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Are Transboundary Nature Protected Areas International Public Goods and Why People Think They Are (Not)? Hybrid Modelling Evidence from the EU Outer Borders

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Abstract: Former studies have shown that transboundary nature protected areas are not perceived as pure international public goods by citizens in neighbouring countries that share national parks. In this study, we assess what drives the valuation of nature protection on the other side of the border in two European transboundary nature areas, the Białowieża Forest and Fulufjället. Applying hybrid choice modelling, we account for people's attitudes when eliciting their preferences towards transboundary nature protected areas, and examine the impact of attitudes on the degree to which those preferences are consistent with the international public good hypothesis. We found that the intention of visiting the foreign part of the transboundary area, appreciation of transboundary justice and altruism, were the main drivers, whereas suspicious attitude towards the neighbouring country, propensity to free-ride, and manifestations of 'patriotism' applied as international public good mitigators to a limited degree only. Value of an extending the protection regime abroad was still positive for Scandinavians, whilst for Polish and Belarusian respondents a policy aiming at extending the protection abroad would lead to loss of human welfare. Facilitating visits of the foreign part by enhancing cross-border access can be expected to shift peoples' preferences towards transboundary co-operation.

Keywords: International public goods, national parks, forest, transboundary nature protected areas, public preferences, willingness to pay, discrete choice experiment, hybrid modeling

JEL codes: Q51, Q57, H41

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1. Introduction

Protecting remaining intact ecosystems and their natural heritage is part of the European Commission's new bioeconomy strategy, as well as part of the Paris agreement and the UN Sustainable Development Goals. Maintaining functional habitat networks relies in particular on having sufficiently large protected areas. A considerable part of the remaining pristine nature areas in many regions of the world is located between two or more jurisdictions with border areas, which are economically peripheral, and thus less intensively managed, less fragmented, or less disturbed (Angelstam et al. 2004). Given that national protected areas in Europe are often small and scattered, transboundary cooperation has therefore been considered a necessity (European Commission 2013). A transboundary nature-protected area (TNPA) is *"an area of land and/or sea that straddles one or more boundaries between states…beyond the limits of national sovereignty or jurisdiction…dedicated to the protection and maintenance of biological diversity"* (Sandwith et al. 2001, p.3).

TNPAs have become a considerable phenomenon of international conservation involving particular challenges concerning their maintenance (Sandwith et al. 2001, Lanfer et al. 2003, Vasilijević and Pezold 2011). Although the main argument behind establishment of TNPAs and their functioning is rooted in a biocentric view on biodiversity conservation (e.g. Oskanen 1997), they are also supposed to fulfil a complex of functions aimed at sustainable regional and rural development, tourism, and cross-border co-operation (Hanks 2003). However, global surveys of TNPA management units (Zbicz 2003, McCallum et al. 2015) indicate that a high proportion of them limit cross-border efforts to the lowest possible level of co-operation, or choose not co-operate at all. To date, TNPAs have rather seldom been addressed by the economic literature explicitly (but see, e.g., Busch 2008).

Therefore, in order to examine empirically the extent to which two TNPAs situated on the EU outer borders are international public goods, Valasiuk et al. (2017, 2018) compared citizens' economic valuation of extended protection of two binational TNPAs: the Białowieża Forest, one of the largest near-natural lowland forests of the European continent (Blicharska et al. 2020), on the Polish-Belarusian border, and the Fulufjället National Park on the Swedish-Norwegian border (Garms et al. 2017). In both cases it was found that citizens stated higher willingness to pay (WTP) for extended area protection in their home country rather than in the neighbouring country. Thus, neither of the TNPAs would qualify as perfect international public goods (Ferroni and Mody 2002, Morrissey et al. 2002) of the regional

type (Ferroni 2002), since assuming that TNPAs as international public goods must be abiding by a summation technology of supply aggregation (Sandler and Sargent 1995; Sandler 1998), the WTP for protecting a given area of the ecosystem across the border should be equal to the WTP for protecting a similar area in the home country.

In this paper, we explore possible mechanism underlying differences in WTP for area protection in the home country versus the neighbouring country. Using survey data from both cases, we analyse the impact of underlying attitudes as potential drivers or mitigators of TNPAs as an international public good (IPG). After their choices between hypothetical protection alternatives for Białowieża and Fulufjället, respectively, survey participants stated their agreement to statements about survey consequentiality, distributional justice in TNPA financing, trust in the neighbour country's institutions, as well as intended visits to the national or foreign part of the TNPA. Such responses yield measurements of latent attitudinal variables (Jöreskog and Goldberger 1975). Our analysis of latent IPG drivers of the TNPA valuation is based on a hybrid choice modelling, which enables simultaneous estimation of a discrete choice component and a latent variable component (see, e.g., Hess and Beharry-Borg 2012).

2. Two transboundary case studies in four countries

2.1. Białowieża case area

The transboundary Białowieża Forest is shared by Poland and Belarus (Agrawal 2000). It is considered one of the last intact lowland forests in Europe (Blavascunas 2014) as well as one of the best known nature protected areas in Europe (Blicharska et al. 2020). Approximately less than one third of the area has never been logged, retaining natural composition, structure and function of forest ecosystems. Since 1946 the Białowieża Forest has been divided by a new state border into the Polish (about one third) and the Belarusian (the remaining two thirds) segments. Due to the border fencing constructed in 1980s, the two adjacent National Park areas constitute two physically separated natural sites with a limited possibility of crossing the state border by visitors.

