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Recreational Value of the Baltic Sea: a Spatially Explicit Site Choice Model Accounting for Environmental Conditions

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Abstract: The Baltic Sea plays a significant role for recreational use in the nine littoral countries with more than 70% of the population visiting the coast, representing some 80 million recreation visits annually. Understanding the values associated with coastal recreation and the potential welfare changes of improving the state of the Baltic Sea is important for managing the marine environment. We estimate a spatially explicit travel cost model of coastal site recreation to the Baltic Sea to assess the welfare of accessing individual sites, identify recreational hotspots and simulate the welfare changes resulting from improving environmental and infrastructure conditions. The total benefits associated with the Baltic Sea based recreation amount to 11.4 billion EUR per year with significant variation across sites. Improving water quality and infrastructure boost the recreational value by nearly 9 billion EUR, almost doubling the recreational benefits compared to current conditions.

Keywords: Recreational benefits, Site choice, Random Utility Model, Baltic Sea, Blue Flag

JEL codes: L83, Q26, Q51

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1. Introduction

Recreation in coastal areas has been growing over the past decades, and it has become a key factor of the economic development and social welfare in countries with coastal tourism (Ghermandi and Nunes 2013). At the same time, many possibilities of coastal recreation are sensitive to environmental quality (Ahtiainen et al. 2013). As a result, studies on the market and non-market benefits of coastal areas and their dependence on environmental quality play a crucial role in effective coastal management.

In this study, we aim at estimating the recreational value of the Baltic Sea – one of the largest semi-enclosed bodies of brackish water in the world, surrounded by nine European countries that benefit from the recreational opportunities it provides. The value of the Baltic Sea-based recreation has been the focus of only a few economic investigations to date. Czajkowski et al. (2015a) study the littoral countries recreation patterns and apply the single site Travel Cost Method (TCM) to estimate the total economic benefits provided by the Baltic Sea based recreation at EUR 14.8 billion per year; they also predict nearly EUR 2 billion higher benefits, if the environmental status of the sea improved. Other TCM estimates of coastal sites were provided by Vesterinen et al. (2010) for Finland, and also by Sandström (1996) and Soutukorva (2005) for Sweden. The benefits of improved water quality for recreation were alternatively estimated using stated preference methods. Ahtiainen et al. (2014) state the value of alleviating eutrophication in the Baltic Sea at EUR 3.6 billion annually. The economic value of the reductions in eutrophication has earlier been measured in the Stockholm archipelago of Sweden (Söderqvist and Scharin 2000), and in Lithuania, Poland, and Sweden (Markowska and Żylicz 1999). Tuhkanen et al. (2016) estimate the value of benefits of water quality improvements in Estonia, while Pakalniete et al. (2017) studies willingness to pay for the improved quality of coastal water used for recreation in Latvia.

Despite the generally uncontroversial nature of revealed preference methods, traditional single-site TCM has been criticized for disregarding substitution possibilities (Fletcher, Adamowicz and Graham-Tomasi 1990). Such limitation can be addressed by applying random utility model-based TCM (Parsons 2017). This approach allows for explicitly accounting substitution among recreational opportunities and makes it possible to accommodate access and quality changes into valuation. Inclusion of site-specific characteristics, such as their environmental qualities (Termansen et al. 2013) or spatial variability (Bateman et al. 2013;

Czajkowski et al. 2017), as explanatory variables of the model facilitates their economic valuation.

Our study provides a new, spatially-explicit analysis of the economic value of the Baltic Sea-based recreation. Unlike earlier studies (e.g., Czajkowski et al. 2015a), we do not treat the Baltic Sea as a single site, but instead model the demand for a set of coastal locations used for recreation in each country. This allows us to estimate more reliable values of recreational benefits associated with the Baltic Sea not only as a whole, but also for each of the sites, and thus identifying recreational hotspots. Moreover, we include indicators of the environmental conditions observed by tourists at each site at the time of their visits as explanatory variables. Therefore, we investigate the importance of environmental quality for choice of recreational locations, and simulate welfare changes resulting from its enhancement, which is a methodologically stronger and more precise approach than in earlier, perception-based estimates (see Czajkowski et al. 2015a).

