaged. Forestry management practice and protection measures concentrate mainly on afforestation of the central part, changes in tree composition (more broad-leaved trees are planted) and conservation of Natura 2000 preservation areas.

This study aims to contribute with a piece of knowledge through the use of a discrete choice experiment that explores recreationists' preferences for various specific forest recreation attributes. Using choice experiment based on random utility theory, we try to disentangle factors that are responsive for changes in recreation utility of visitors in the JH Mts. We estimate visitors´ preferences for alternative forest sites as a function of site characteristics using choice experiment technique. In the analysis, specific emphasis is put on aesthetical perception of forest stands as forest scenic beauty may represent a crucial factor in decisions of visitors in terms of which recreation area to visit - as shown in Hunziker (1995).

1 Random utility models

The choice experiment method has its foundation in Lancaster's consumer theory (Lancaster, 1966) and in the random utility modelling. According to Lancaster's consumer theory, consumers derive their utility not from the product as such, but from the attributes by which the product can be described.

Random utility models stem from McFadden´s random utility framework (McFadden, 1974). They provide a theoretical basis for modelling consumer´s choice among alternatives

(scenarios). We model the probability of choosing one alternative among others, which is regressed on attributes of the composite good and/or respondent characteristics.

Each alternative in the choice set (*i*, *j*) yields particular level of utility *U* to the respondent. The probability of an individual choosing alternative *i*, $Prob_i$, is equal to the probability that the utility of alternative *i* is higher or equal to the utility associated with other alternatives in the set. Utility *U* may be divided into a set of observed attributes measurable by the analyst *V* and unmeasurable residuum ε (Henscher et al., 2005):

$$U_i = V_i + \varepsilon_i \qquad (1)$$

The notation may be then stated as equation:

$$Prob_i = Prob[(V_i + \varepsilon_i) \geq (V_j + \varepsilon_j)] \qquad (2)$$

where *j* represents every other alternative in the given choice set than *i* (*j* = 1,..., *J*). After rearrangement, we get:

$$Prob_i = Prob[(\varepsilon_j - \varepsilon_i) \leq (V_i - V_j)] \qquad (3)$$

The probability of an individual choosing alternative *i* is equal to the probability that the difference in unobserved sources of utility of j compared to *i* is less or equal to the difference in observed sources of utility associated with alternative *i* compared to alternative *j* after evaluating every alternative in the choice set (*Ibid.*).

Standard random utility models specify the deterministic part of utility *V*, for individual *i* and alternative *j* as (Cameron and Trivedi, 2009a):

$$V_{ij} = x'_{ij}\beta + z'_i\gamma_j \qquad (4)$$

where $\boldsymbol{x}_i$ are alternative specific variables and $\boldsymbol{z}_i$ are case specific variables. This choice experiment study considers – as alternative specific variables – forest and recreation characteristics, specifically surface type of hiking trail, type of forest stand visually displayed, crowdedness by hikers and travel distance to the recreation area. Case specific variables are normally socio-economic characteristics of population, this covariates are not part of this study.

For alternative specific variables $\boldsymbol{x}_i$ we applied the conditional logit model (CLM) in order to estimate β parameters. The CLM specification is following (Cameron and Trivedi, 2009b):

$$p_{ij} = \frac{e^{x'_{ij}\beta}}{\sum_{l=1}^{m} e^{x'_{il}\beta}}, \quad j = 1, \dots, m \qquad (5)$$

The probabilities are in the range between 0 and 1, and sum over *j* to one, because exp(**x**'$_{il}\beta$)>0. Using CLM we assume that error term is independent and identically distributed (IID) with an extreme-value Gumbel distribution.

Using the Hanemann (1984) expression we compute compensating variation for welfare measures. Compensating variation for the improvement of forests characteristics, where V_0 is initial level of utility and V_1 is utility after positive change, could be following:

$$CV = -\frac{1}{\beta_{TC}}\left[ln\left(\sum_m \exp(V_{j0})\right) - ln\left(\sum_m \exp(V_{j1})\right)\right] \qquad (6)$$

where β_{TC} is parameter on the travel cost variable.