In the Polish part a total ban on human interference with the natural ecosystems and processes applies to the Białowieża National Park and twenty-four scattered nature reserves, amounting to 225 km^2 or approximately 35% of total surface of its afforested area. In the Belarusian part a passive protection regime applies to the strict conservation core zone of the

National Park and makes up a total of 570 km^2 or about 37% of the Belarusian segment. In both countries, forests outside the strict reserve zones of the protected areas are subject to active management including wood harvest and salvage logging (e.g. Lethier 2017, Mikusiński et al. 2018). Both a strengthened transboundary regulation and an increase of the strictly protected area have been proposed for the Białowieża Forest as a result of the latest UNESCO World Heritage monitoring mission (Lethier and Avramoski 2016, Debonnet and Ossola 2018).

2.2. Fulufjället case area

The transboundary Fulufjället is shared by Sweden and Norway and forms a distinct mountain isolated from the rest of the Scandinavian mountain range. The large central area is located above the tree line at ca. 900 m above the see level, while the slopes below the tree line are covered by near-natural boreal forests forming one of the few patches satisfying focal boreal forest species in surrounding region (Angelstam and Manton 2021). On the Swedish side the National Park was established in 2002, which provided inspiration for Norway to establish the adjacent National Park in 2012 (Länsstyrelsen Dalarna 2006, Norwegian Environment Agency 2014). The larger Swedish part, 385 km^2, has a well-established zoning system comprising four zones: a wilderness zone; a low-intensity activity zone; a high-intensity activity zone; and a development zone which includes infrastructure and facilities for visitors. The National Park in Norway covers a considerably smaller area (86 km^2), lacks zoning and is managed fairly similar to the Swedish low-intensity activity zone.

Within Fulufjället National Park, logging is banned, other than single trees for maintenance of trails and safety. The forest areas around the National Park are managed for intensive wood production, but a few forest areas adjacent to the National Park are candidates for park extension and landscape restoration.

3. Methodology

3.1. Survey questionnaire and experimental design

We build on the survey material for Białowieża presented by Valasiuk et al. (2017) and the survey material for Fulufjället presented by Valasiuk et al. (2018). Both questionnaires consisted of five parts: (1) introductory questions about respondents' past visitation to forests, the functions of natural and wood-production forests, and a description of the TNPA, including whether or not respondents had visited the case area; (2) scenario about the TNPA,

extending the national park and the natural forest area, and the specified protection attributes (sizes of new natural forest area on domestic and foreign part of border) and costs for the citizens; (3) the DCE, choices of park extension alternatives, including a status quo (SQ) alternative (Table 1, Figure 1); (4) debriefing block of attitudinal questions; and (5) a respondents' socioeconomic characteristics. The two questionnaires were developed in English and then translated into the languages of the four countries (the English originals of the two questionnaires are included in the Supplementary material).

Respondents were asked questions regarding their preferences with respect to improved conservation of the ecosystem protected by the two spatially adjacent National Parks: one located in their country and the other one located in the neighbouring country. In each case, choice problems were phrased as a trade-off between higher taxes and number of square kilometres put under protection.[1] The protection could be accomplished either by expanding the domestic park (implying higher taxes) and/or by expanding the neighbouring park (implying higher taxes and international money transfers via devoted bilateral fund).[2]

It was communicated to the respondents that all the forest areas considered at either side of the border had the same protection potential in terms of providing natural forest habitat for rare and endangered species in the perspective of next two centuries. Hence, any square kilometre, contemplated for additional protection was presented as identical for conservation purposes, supposedly diminishing biologically-founded reasons for systematically picking additional areas for conservation on one or the other side of the border. Changes in spatial extension attributes were provided in both absolute and relative terms (Figure 1).

Table 1 – Programme attributes and their levels

[1] In the Białowieża case, the wording was 'extension of the area covered by the passive protection regime' and no specific areas were used to illustrate potential alternatives (Valasiuk et al. 2017). In the Fulufjället case, the wording was 'park extension' and in the description preceding the DCE, specific areas were named as potential alternatives (Valasiuk et al. 2018).

[2] An efficient experimental design of the DCE was generated using NGENE software. Three types of the experimental design with zero priors having a different number of programme alternatives (one, two or three) plus SQ option, were prepared for the pilot survey with sixteen choice-cards for each type. The number of alternatives was varied in treatments and remained constant for the same respondent. Efficient experimental design for the main survey was generated using priors from the pilot experiment. Three types (the same as in the pilot study) times four blocks in each type yield twelve modifications of the experimental design, so a particular respondent faced one set of sixteen choice-cards being chosen randomly out of the twelve possible sets. Specifically, each design was optimized for median Bayesian D-error of the MNL model (Scarpa and Rose 2008). The order of choice tasks presented to each respondent were randomized to counter-balance possible ordering effects.

Programme attribute	Levels in the Fulufjället survey	Levels in the Białowieża survey
Passive protection extension on the domestic side	+0 sq.km +20 sq.km +40 sq.km +60 sq.km SQ=+0	+0 sq.km +35 sq.km +70 sq.km +105 sq.km SQ=+0
Passive protection extension on the foreign side	+0 sq.km +20 sq.km +40 sq.km +60 sq.km SQ=+0	+0 sq.km +35 sq.km +70 sq.km +105 sq.km SQ=+0

Additional amount of income tax, which you would have to pay annually during five years	Norway	Sweden	Poland	Belarus
	125 NOK	100 SEK	25 PLN	3 USD [5 USD]
	250 NOK	200 SEK	50 PLN	6 USD [10 USD]
	375 NOK	300 SEK	75 PLN	9 USD [15 USD]
	500 NOK	400 SEK	100 PLN	12 USD [20 USD]
	SQ=0	SQ=0	SQ=0	SQ=0

Note: SQ refers to “status quo”. NOK is Norwegian kroner, SEK is Swedish kronor, PLN is Polish złoty, and USD is US dollars. Monetary levels in square brackets in the Belarusian study were used in the pilot survey. (For Belarus, accounting for a higher volatility of the then national currency BYR, the bids were instead denominated in USD, a currency being routinely used by the country’s residents for transactions and saving purposes.)