In section 2, we describe empirical approach – survey data and econometric framework of the analysis. In section 3, the estimation results of the site choice and the count data models are presented. The following section 4 contains interpretation of these results, in terms of implied welfare measures of the Baltic Sea-based recreation possibilities, the description of the distribution of recreational value along the Baltic Sea coast, and the simulated change of the recreational value resulting from improvements of environmental conditions. The last section presents conclusions.

2. Empirical approach

2.1. Survey data

The data used for this study comes from a survey conducted in all of the nine countries[1] around the Baltic Sea (Ahtiainen et al. 2013). In each country approximately 1,000 respondents participated in the survey, resulting in a total sample of 9,127 observations. The survey consisted of five sections: (i) an introduction, including a definition of the Baltic Sea; (ii) questions about respondents' connection to the Baltic Sea, general use of the Baltic Sea, and their place of residence; (iii) details of the most recent visit to the sea; (iv) attitudinal questions;

[1] For Russia, the two administrative regions on the coast of the Baltic Sea were surveyed – Kaliningrad and Leningrad Oblast. However, we eventually decided to exclude these observations from the analysis because of extremely low number of respondents who made domestic recreational trips to the Baltic Sea.

and (v) socio-demographic questions.[2] Table 1 summarizes the information about recreational trips, respondents' socio-demographics, and a list of coastal sites observed in each country.

In TCM the most crucial variables is the distance to each of the analyzed sites. We assumed that each respondent could have chosen from all the travel destinations in his country. Travel distances to each of the sites were measured using ARCGIS (ESRI® ArcMap™ 10.0). The Euclidean distances were corrected using a country-specific scaling coefficient, reflecting the ratio of the average Euclidian distance to the routing distance, calculated for a set of randomly selected grids and destination sites within that country. The travel cost was determined as a vehicle operating cost (which conservatively included petrol, oil and tire use only;(which conservatively included petrol, oil, and tire use only; Hang et al. 2016) and the opportunity cost of time (Czajkowski et al. 2015b) for a return journey.

The environmental qualities of recreational destinations were characterized by eligibility to the eco-label Blue Flag and by their level of compliance with the EU Bathing Water Directive (2006/7/EC). The Bathing Water Directive operates on four levels: excellent, good, sufficient, and poor compliance, or noncompliance. For simplicity of analysis, we grouped the good and sufficient compliance levels into one category: mandatory compliance. Limit values are defined by the presence of microbial parameters: concentration of Intestinal Enterococci/100ml and concentration of Escheria Coli/100ml; physical parameters (pH, colour); and biophysical properties (water transparency measured through the Secchi depth, residues, and floating material). The Blue Flag programme requires sites to be at the excellent compliance level over a 4-year period on average, and also a minimum level of infrastructure (toilet facilities with a minimum of septic tank, lifesaving facilities, and information on water quality at the site[3]), including at least one site per municipality with handicap access. Data included is taken from the Environment of Evolutionary Adaptedness (EEA) official report for each country. Table 1 shows the quality parameters of bathing water and the values for the respective compliance levels.

[2] English translation of the original survey is available as the online supplement to this paper.

[3] More details about the standards of the Blue Flag Foundation are available at http://www.blueflag.global.

Table 1: Water quality parameters in accordance to the EEA bathing water directives and Blue Flag criteria

Water quality characteristics	Excellent compliance (CG)	Mandatory compliance (CI)	Blue Flag sites criteria
Conc. of Intestinal Enterococci (IE)/100ml (streptococci)	100	-	100
Conc. of Escheria Coli (EC)/100ml (faecal coliforms)	100	2000	100
pH	Between 6-9	Between 6-9	Between 6-9
Colour	No change	No abnormal change	No change
Transparency (Secchi depth)	2m	1m	1m
Residues & floating material	Absence	-	Absence
Infrastructure	Not included	Not included	Yes

Respondents' choices of sites, along with a number of their visits to the sites, reveal information about their preferences. People choose sites that provide the best recreational opportunities, and how many trips they make is determined by preferences and constrained by budgets. This information is sufficient to model demand for recreational trips and investigate how demand is influenced by various site characteristics.