2 Study area and data collection

The Jizerske hory Mountains Protected Landscape Area was established in 1968 and it is one of the oldest protected areas in the Czech Republic. The surface area of the PLA is approximately 368 km^2. The JH Mts. are situated in the North Bohemia, close the Polish and German borders. The geographical position of the JH Mts. is illustrated in Figure 1. Two large cities of Liberec and Jablonec nad Nisou, with a combined population of almost 190 thousand, lie near the Jizerske hory Mountains, to their southwest.

Forest ecosystems cover almost 73% of the study area (that is 270 km^2). The most common wood in the JH Mts. is spruce (*Picea abies*), representing 67% of the forest ecosystems. Beech (*Fagus sylvatica*) represents 10% of the forest ecosystems.

Above all, beech forest, peat coenosis, mountain pine forest, and herb-rich and waterlogged meadows are subject to strictest protection in small-scale conservation areas (3 national nature reserves, 13 nature reserves, and 8 nature monuments). Under European Commission directives, Natura 2000 preservation areas were defined and designated in the JH Mts. A bird area was proposed for two endangered bird species: the black grouse (*Tetrao tetrix*) and the little owl (*Aegolius funereus*). Additional 7 natural habitat localities were proposed for protection within the Natura 2000 network in the JH Mts.

The JH Mts. are a favorite destination for summer and winter recreational activities such as hiking, mountain biking, cross-country skiing, and downhill skiing.

Fig. 1: Geographical position of the Jizerske hory Mts. Protected Landscape Area

Source: CENIA, 2007

In order to derive welfare measures for different forest stands and their attributes, relevant information has to be obtained from visitors to the recreation site. Individual data are usually obtained by administering a survey. Therefore, a questionnaire that queried respondents about the current visit to the JH Mts, their visual perception of forest quality, preferences and attitudes regarding to forest recreation was constructed. The survey on the JH Mts. was conducted from July to October 2007.

The questionnaire was administrated on-site to visitors at four sites located in the central part of the Jizerske hory Mts. Respondents were intercepted randomly and interviewed by trained interviewers face-to-face on each of these four sites. Interviewing began early on the day, and respondents were selected randomly throughout the day. The questionnaire was proposed to allow interviews to be completed in 15 minutes in order to avoid the respondent's fatigue. The survey resulted in a total of 722 completed questionnaires.

Visitors doing summer recreational activities such as hiking and mountain biking in the central part of the JH Mts. were the target population of the survey. These individuals had immediate experience with the different quality of forest that they observed on their trips.

The scenic beauty estimation technique (SBE) was used to quantify the respondent's visual preferences, based upon his/her perceptual and aesthetic judgment of the feature of different types of mountain forest stands, and to provide valid indicators of aesthetic perception. We used sampling procedure evolved by ; Forest ecosystems of different air pollution impacts and species composition were determined in JH Mts. and 26 forest stands

were selected. More than 250 photographs of the forest sites were acquired and then tested on several focus groups.

In the final survey, recreationists evaluated 12 representative colour slides on Likert-type (1 to 10) evaluation scale. All colour slides represented near-view scenes without dominant objects from four broad types of forest sites:

1. spruce forest,
2. broad-leaved forest,
3. immature spruce forest,
4. dead forest.

Pictures of these four types of forest stands were included in the choice experiment study.

3 Empirical findings

3.1 Conditional logistic regression

The same types of forest stands that were evaluated under the scenic beauty estimation procedure were included in the choice experiment study. The choice experiment design consisted of 4 attributes with several attributes' levels that are following (in bold, the attribute's level representing the status-quo situation is marked):

5. Surface type of hiking trail: panel, **asphalt**, sandy stabilized, forest trail,
6. Type of forest stand visually displayed: **high spruce forest**, broad-leaved forest, immature spruce forest, dead forest,
7. Crowdedness by hikers: low, **middle**, high,
8. Travel distance to the recreation area: 15, 30, 60 and 120 km.

To estimate the regression parameters for each attribute's level under investigation, we use a conditional (fixed-effects) logistic regression. The parameter estimates for the CL model are shown in Table 1. The coefficients have the expected signs and are statistically different from zero at 5% level.