The payment vehicle was designed as a compulsory tax paid by each tax-payer in every of the two countries in the dyad during a five-year period to a specific bilateral fund, established exclusively in order to finance the common programme of spatial extension of the National Park regime regardless the particular side of the state border. It was stated that

financial means were necessary for the implementation of the new Białowieża and Fulufjället protection programmes, including payments to compensate the current owners of the new protected areas.

Variants comparison 1	Status quo	Variant 1	Variant 2	Variant 3
Additional area in the Polish part of the Białowieża Forest covered by passive protection regime (Total proportion of passive protection zone in the Polish part of the Białowieża Forest)	+ 0 km^2 (35%)	+ 105 km^2 (51%)	+ 70 km^2 (46%)	+ 0 km^2 (35%)
Additional area in the Belarusian part of the Białowieża Forest covered by passive protection regime (Total proportion of passive protection zone in the Belarusian part of the Białowieża Forest)	+ 0 km^2 (37%)	+ 105 km^2 (44%)	+ 0 km^2 (37%)	+ 35 km^2 (40%)
Additional sum of taxes, imposed on your income annually during the five next years	None	100 PLN	50 PLN	75 PLN
Please, pick your best variant	☐	☐	☐	☐

Fig.1. Example of the choice card from the Polish Białowieża questionnaire

The debriefing block of attitudinal questions followed the DCE part of the questionnaire (Table 2). The following statements were listed, asking respondents to tick a number from 1 to 5, indicated level of disagreement or agreement.

Table 2 – Debriefing block of attitudinal questions

Białowieża (Poland/Belarus)	Fulufjället (Norway/Sweden)
I am afraid that the money spent on the protection on the Belarusian/Polish side of the Białowieża Forest could be embezzled (stolen)	*I am afraid that money spent on the protection on the Swedish/Norwegian side of Fulufjället could be misused*
I expect that Poland/Belarus will comply with the international agreement to a larger extent	*I expect Norway/Sweden to comply with the international agreement to a larger extent*

than Belarus/Poland	*than Sweden/Norway.*
I prefer to pay more for passive protection of the Polish/Belarusian side of the Białowieża Forest because it belongs to Poland/Belarus	*I prefer better to protect the Norwegian/Swedish side of Fulufjället because it belongs to Norway/Sweden*
I expect that Belarus/Poland will extend the passive protection zone of the Białowieża Forest on its side of the border whether or not the bilateral programme discussed in the questionnaire is implemented	*I expect Sweden/Norway to extend the National Park of Fulufjället on its side of the border whether or not the bilateral programme discussed in the questionnaire is implemented*
*I believe that the participation of Belarus in the funding of passive protection extension programme should be higher than the participation of Poland because the area of the Białowieża Forest on the Belarusian side is greater than on the Polish side**	*I believe that the participation of Sweden in the programme funding should be higher than the participation of Norway because the area of Fulufjället on the Swedish side is greater than on the Norwegian side**
I believe that participation of Poland in the funding of passive protection extension programme should be higher than the participation of Belarus because Poles are wealthier	*I believe that the participation of Norway in the programme funding should be higher than the participation of Sweden because Norwegians are wealthier.*
I believe that the participation of Poland in the programme funding should be higher than the participation of Belarus because the Polish population is greater than the Belarusian population	*I believe that the participation of Sweden in the programme funding should be higher than the participation of Norway because the Swedish population is greater than the Norwegian population*
I believe that results of this survey will be used for the selection of the new protection programme for the Białowieża Forest	*I expect the results of this survey to be used for the selection of the new protection programme for Fulufjället*
*I do believe that in the event of the implementation of the new Białowieża Forest protection programme I will be charged its costs (in the form of higher taxes)**	
I believe that tax values presented in the	*I believe that the tax values presented in the*

questionnaire, connected with different options of the Białowieża Forest protection programme are real tax rates that can be introduced	*questionnaire, connected with different options of Fulufjället protection programme are real tax rates that may be introduced*
I expect to visit the Polish side of the Białowieża Forest in the next 5 years	*I expect to visit the Norwegian side of Fulufjället in the next five years*
I expect to visit the Belarusian side of the Białowieża Forest in the next 5 years	*I expect to visit the Swedish side of Fulufjället in the next five years*

* Attitudinal questions which are not addressed in the subsequent analysis

3.2. Econometric framework

Hybrid choice models (Ben-Akiva et al. 1999; 2002, Walker and Ben-Akiva 2001) allow analysts to incorporate perceptions and cognitive processes into a Random Utility Model (RUM) framework. In this study we develop a Hybrid Mixed Logit (HMXL) model which combines the Mixed Logit, with the Multiple Indicators and Multiple Causes (MIMIC) model. Connecting discrete choice models with a MIMIC model is an emerging approach for incorporating psychological factors in the RUM framework. Applications in the environmental literature include Hess and Beharry-Borg (2012), Dekker et al. (2012), Hoyos et al. 2015, Czajkowski, Hanley and Nyborg 2017. Our hybrid choice model consists of two parts: a discrete choice component and measurement equations component.

