Summary of the case study on valuation of the forest ecosystem services

Title of the valuation study: **Providing preference-based support for forest ecosystem service management**
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Objectives of the study

Polish law encourages the society to participate in public goods management. About 3% of the Polish forests are ecologically very valuable, natural forests. Currently, half of them are under protection. The paper examined individual preferences for changes in selected ecosystem services resulting from new forest management strategies.

Therefore, the authors applied a discrete choice experiment (DCE). Out of the modelled preferences, an estimation of implicit prices was carried out. Moreover, the study specially focused on respondents' unobserved and observed preference heterogeneity and scale heterogeneity. Finally, differences in preferences towards forest management were evaluated based on the respondents' individual recreation profiles. The knowledge gained could be used to assess welfare changes under new forest policy scenarios.

Scope of the study

The ecosystem services valuated in the study were cultural services (recreation) and habitat services (habitat maintenance). The geographical scope covered was national.

Valuation method(s) applied

The **discrete choice experiment** elicited preferences and monetary values associated with non-market goods and different attributes. Respondents were asked to state which of the several alternatives they prefer mostly.
Representative polish residents (n=1001) were contacted via a professional polling agency with face-to-face **computer-assisted survey techniques**. After **pre-testing**, the questionnaire included four attributes: (1) protecting the most ecologically valuable forest ecosystems, (2) reducing litter in forests, (3) improving recreation infrastructure, and (4) a cost component (income tax increase from 0-100 PLN). The selection of these attributes was motivated by **qualitative research** to figure out the most important subjects for general public in terms of recreation and biodiversity conservation. The possible levels of attributes (1)-(3) were status quo (SQ) choice, partial improvement and substantial improvement. The choice sets utilized in the study were prepared using **Bayesian d-efficient design** optimized for the random parameter logit model.

Finally, each respondent was faced with 26 choice-tasks, each consisting of four alternatives. As the design was counterbalanced, the order of choice-sets and the three non-status-quo alternatives presented was randomized. Moreover, two use-related questions were asked in the survey to create recreation-profiles.

For the analysis, the study employed **the generalized multinomial logit model** (G-MNL), which takes personal preference and scale heterogeneity in the environmental context into account. The **log likelihood function** simulated used 1000 shuffled **Halton draws** and was maximized numerically. Hence, the utility associated with each alternative was a function of observed attributes and accompanying individual-specific (random) parameters. Nevertheless, correlations between all random parameters were allowed. Additionally, **random parameter logit models** (RPL) were used to investigate if G-MNL provides a substantial improvement of model fit.

Out of the **recreation profiles**, the authors investigated to what extent the frequency of forest recreation trips and the number of different locations visited correlated with respondents' preferences. To estimate the implicit prices of the attribute levels, marginal rates of the substitution of the monetary parameter for each attribute were calculated using **parametric bootstrapping**.

Additionally, a **willingness to pay** (WTP) of a typical user and non-user was provided. With that information, a median equivalent variation associated with **minimum** and **maximum improvement scenarios** for both classes of respondents was assessed.

Key results

- Forests were extensively used for recreation in Poland with a **mean visit frequency of 49 visits a year** and no observation without a visit in the last 12 months. Non-users were generally more satisfied with the current management of Polish forests, while frequent users were willing to avoid the status quo.

- Preference heterogeneity was determined by respondents' recreational use profiles. The frequency of forest recreation trips and the number of different locations visited correlated significantly with respondents' preferences and hence were reflected in the individual welfare change. The **Table 1 shows median implicit prices (per person/year)** and was generated using parametric bootstrapping.

Table 1 Implicit prices of the choice attributes – the models accounting for use-related preference heterogeneity (95% confidence intervals in parentheses) [EUR]

	Random parameters logit		Generalized multinomial logit	
	Non-users[a]	Users[b]	Non-users	Users
SQ – alternative specific constant for the status quo alternative (no change)	−1.72 (−5.09–1.99)	−5.35*** (−7.04 to −3.64)	5.25*** (1.75–9.21)	−9.99*** (−12.08 to −7.92)
ECO_1 – partial (50%) improvement in the area of passively protected ecologically valuable forests	4.23*** (2.91–5.55)	5.49*** (4.95–6.03)	3.73*** (2.37–5.11)	6.37*** (5.8–6.94)
ECO_2 – substantial (100%) improvement in the area of passively protected ecologically valuable forests	4.84*** (3.05–6.6)	7.17*** (6.38–7.94)	4.37** (2.6–6.11)	8.57*** (7.8–9.32)
LIT_1 – partial (50%) reduction of litter in the forests	4.77*** (3.52–6.05)	6.38*** (5.84–6.92)	4.99*** (3.68–6.35)	7.96*** (7.41–8.52)
LIT_2 – substantial (90%) reduction of litter in the forests	5.47*** (3.76–7.17)	9.34*** (8.55–10.12)	5.35*** (3.71–6.99)	11.75*** (10.96–12.58)
INF_1 – partial (50%) increase of forests with tourist infrastructure present	3.6*** (3.15–4.05)	3.92*** (2.55–5.38)	3.5*** (2.17–4.89)	4.07*** (3.6–4.55)
INF_2 – substantial (100%) increase of forests with tourist infrastructure present	4.15*** (2.9–5.46)	4.9*** (4.42–5.38)	4.15*** (2.87–5.51)	5.7*** (5.23–6.17)

[a] Respondents with minimum number of trips (*vis_trip* = sample minimum) and visited locations (*vis_loc* = sample minimum).
[b] Respondents with mean number of trips (*vis_trip* = sample mean) and visited locations (*vis_loc* = sample).

- The Polish public is willing to pay considerable amounts to reduce the amount of litter in the forests, to put the most ecologically valuable forests under protection, and to provide more recreation and tourist infrastructure.

- A change in forest management can lead to substantial changes in welfare of visitors (Table 2). Thus, non-market valuation methods can be used to design new forest management strategies. Moreover, utilizing extensive qualitative analysis can identify the forest attributes that the public would like to change most.

Table 2 Welfare change estimates associated with the new management scenarios (95% confidence intervals presented in parentheses) [EUR]

	Random parameters logit	Generalized multinomial logit
Maximum improvement scenario $-SQ + ECO_2 + LIT_2 + INF_2$	25.26*** (22.69–27.78)	24.33*** (22.12–26.58)
Minimum improvement scenario $-SQ + ECO_1 + LIT_1 + INF_1$	19.12*** (17.02–21.26)	18.53*** (16.6–20.51)

- Integrating respondents' use-related preference heterogeneity greatly improved statistical properties of the model and provided additional insights into the distribution of potential gains from introducing an improvement scenario. Thus, to take scale heterogeneity into account might improve statistical properties of a model and potentially reduces bias.