Table 2: Summary of the information about recreational trips and explanatory variables (standard deviations in brackets)

	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Sweden
Respondents	914	477	932	953	1,018	995	1,008	908
Respondents who visited the Baltic Sea in the last 12 months	546	84	445	197	464	324	310	650
Respondents who visited the Baltic Sea earlier than in the last 12 months	280	287	350	571	411	541	594	232
Respondents who had not visited the Baltic Sea	88	106	137	185	143	130	104	26
Mean distance travelled (km)	452.66 (253.23)	375.65 (189.1)	614.38 (377.34)	1,180.28 (499.57)	359.42 (237.72)	516.56 (240.89)	1,068. 13 (410.45)	917.63 (624.47)
Mean time travelled (hours)	4.97 (2.78)	5.83 (2.93)	11.58 (8.28)	12.80 (70.41)	4.96 (3.28)	6.03 (2.814)	12.20 (4.71)	10.18 (7.17)
Mean travel cost (EUR)	93.71 (52.42)	91.12 (45.87)	231.17 (165.31)	314.40 (133.07)	86.45 (57.17)	126.61 (59.04)	263.08 (100.99)	208.50 (142.89)
Mean travel cost – vehicle operating cost (EUR)	45.15 (25.25)	61.37 (30.89)	102.80 (73.51)	148.04 (62.66)	65.06 (43.03)	102.63 (47.86)	205.08 (78.81)	96. 91 (65.94)
Mean travel cost – opportunity cost of time (EUR)	48.56 (27.16)	29.74 (14.97)	128.37 (91.80)	166.36 (70.41)	21.38 (14.14)	23.97 (11.17)	57.99 (22.40)	111.60 (78.62)
Mean age (years)	50.73 (15.36)	47.09 (16.65)	50.54 (17.19)	16.07 (180.53)	44.08 (16.80)	47.53 (17.83)	49.56 (15.98)	54.19 (17.67)
Male (share)	0.53 (0.50)	0.45 (0.50)	0.52 (0.50)	0.50 (0.50)	0.53 (0.50)	0.47 (0.50)	0.69 (0.47)	0.56 (0.49)
Compulsory education (share)	0.14 (0.35)	0.19 (0.39)	0.35 (0.48)	0.25 (0.43)	0.20 (0.40)	0.26 (0.44)	0.55 (0.23)	0.24 (0.43)

High school education (share)	0.08 (0.27)	0.63 (0.24)	0.16 (0.37)	0.19 (0.39)	0.23 (0.42)	0.28 (0.44)	0.53 (0.50)	0.26 (0.44)
Vocational education (share)	0.22 (0.42)	0.61 (0.49)	0.31 (0.46)	0.47 (0.50)	0.34 (0.48)	0.27 (0.44)	0.05 (0.21)	0.14 (0.34)
University education (share)	0.56 (0.50)	0.14 (0.35)	0.53 (0.50)	0.07 (0.26)	0.22 (0.42)	0.20 (0.50)	0.37 (0.48)	0.36 (0.48)
Household income (1,000 EUR/month)	2.4 (1.07)	1.74 (1.08)	2.23 (1.02)	2.17 (9.96)	0.73 (0.34)	0.69 (0.36)	1.28 (0.92)	3.21 (1.35)
Occupation related to the Baltic Sea (share)	0.064 (0.25)	0.06 (0.24)	0.08 (0.27)	0.04 (0.20)	0.07 (0.25)	0.03 (0.16)	0.07 (0.25)	0.08 (0.26)
Number of children in household	0.68 (1.01)	0.51 (0.82)	0.62 (1.16)	0.50 (0.88)	0.67 (0.93)	0.47 (0.82)	0.55 (0.91)	0.48 (0.87)
Coastal sites observed	135	5	42	39	17	7	49	94
Blue Flag sites	66	01	0	10	5	2	20	5
Number of trips								
Number of trips to Blue Flag sites	307	65	n/a	40	356	21	175	12
Number of trips to excellent quality sites	407	82	323	141	408	324	107	495
Number of trips to sites with mandatory quality	112	2	120	56	14	n/a	151	153
Number of trips to poor quality sites	27	n/a	2	n/a	42	n/a	52	2

2.2. Theoretical and econometric framework

In the estimation of recreational benefits we follow the framework proposed by Hausman et al. (1995): a two-stage budgeting model, in which an individual first decides how many trips to make, and then he decides how to allocate these trips across available recreational sites. This first step is modelled using a count data model, and the second step using discrete choice model. Linking these two components is a best-practice approach for the estimation of recreational values since publication of the seminal paper by Bockstael et al. (1987) – see Parsons et al. (1999) for a discussion and a comparison with other approaches.