3.2.1. Discrete choice component

The theoretical foundation for the discrete choice model is random utility theory, which assumes that the utility a person derives depends on observed characteristics and unobserved idiosyncrasies, represented by a stochastic component. As a result, individual i's utility resulting from choosing alternative j in choice set t can be expressed as:

$$V_{ijt} = a_i c_{ijt} + \boldsymbol{b}_i' \boldsymbol{X}_{ijt} + e_{ijt}, \quad (1)$$

where the utility expression is assumed additively separable in the cost of the alternative, c_{ijt}, and other attributes, $\boldsymbol{X}_{ijt}$; a_i and $\boldsymbol{b}_i$ denote estimable parameters; and e_{ijt} is a stochastic component allowing for factors not observed by the econometrician to affect individuals' utility and choices. It should be emphasized that a_i and $\boldsymbol{b}_i$ are *individual*-specific, thus allowing for heterogeneous preferences amongst respondents and leading to a Mixed Logit

Model (MXL). Assuming instead that parameters are the same for all respondents implies homogenous preferences and leads to the Multinomial Logit Model (MNL) as a special case. e_{ijt}

The logit probability requires a specific distribution for the variance of the stochastic component of the utility function e_{ijt}. Without a loss of generality, this can be achieved by normalising utility function coefficients, leading to the following specification:

$$U_{ijt} = \sigma_i a_i c_{ijt} + \sigma_i \boldsymbol{b}_i{}' \boldsymbol{X}_{ijt} + \varepsilon_{ijt} \tag{2}$$

Note that due to the ordinal nature of utility, this specification still represents the same preferences as (1) does. The estimates $\sigma_i a_i$ and $\sigma_i \boldsymbol{b}_i$ do not have direct interpretation, but if interpreted in relation to each other, the scale coefficient ($\sigma_i = \pi / \left(\sqrt{6} s_i\right)$) cancels out.

Given that we are interested in the marginal rates of substitution with respect to the monetary attribute c_{ijt}, it is convenient to introduce the following modification of , which is equivalent to using a money-metric utility function (in our case, it means estimating the parameters in WTP space; Train and Weeks 2005):

$$U_{ijt} = \sigma_i a_i \left(c_{ijt} + \frac{\boldsymbol{b}_i{}'}{a_i} \boldsymbol{X}_{ijt} \right) + \varepsilon_{ijt} = \lambda_i \left(c_{ijt} + \boldsymbol{\beta}_i' \boldsymbol{X}_{ijt} \right) + \varepsilon_{ijt} \tag{3}$$

In this specification (rescaling the utility function), the vector of parameters, $\boldsymbol{\beta}_i = \frac{\mathbf{b}_i}{a_i}$ can be directly interpreted as a vector of the implicit prices (marginal WTPs) for the non-monetary attributes, $\boldsymbol{X}_{ijt}$ facilitating an interpretation of the results.

In our HMXL model we assume that the random parameters $\boldsymbol{\beta}_i$ and λ_i depend on individual-specific latent variables, denoted by $\mathbf{LV}_i$. The functional form of this dependence may vary due to distributional assumptions. For a normally distributed $\boldsymbol{\beta}_i$, this dependence is of the form:

$$\boldsymbol{\beta}_i = \boldsymbol{\Lambda}' \mathbf{LV}_i + \boldsymbol{\beta}_i^*, \tag{4}$$

where $\mathbf{\Lambda}$ is a matrix of estimable coefficients and $\boldsymbol{\beta}_i^*$ has a multivariate normal distribution with a vector of means and a covariance matrix to be estimated. For the log-normal distribution we have:

$$\lambda_i = \exp\left(\boldsymbol{\tau}'\mathbf{LV}_i + \lambda_i^*\right), \tag{5}$$

where $\boldsymbol{\tau}$ is a vector of estimable coefficients and λ_i^* follows a normal distribution with the parameters describing its mean and standard deviation to be estimated. As a result, the conditional probability of individual i's choices in choice set t is given by:

$$P(y_i \mid X_i, \boldsymbol{\beta}_i^*, \lambda_i^*, LV_i, \Lambda, \boldsymbol{\tau}, \boldsymbol{\theta}) = \prod_{t=1}^{T_i} \frac{\exp\left(\lambda_i\left(c_{ijt} + \boldsymbol{\beta}_i' \boldsymbol{X}_{ijt}\right)\right)}{\sum_{k=1}^{C} \exp\left(\lambda_i\left(c_{ikt} + \boldsymbol{\beta}_i' \boldsymbol{X}_{ikt}\right)\right)}, \tag{6}$$

where $\boldsymbol{\theta}$ is a vector of parameters on which λ_i^* and $\boldsymbol{\beta}_i^*$ depend.

3.1.2. Measurement equations

The main purpose of including latent variables in the models is that they describe some psychological factors. These factors usually cannot be observed directly, unlike other individual characteristics such as age and gender. Instead a researcher must use various indicator questions in a survey, responses to which could be expected to be determined by the latent variables.

The measurement component of the hybrid choice model can be specified as follows:

$$\mathbf{I}_i^* = \mathbf{\Gamma}'\mathbf{LV}_i + \boldsymbol{\eta}_i, \tag{7}$$

where $\mathbf{I}_i$ represents (ordered) indicator variables, $\mathbf{\Gamma}$ is a matrix of coefficients and $\boldsymbol{\eta}_i$ denotes a vector of error terms assumed to come from a multivariate normal distribution with zero means and an identity covariance matrix.[3] Under this specification, the relationship between I_{il} and I_{il}^* (for the l-th indicator variable which takes J possible, ordered values) becomes:

[3] It is important to note that the number of measurement equations need not equal the number of latent variables. For instance, cases may arise where more than one indicator for a latent variable may be available (This framework can accommodate such a setting by specifying multiple measurement equations for a single latent variable.

$$\begin{array}{lll} I_{il}=1, & \text{if} & I_{il}^{*}<\alpha_{1l} \\ \vdots & \vdots & \vdots \\ I_{il}=k, & \text{if} & \alpha_{k-1l}\le I_{il}^{*}<\alpha_{kl} \\ \vdots & \vdots & \vdots \\ I_{il}=J, & \text{if} & \alpha_{J-1l}\le I_{il}^{*} \end{array}, \tag{8}$$

where the α's are the threshold parameters to be estimated for each indicator. This specification leads to the well-known ordered probit likelihood form for I_i:

$$P\left(I_i \mid \mathbf{LV}_i,\boldsymbol{\Gamma},\boldsymbol{\alpha}\right)=\prod_{l=1}^{L}\left(P\left(I_{il}\mid \mathbf{LV}_i,\boldsymbol{\Gamma}_l,\alpha_l\right)\right)=\prod_{l=1}^{L}\left(\Phi\left(\alpha_{kl}-\boldsymbol{\Gamma}_l'\mathbf{LV}_i\right)-\Phi\left(\alpha_{k-1l}-\boldsymbol{\Gamma}_l'\mathbf{LV}_i\right)\right), \tag{9}$$

where $\Phi(\cdot)$ denotes the normal cdf, Γ_l and α_l are the l-th row of the $\boldsymbol{\Gamma}$ matrix and the vector of the threshold parameters for the *l*-th indicator variable, respectively.