Tab. 1: Conditional logistic regression for choice experiment study

Number of observation = 10412 LR chi2(9) = 948.56			Log likelihood = -3134 Pseudo R2 = 0.1314		
choice	**Coef.**	**Std. Err.**	**z**	**P>|z|**	**[95% Conf. Interval]**

price	-0.004	0.00	-15.56	0.00	0.00	0.00
not crowded	0.83	0.05	16.82	0.00	0.73	0.93
very crowded	-1.02	0.06	-16.67	0.00	-1.15	-0.90
trail_panel	-0.39	0.06	-7.00	0.00	-0.51	-0.28
trail_stabilized	0.37	0.04	8.50	0.00	0.28	0.45
trail_forest	0.11	0.04	2.39	0.02	0.02	0.19
trees_dead	-0.97	0.06	-16.94	0.00	-1.08	-0.85
trees_beech	0.19	0.06	3.15	0.00	0.07	0.32
trees_immature	0.18	0.04	4.85	0.00	0.11	0.25

The coefficient on trip costs (*price*) works as we had expected: negative and with a low standard error. As shown in Table 1, the site characteristics that increase a recreationist's utility are the low crowdedness of the recreation site (*not_crowded*), sandy stabilized trail (*trail_stabilized*), forest trail (*trail_forest*), broad-leave trees (*trees_beech*) and immature trees (*trees_immature*). The opposite effect on the utility has the high crowdedness of the area (very crowded), panel trails (*trail_panel*) and dead forest stands (*trees_dead*).

3.2 Nested logistic regression

To account for the possibility that independence of irrelevant alternatives does not hold, we ran also nested logit model which relaxes IIA across nests. The hierarchical structure of the choice model was that the respondent decides first whether to choose the status quo alternative (to choose neither of the two presented sites) versus to visit any of the sites. This decision-making stage is explained by his/her socio-economic characteristics. In the case he/she chooses one of the sites to visit, the second stage of the model explains which site is visited based on the characteristics of the site.

However, the nested model does not significantly improve the explanation of choice data variability, as shown with log-likelihood ratio test – with p-value of 0.1572 we cannot reject the null hypothesis that the two models are identical.

Tab. 2: Nested logit regression for choice experiment study

Number of observation = 10412 LR chi2(15) = 1047.24			Log likelihood = -3085 Pseudo R2 = 0.1451			
choice	**Coef.**	**Std. Err.**	**z**	**P>|z|**	**[95% Conf. Interval]**	
price	-.003	0.00	-9.35	0.00	0.00	0.00
not crowded	0.51	0.07	7.90	0.00	0.37	0.65

very crowded	-0.92	0.07	-13.06	0.00	-1.05	-0.78
trail_panel	-0.23	0.09	-2.38	0.02	-0.41	-0.04
trail_stabilized	0.27	0.06	4.55	0.00	0.15	0.39
trail_forest	0.11	0.08	1.40	0.16	-0.04	0.25
trees_dead	-0.50	0.07	-6.84	0.00	-0.64	-0.36
trees_beech	0.24	0.06	3.95	0.00	0.12	0.36
trees_immature	0.22	0.05	4.26	0.00	0.12	0.32
chosen						
male	0.01	0.02	0.92	0.36	-0.02	0.04
cyclist	0.01	0.09	0.14	0.89	-0.16	0.18
age	0.00	0.00	0.86	0.39	0.00	0.01
prague	0.03	0.10	0.27	0.79	-0.18	0.23
liberec	-0.02	0.10	-0.24	0.81	-0.22	0.17
job	-0.09	0.10	-0.98	0.33	-0.28	0.09
university	0.05	0.09	0.55	0.58	-0.12	0.21
IV parameters: chosen						
travel	1.28	0.10	12.38	0.00	1.07	1.48
stat_quo	1.28	0.10	12.36	0.00	1.08	1.49

4 Welfare analysis

The welfare estimates in terms of compensating surplus for each attributes' level are presented in Table 3. The table presents implicit prices derived from both CE models. For non-vegetative characteristics the results brought by both models are of similar magnitude. The highest utility is achieved by visitor when the JH Mts. are not crowded, 218 CZK per person and trip (150 CZK respectively for the final model). In opposite direction, there is a welfare loss 258 CZK (260 CZK). When the forest trail is stabilized or natural, recreationists experience utility estimated at 96, respectively 25 CZK per trip based on the base model; the estimates of utility from the final model are lower (75 and 25 CZK per trip). Panel trails are associated with a welfare loss of 88 CZK (65 CZK for the final model).