Formal description of the model is the following. At the second stage, an individual i chooses between making a trip to one of J available recreational sites (it includes an option not to make any trip) in such a way that he wants to maximize his utility function

$$U_{ij} = \alpha_j - \beta TC_{ij} + \eta_i I_{ij} + \varepsilon_{ij}, \tag{1}$$

where α_j is an alternative specific constant for alternative j, $j \in \{0,1,\ldots,J\}$, and α_0 (not making a trip) is constrained to 0, and therefore used as a reference level. Inclusion of all possible alternative specific constants makes it impossible to estimate the effects of some site-specific characteristics, such as their environmental qualities, but this approach allows to control for all possible site differences, also the unobserved site-specific attributes (Murdock

2006).[4] TC_{ij} represents a travel cost being equal to joint vehicle operating cost and the opportunity cost of travel time, I_{ij} is an indicator variable which equals 0 for the opt-out alternative and 1 otherwise, η_i is a random parameter distributed normally with mean being equal to 0, and the standard deviation to be estimated. This error component allows us to relax the IIA assumption of a simple MNL model. Lastly, ε_{ij} is a stochastic term following extreme value distribution, which leads to well-known mixed logit formula of the likelihood function:

$$L_i = \int \prod_{j=0}^{J} \left(\frac{\exp\left(\alpha_j - \beta TC_{ij} + \eta_i I_{ij}\right)}{\sum \exp\left(\alpha_l - \beta TC_{il} + \eta_i I_{ij}\right)} \right)^{y_{ij}} f\left(\eta_i\right) d\eta_i , \tag{2}$$

where y_{ij} is equal 1 if an individual i has chosen alternative j and 0 otherwise. The integral in (2) is approximated by using Quasi Monte Carlo method with 10,000 scrambled Sobol draws (Czajkowski and Budziński 2017).[5,6]

Following Hausman et al. (1995), we define inclusive value of individual i as

$$IV_i = \mathbf{E}\left(U_i\right) = \int \log\left(\sum_{j=0}^{J} \exp\left(\alpha_j - \beta TC_{ij} + \eta_i I_{ij}\right) \right) f\left(\eta_i\right) d\eta_i , \tag{3}$$

which corresponds to the expected utility from a trip choice situation. This framework can be then used to calculate the per-trip consumer surplus in the following way:

$$S_i = \frac{IV_i}{\beta} . \tag{4}$$

Next, in order to obtain site-specific welfare estimates, we follow Termansen et al. (2013) approach. The per-trip CS when the access to the site k is lost can be calculated as:

$$S_{ik}^{*} = \frac{1}{\beta} \int \log\left(\sum_{\substack{j=0 \\ j\neq k}}^{J} \exp\left(\alpha_j - \beta TC_{ij} + \eta_i I_{ij}\right) \right) f\left(\eta_i\right) d\eta_i . \tag{5}$$

[4] Conversely, dropping alternative specific constants makes it possible to include other characteristics of the sites.
[5] To assure that our sample is representative for general population in each country, we estimate the model using the weighed maximum likelihood method. The individual-specific weights represent each individual's contribution, considering sample quotas for age, gender and education.
[6] Note, that due to data limitations, we only have information regarding the last trip of each individual, and thus our site-choice component is based on a single choice situation per individual.

This is equivalent to assuming that travel cost to the site k becomes infinitely large. The loss of welfare due to the loss of access to the site k is then given as $S_i - S_{ik}^*$. Analogous calculations can be made for any subset of sites, including all sites in a country, which means calculating total recreational value of the Baltic Sea for citizens of the country.