Finally, after combining equations, we obtain the full-information likelihood function for our HMXL model, where for ease of exposition we stack the parameter vectors $\boldsymbol{\Lambda},\boldsymbol{\tau},\boldsymbol{\theta},\boldsymbol{\Gamma},\boldsymbol{\alpha}$ into the single vector $\boldsymbol{\Omega}$:

$$L_i=\int P\left(\mathbf{y}_i \mid \mathbf{X}_i,\boldsymbol{\beta}_i^{*},\lambda_i^{*},\boldsymbol{\Omega}\right)P\left(\mathbf{I}_i\mid\boldsymbol{\Omega}\right)f\left(\boldsymbol{\beta}_i^{*},\lambda_i^{*}\mid\boldsymbol{\theta}\right)d\left(\boldsymbol{\beta}_i^{*},\lambda_i^{*}\right). \tag{10}$$

As random disturbances of $\boldsymbol{\beta}_i^{*},\lambda_i^{*}$ are not directly observed, they must be integrated out of the conditional likelihood. This multidimensional integral can be approximated using a simulated maximum likelihood approach. [4]

3.2.3. Hybrid modelling approach

In modelling respondents' choices, we assumed the following utility function form:

$$V=SQ+\beta_t*\left(S_d+S_f\right)+\Delta*S_f+S_f*\sum_{i=1}^{8}\left(\Delta_{LVi}*LV_i\right) \tag{11}$$

where SQ represents alternative specific constant associated with the status quo (no extension), parameter β_t stands for marginal WTP or the total extension area S_d+S_f, whilst Δ represents additional marginal WTP for the area of extension abroad alone S_f. Note that

[4] The models were estimated using maximum simulated likelihood techniques, using 10,000 scrambled Sobol draws (Czajkowski and Budziński, 2015). The software used here (estimation package for DCE data) was developed in Matlab and is available at https://github.com/czaj/DCE under CC BY 4.0 license. The dataset, additional results and estimation codes are available from http://czaj.org/research/supplementary-materials.

by including the separate variable for extension abroad, the coefficient of the latter represents the deviation in WTP for extension abroad, relative to the extension in a respondent's country. A negative coefficient Δ means that respondents value TNPA's extensions abroad lower than the same extension in their country, and vice versa, whereas $\Delta = 0$ would mean that respondents are indifferent whether the extension takes place in their country or abroad.

The HMXL framework makes it possible to use latent variables to explain the drivers of preferences for specific choice attributes by using latent variables, linked with specified indicator questions. In our case, we are interested in the drivers of Δ, i.e. in what drives differences in preferences for extensions abroad, relative to extensions in own country, thus rendering appropriate attitudes either drivers or mitigators of the IPG-state.

In this specification, the latent variables influence the way the spatial extension abroad is entering the model. Thus, expression $\Delta + \Delta_{LVi} * LV_i$ reflects a joint impact of the marginal WTP for extension abroad Δ, and the *i*-th latent variable on how one additional square kilometre of the extension abroad changes the money metric utility derived from the total extension. We performed a simple simulation based on estimated HMXL models' parameters. Using them, we calculate expressions $\Delta + \Delta_{LVi} * LV_i$. Finally, accounting for the sign[5] and statistical significance of the γ_i – the parameter with the latent variable from the corresponding *i*-th measurement equation, we determine the impact of the respondents' attitudes on their preferences towards the TNPA under scrutiny.

3.3. Data and survey administering

After pre-testing the questionnaires in in-depth interviews in Warsaw and Minsk and focus group sessions in Stockholm and Oslo, pilot surveys were carried out in the four countries. As the questionnaires were found to work well in the pilot, they were carried over to the main survey without further changes, except for adjustments in the design of the choice attribute levels in order to improve statistical efficiency.

[5]Note, that for the convenience of further interpretation of the simulation results, we had to rearrange the signs in some of the pares [coefficient with LV_i in the utility function – coefficient with the same LV_i in the measurement equation] to make all the LVs entering all the measurement equations positively. Change of the coefficient in the measurement equation from negative to positive entailed reverse change of the sign of the appropriate coefficient in the utility function. For instance, if latent variable in the original model enters both the utility function in the DCE component, and the corresponding measurement equation in the MIMIC component with the negative sign, it is equivalent in the simulation to as if the both parameters were positive. The intuition behind it is as follows: if a more negative attitude to something underpins more disutility, then a more positive attitude to the same thing results in a greater utility being derived.

The Białowieża questionnaire was operationalised in the form of offline software tool, and administered as a series of computer-assisted personal interviews (CAPI) to samples of Belarusian and Polish respondents, interviewed at their homes. The rejection rate was about 7% of the Belarusian sample while it was about 20% of the Polish sample. The survey was administered during July-December 2015 in Belarus and during December 2015 – February 2016 in Poland. The pilot sample included 100 Belarusian and 100 Polish complete interviews, while the main sample included 900 and 901 complete interviews, respectively. After removal of protesters (i.e. respondents explaining systematic picking status-quo as their best choice by indicating that it is the government who must finance nature restoration programmes, not themselves directly) the dataset (main surveys plus pilots) was reduced to 763 Belarusian, 755 Polish respondents (Valasiuk et al. 2017).