Tab. 3: Implicit prices per person and trip (2007 prices)

Implicit price	**CE without SBE**	
	CZK	**€**
not crowded	218	7.8
very crowded	-258	-9.2
trail_panel	-88	-3.2
trail_stabilized	96	3.4

trail_forest	25	0.9
trees_dead	-216	-7.7
trees_beech	44	1.6
trees_immature	40	1.4

Conclusion

Discrete choice experiment, which has foundation in Lancaster's consumer theory and in the random utility theory, was used to investigate the preference and welfare measures of mountain recreationists for different forest recreation attributes. Choice experiment study was carried out in order to estimate welfare measures of different attributes of forest recreation, including the aesthetical functions. In our choice experiment case study, forest recreation was considered as composite good consisting of different mixture of four attributes: i) surface type of hiking trail, ii) type of forest stand visually displayed, iii) crowdedness by hikers, and iv) travel distance to the recreation area.

We applied conditional logit model which proved that broad-leave and immature trees have positive effect on utility, the opposite effect has dead forest stands. The highest utility is achieved when the recreation area is not crowded. In opposite direction, there is the welfare loss associated with high crowdedness of the recreation site. The type of forest trail also has effect on utility, stabilized and natural trails positively contribute to the utility, panel trails are associated with negative effect on visitor's utility.

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References

Bishop, K. D. „Assessing the benefits of community forests: an evaluation of the recreational use benefits of two urban fringe Woodlands." *Journal of Environmental Planning and Management*, 35(1), 1992: 63-76.

Cameron, A. C., and Trivedi, P. K. *Microeconometrics using Stata*. Stata Press, 2009a.

Cameron, A. C., and Trivedi, P. K. *Microeconometrics: Methods and Applicatons*. Cambridge University Press, 2009b.

Daniel, T. C., and Boster, R. S. *Measuring Landscape Esthetics: The Scenic Beauty Estimation Method*. USDA Forest Service, Research Paper RM-167, 1976.

Hanemann, W. M. „Welfare Evaluations in Contingent Valuation Experiments with Discrete Responses." *American Journal of Agriculture Economics*, 66, 1984: 332-341.

Hanley, N. „Valuing rural recreation benefits: an empirical comparison of two approaches." *Journal of Agricultural Economics*, 40(3), 1989: 361–374.

Henscher, D. A., Rose, J. M., and Greene, W. H. *Applied Choice Analysis - A Primer*. Cambridge, UK: Cambridge University Press, 2005.

Hesseln, H., Loomis, J. B., Gonzalez-Caban, A., and Alexander S. „Wildfire effects on hiking and biking demand in New Mexico: a travel cost study." *Journal of Environmental Management*, 69, 2003: 359–368.

Horne, P., Boxall, C. P., and Adamowicz, L. W. „Multiple-use management of forest recreation sites: a spatially explicit choice experiment." *Forest Ecology and Management*, 207, 2005: 189–199.

Hunziker, M. „The spontaneous reforestation in abandoned agricultural lands: perception and aesthetic assessment by locals and tourists." *Landscape and Urban Planning*, 31, 1995: 399–410.

Lancaster, K. „A new approach to consumer theory." *Journal of Political Economy*, 74, 1966: 132-57.

Lehtonen, E., Kuuluvainen, J., Pouta, E., Rekola, M., and Li, C. Z. „Non-market benefits of forest conservation in southern Finland." *Environmental Science and Policy*, 6(3), 2003: 195-204.

McFadden, D. Conditional logit analysis of qualitative choice behavior. In: P. Zarembka (ed.): *Frontiers of Econometrics*, New York: Academic Press, 105–142., 1974.

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