The Scandinavian questionnaire was adapted to an Internet-consistent format (CAWI), and pilot-tested in September and October 2015 with a sample of 458 Swedes and 282 Norwegians recruited from an Internet panel (IQS Sp. z o.o.). The main survey, carried out in November and December 2015, comprised 889 Swedes and 902 Norwegians. After removal of protesters, the dataset (main surveys plus pilots) was reduced to 1001 Norwegian respondents and 1167 Swedish respondents (Valasiuk et al. 2018.)

4. Results

The results of the four country-specific HMXL models are reported in Table 3. The top panel of Table 3 presents the main effects, i.e. the estimated means and standard deviations of the distributions of WTP for each DCE component of the model. The bottom panel represents the measurement component of the model including the coefficients of the latent variables interacted with $^{\Delta}$ and the coefficients of the same latent variables used to explain responses to eight attitudinal questions. All models were estimated in WTP-space, and therefore the estimated choice coefficients may readily be interpreted as marginal WTP for attribute levels (in PPP-corrected 2015 Euros).[6]

Table 3 – Structural model linking preferences for the extensions of the national parks with attitudinal questions aimed at explaining the reasons for valuing the extension abroad differently than in one's country

[6] We assumed a normal distribution for the non-monetary random parameters, whilst the cost coefficient was assumed log-normally distributed to impose the theory-driven restriction that marginal utility of money is positive. A restriction of non-correlation between parameters has been imposed on the models.

Choice attributes		**Norway** (Fulufjället)	**Sweden** (Fulufjället)	**Belarus** (Białowieża)	**Poland** (Białowieża)
Status quo (alternative specific constant)	Mean (S.E.)	-23.62*** (0.84)	-35.95*** (1.06)	40.34*** (13.61)	-11.86*** (0.36)
	St. dev. (S.E.)	53.07*** (2.03)	73.08*** (1.59)	233.37*** (43.82)	24.05*** (0.67)
Extension [100km^2]	Mean (S.E.)	38.11*** (1.40)	33.51*** (1.32)	6.59 (4.56)	8.10*** (0.52)
	St. dev. (S.E.)	47.80*** (1.63)	36.52*** (0.85)	38.92*** (7.80)	15.81*** (0.65)
Extension abroad [100km^2]	Mean (S.E.)	-31.39*** (1.36)	-17.50*** (1.09)	-39.25*** (8.46)	-14.76*** (0.62)
	St. dev. (S.E.)	11.78*** (1.35)	11.56*** (0.58)	18.71** (7.46)	4.87*** (0.43)
Latent variables					
LV$_1$ – *I expect to visit the domestic side of the site under consideration in the next five years*	Interaction with Extension abroad	-15.30*** (1.02)	4.43*** (0.70)	n.s.	n.s.
	Measurement component	3.49*** (1.06)	0.69** (0.32)		
LV$_2$ – *I expect to visit the foreign side of site under consideration in the next five years*	Interaction with Extension abroad	24.03*** (1.34)	n.s.	20.54*** (6.45)	6.09*** (0.44)
	Measurement component	0.67*** (0.14)		0.77*** (0.23)	1.21*** (0.36)
LV$_3$ – *I believe that the participation of Poland (Sweden) in the programme funding should be higher than the participation of Belarus (Norway) because the*	Interaction with Extension abroad	2.04** (0.87)	5.47*** (0.83)	-13.79** (5.87)	n.s.
	Measurement component	0.90*** (0.31)	0.35* (0.19)	4.29*** (1.64)	

Polish (Swedish) population is greater than the Belarusian (Norwegian) population					
LV_4 – *I believe that the participation of Poland (Norway) in the programme funding should be higher than the participation of Belarus (Sweden) because Poles (Norwegians) are wealthier*	Interaction with Extension abroad	14.63*** (1.14)	n.s.	n.s.	n.s.
	Measurement component	0.27** (0.13)			
LV_5 – *I am afraid that money spent on the protection on the foreign side of the site under consideration could be misused*	Interaction with Extension abroad	-3.12*** (0.93)	n.s.	n.s.	n.s.
	Measurement component	0.41** (0.20)			
LV_6 – *I expect the domestic party to comply with the international agreement to a larger extent than the foreign party*	Interaction with Extension abroad	n.s.	n.s.	n.s.	n.s.
	Measurement component				
LV_7 – *I expect the foreign party to extend the passive protection regime on its side of the border whether or not the bilateral programme discussed in the questionnaire is implemented*	Interaction with Extension abroad	n.s.	7.24*** (0.57)	n.s.	-4.67*** (0.34)
	Measurement component		0.52*** (0.20)		0.81** (0.33)

LV_8 – *I prefer to protect the domestic side of the site under consideration than its foreign side because it belongs to my country*	Interaction with Extension abroad	n.s.	-13.93*** (0.77)	n.s.	n.s.
	Measurement component		1.06*** (0.26)		
Model diagnostics					
LL at convergence		-19,252.96	-21,623.45	-16,859.44	-14,521.75
LL at constant(s) only		-26,407.73	-30,147.70	-19,207.89	-19,636.19
McFadden's pseudo-R^2		0.2709	0.2827	0.1223	0.2605
Ben-Akiva-Lerman's pseudo-R^2		0.5680	0.5784	0.4897	0.6016
AIC/*n*		2.4120	2.3226	2.7712	2.4135
BIC/*n*		2.4388	2.3461	2.8052	2.4478
n (observations)		16,011	18,668	12,208	12,080
r (respondents)		1,001	1,167	763	755
k (parameters)		56	56	56	56

***, **, * significance at 1%, 5%, 10% level. Standard errors provided in parentheses, n.s. represents not significant effects. Detailed results (including estimated cost*scale parameters that are not interpretable and thresholds of the ordered probit models) are estimated in the Supplementary materials.

The WTP estimates associated with the alternative specific constant for the status quo alternative show, that citizens of all countries except Belarus preferred a new policy incorporating some form of extension of the national park. In all cases, however, the estimated WTP shows a considerable heterogeneity, as indicated by high standard deviations, relative to means. This is especially pronounced for Belarus, and indicates that there are strong supporters as well as strong opposers of a proposed policy. Each 100 km^2 extension of the national park is valued at 38 EUR by Norwegians and 33 EUR by Swedes. Polish respondents would, on average, be willing to pay 8 EUR for the same scale of extension. For Belarus, the mean WTP associated with the total extension of the national park was not statistically significantly different from zero, which means that respondents from Belarus, on

average, favour the current policy and are negative towards any extension abroad. Once again, in all countries a large heterogeneity of preferences is evident.

Additional WTP assigned to the extension abroad was negative and significant in all the country-specific models, indicating that respondents value national park extensions less than in their own country. The latter finding rejects again the hypotheses that TNPAs are IPGs in the Białowieża (Valasiuk et al. 2017) and Fulufjället (Valasiuk et al. 2018) cases, since it would imply the z-test to reject the hypothesis stating that the coefficient with the extension abroad in this utility function specification is statistically different from zero. Preferences for extension abroad exhibited heterogeneity in all countries involved, as the corresponding standard deviations are statistically significant. Interestingly, whilst for Norwegian and Swedish respondents the absolute value of an extension abroad was still positive, approximately 6.72 EUR for Norwegians and 16.01 EUR for Swedes, for Polish and Belarusian respondents a policy aiming at extending the national park on the other side of the border would lead to loss of human welfare.

We now turn to investigating the main behavioural drivers of respondents' different preferences for extensions abroad, relative to extensions in their own country. In all the countries except for Sweden those stating that they expect to visit the foreign part of the park were willing to pay more for extensions abroad. Although, the intention to visit the national park in their own country was a significant mitigator of WTP for extension abroad for Norwegians, the opposite was true for Swedes – those Swedish respondents who reported that they intend to use the domestic part of the national park had significantly higher WTP for the park extension abroad. No significant effect in this regard was found among Belarusians and Polish respondents.

Considering the factors that justify one country's higher contribution, both Swedes and Norwegians who agree that Sweden should bear a larger part of the cost because its population is larger were also less negative about extensions abroad. The reverse effect is observed in Belarus, where those who agree that more populous Poland should pay more are also more negative about park extensions abroad. When the differences of wealth between countries are considered, agreeing that it plays a role is a significant explanatory factor for different valuation of extensions abroad only in Norway, making it slightly less negative.

Being afraid that money spent on the protection on the foreign side of the site under consideration could be misused showed a significant effect only among Norwegians, reducing (as expected) the willingness to pay for extension of the park on the other side of the border.

One of the hypothesised reasons for the different preferences of park extensions abroad, relative to extensions in one's country is the expectation that foreign party may comply with the extension program to a lesser extent. However, this factor was not significant in any of the considered countries. Similarly, one of the possible explanations for the difference in valuation of foreign relative to domestic park extensions is the expectation that the foreign country would introduce an extension irrespectively of the program, and hence there is no need to pay for such a policy. This effect was found to be a significant explanatory factor in Sweden, where it increased valuation of foreign extensions, and in Poland, where – on the contrary – it leads to even lower valuation of extensions abroad. Finally, the national ownership of the extended part was a significant mitigator of foreign extensions' valuation in the case of Sweden only.

5. Discussion

Using the standard DCE framework, Valasiuk et al. (2017, 2018) showed that neither the Białowieża TNPA nor the Fulufjället TNPA are perfect international public goods (IPGs). The WTP difference was, however, considerably more pronounced for Białowieża than for Fulufjället because, unlike the Fulufjället case, positive welfare spill overs across the border in the Białowieża case were enjoyed by the citizens of neither of the constituent countries, rendering the case a combination of two pure national public goods (Bjorvatn and Schjelderup 2002, Levaggi 2010). The latter finding provides economic explanation for the poor level of transboundary co-operation since in accordance with Busch (2008), national welfare is necessarily not greater under the transboundary equilibrium than under the isolated equilibrium if positive spill over effect condition does not hold.

Hybrid DCE models' main effects demonstrate the same pattern, pointing at the robustness of the results. In addition to objective and behavioural factors, people's considerations, which might appear potential drivers of their preferences towards Białowieża and Fulufjellet with respect to IPG-state, were examined by means of the hybrid DCE modelling. The respondents' preferences were related to their attitudes and beliefs. Presence of visiting (i.e., use value) expectations might shift respondent's preferences in favour of the part which expects to enjoy directly, which was observed in case of Norwegians, Poles and

Belarusians. Interestingly, use value expectations demonstrated a similar pattern regarding their influence on preferences of Norwegians and Poles, whereas Brown et al. (2015) in their public participation GIS study found significantly higher propensity towards use values of natural goods among Norwegians than among Poles. Although we found no clear explanation for the reverse pattern observed in the case of the domestic part visiting expectations in the Swedish sample, one possible reason is the Swedish respondents' notion of the positive cross-border welfare spill over effect (Busch 2008). Still, for Białowieża, use value expectations clearly drive the preferences more IPG-consistent if people expect to visit the foreign segment of the TNPA. Removing the physical border fence installations, and promoting increased cross-border visits could therefore be expected to shift people's preferences towards more close transboundary co-operation and interest in the protection of the foreign side of the Białowieża Forest (Valasiuk et al. 2017).

The attitudinal questions addressing the inter-country size disparities somehow differ from the economic reasoning. Thus, according to the Warr neutrality theorem (1983), when individuals behave as atomistic utility maximisers in the determination of their provision of a single public good, a distribution of income has no effect on the level of provision in the interior solution, regardless of differences in individuals' marginal propensities to contribute. More specifically, Boadway and Hayashi (1999) provide a game-theoretical argument for the disproportionate burden sharing hypothesis for the countries which differ in their size understood as a product of their population and per capita income entering the model as two separate variables. According to them, larger countries contribute disproportionately to the financing of IPG only in a restricted sense, since given that the country's economic size is a product of its population and per capita income, their different combinations are possible between the countries involved. At the same time, residents of more populous IPG-contributing countries are worse off in terms of individual level welfare than those in the less populous countries regardless of their per capita income levels.

In the Fulufjället case, the more respondents agreed with the propositions of unequal financing of the TNPA due to the countries' disparities in terms of wealth or population, the more IPG-consistent and mutually co-operative preferences they expressed. A less apparent and more interesting observation was made in the Białowieża case, where Poland clearly dominates over Belarus in terms of both in population and per capita income, which means that contributing Poland would unambiguously be disproportionally burdened in the Nash equilibrium. Moreover, following Boadway and Hayashi (1999) Polish citizens would be

worse off in terms of individual level welfare compared to Belarusians. In these conditions, the less Belarusian respondents agreed that Poland should contribute more to the funding of the programme (i.e. presumably, the better they saw the hypothetical disproportionate burdening of Poland and the less they agreed to it) – the more supportive they were towards funding foreign park extensions. Therefore, the latter pattern might be interpreted as a manifestation of conscious altruism and preferences in favour of international justice. These attitudes however did not prevail over the Belarusians' propensity to maintain status quo.

As expected, suspicions towards the foreign party appeared to be a mitigator of the IPG-consistent preferences. Obviously, respondents could exhibit aversion towards contributing to a bilateral IPG provision programme if they are suspicious towards credibility of the adjoining foreign party. Given the comparative performance of the countries under consideration with respect to their overall transparency and corruption levels (e.g. Transparency International Corruption perceptions index in 2018 was 85/100 for Sweden, 84/100 for Norway compared to 60/100 for Poland and 44/100 for Belarus)[7], one could *a priori* expect this factor to be more pronounced in the East European case as compared to the Scandinavian case. Surprisingly, this tendency was only found in the case of Norwegian respondents.

Free-riding is the commonly acknowledged essence of market failure in public goods provision (Samuelson 1954). In this study, we addressed a special case of an *international* free-riding, where respondents might understate their real WTP for the foreign segment of the binational public good in anticipation of its unilateral provision, thus free-riding on the actions of neighbouring country. Like Voltaire et al. (2017), we verified if the respondents' trust in the other agents' contribution to conservation action (in this case – unilateral designation by the foreign party) reduces their stated preferences. As the simulation results suggest, Swedish and Polish respondents showed the reverse patterns of preferences in respect to their propensity to free-ride. In principle, free-riding alone might preclude the mutually adjacent countries from co-operation on TNPA, as in the extreme no country may act. However, a more likely scenario seems suboptimal provision of the public good carried on by a more wealthy country (Olson 1965, Sandler 1998), which might be applicable to Poland in the case of Białowieża.

[7] https://www.transparency.org/cpi2018 accessed 6th October 2019

Finally, lack of IPG state in the case of TNPA might be explained with the greater preferences of the country citizens toward their domestic segment simply because it belongs to their country. Dallimer et al. (2015), although not focussing on TNPA, found in their international DCE on ecosystem services of semi-intact grasslands, that individuals would on average be most concerned about policies affecting their domestic nature sites. Considering both history of the two actual EU borderlands under consideration as well as their present state (including the frontier regime and overall interstate relations in between EU and two different non-EU countries) one might have different *a priori* expectations regarding patriotism as an IPG driver. In our case we only found this pattern in the Swedish sample. Although, 'patriotic' considerations could have been a quite generic and legitimate explanation of TNPA not being a pure IPG, quite surprisingly, no significant 'patriotic' considerations were found as negative IPG-drivers in the other three countries involved.

7. Concluding remarks and policy implications

Using both advanced (Valasiuk et al. 2017, 2018) and a simpler approach in this study the hypothesis that Transboundary Nature Protected Areas (TNPA) are an international public good (IPG) was rejected for both the Białowieża and Fulufjället case studies, so our results demonstrated robustness over modelling approach. Explaining what drives IPG-consistent preferences, we found that appreciation of transboundary justice and altruism is a driver towards more co-operative nature conservation, especially in Scandinavia. Suspicious attitude of people towards the neighbouring country, a propensity to free-ride, and manifestations of 'patriotism' applied as IPG mitigators only to a limited degree.

The clearest driver of IPG-consistent preferences was, however, use value expectations regarding the foreign segment of TNPA as in three countries out of four, expectations to visit the foreign part of the TNPA proved to be an IPG driver. This pattern coincides with the Białowieża case study being divided by existing border/visa limitations across the Polish-Belarusian border, while Swedes and Norwegians are free to cross the national border dividing Fulufjället. The limited physical access between Poland and Belarus implies weaker cross-border exchange of information and knowledge, entailing poorer awareness of the Białowieża's transboundary nature. Assuming potentially high non-use value, the latter circumstance translates into the lost positive transboundary welfare spill overs elicited via citizen's preferences. Consistent with Busch (2008), enhancing transboundary co-operation contemplated by international organisations in case of Białowieża (Debonnet and Ossola

2018) is not incentivised economically. Thus, in order to shift peoples' preferences towards transboundary co-operation, incentives to visit the segments abroad should be created symmetrically in the countries sharing a TNPA, whilst the existing limitations of its transboundary accessibility should be relaxed or totally removed.

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