In the first stage of the budgeting model, an individual decides how many trips to the Baltic Sea to make. This decision depends on vector of individual characteristics $\mathbf{X}_i$ and the price index. Following Hausman et al. (1995), we describe per trip consumer surplus, S_i, as a price index, and assume that the mean number of trips is given by:

$$\lambda_i = \exp\left(\mathbf{X}_i \boldsymbol{\tau} + \phi S_i\right). \tag{6}$$

The number of trips $\left(T_i\right)$ is modelled using the negative binomial P model (NBP; Greene 2008), in which the probability of observing t trips is given by:

$$P\left(T_i = t\right) = \frac{\Gamma\left(\theta\lambda_i^Q + t\right)}{\Gamma\left(\theta\lambda_i^Q\right)t!} u_i^{\theta\lambda_i^Q} \left(1 - u_i\right)^t , \tag{7}$$

where $u_i = \dfrac{\theta\lambda_i^Q}{\theta\lambda_i^Q + \lambda_i}$. θ and $P = 2 - Q$ are the parameters to be estimated, where for $P = 2$, the model collapses to the standard negative binomial regression (NB). The model is estimated using the weighted maximum likelihood method.

Estimating the total consumer surplus requires integrating the demand function over the price index (Bujosa Bestard and Riera Font 2010):

$$CS_i = \int_0^{S_i} \exp\left(\mathbf{X}_i \boldsymbol{\tau} + \phi s_i\right) ds_i = \frac{1}{\phi} \exp\left(\mathbf{X}_i \boldsymbol{\tau}\right)\left[\exp\left(\phi S_i\right) - 1\right]. \tag{8}$$

The resulting total change in the consumer surplus related to the loss of access to the site k can be calculated as:

$$\Delta_k CS_i = \frac{1}{\phi} \exp\left(\mathbf{X}_i \boldsymbol{\tau}\right)\left[\exp\left(\phi S_i\right) - \exp\left(\phi S_{ik}^*\right)\right].^{7} \tag{9}$$

[7] The software codes for the discrete choice models presented here have been developed in Matlab and are available at https://github.com/czaj/DCE under Creative Commons BY 4.0 license. The code and data for estimating the models presented in this paper (including count data models), as well as supplementary materials, are available from http://czaj.org/research/supplementary-materials.

3. Estimation results

We start with the results of the site choice model, which are presented in Table 3a. The fixed effects (coefficients associated with alternative specific constants for individual sites) are not reported for brevity – they are available in the supplementary materials to this paper. The estimates of the travel cost coefficient are significant and of the expected sign.[8] These coefficients cannot be compared between the countries, because (as is the case in all discrete choice models) they are confounded with country-specific scale parameter. The estimates of the standard deviation of the error component were significantly different from zero and well identified for all countries with the exception of Finland and Germany. This is an indication of the existence of correlation between utility from choosing the available sites, and also a substitution pattern between choosing one of the sites or not to travel that are not consistent with the IIA assumption of a simpler MNL model. The lower part of Table 3a presents model diagnostics. The number of estimated parameters corresponds to the number of observed recreational sites and the two coefficients represent the travel cost and the error component. The Ben-Akiva-Lerman pseudo-R^2 represents the average predicted probability of the site actually selected. It indicates that the explanatory power of the models varies between countries, with the probability of correct predictions ranging from 22% to 72%.[9] Additional explanatory variables, such as the month when the trip was made or the self-reported purpose of the visit, did not significantly improve the models' fit to the data.

Table 3a: The results of the country-specific site choice models

	Denmark	**Estonia**	**Finland**	**Germany**	**Latvia**	**Lithuania**	**Poland**	**Sweden**
Travel cost (in 100 Euro)	2.0441*** (0.0722)	1.5418*** (0.2060)	0.2752*** (0.0166)	0.2205*** (0.0333)	2.2155*** (0.1397)	1.7906*** (0.6772)	0.6920*** (0.0934)	1.2743*** (0.0346)
Standard deviation of the error component	1.7935*** (0.4451)	1.8485*** (0.6669)	-	-	3.3735*** (0.4912)	6.9506** (3.0652)	2.7872*** (0.6231)	3.9558*** (0.7908)
Model diagnostics								
Log-likelihood	-2,283.66	-279.91	-1,551.05	-997.26	-1,260.52	-1,065.90	-1,552.39	-2,265.65
Number of parameters	137	7	43	40	19	9	51	96
Number of respondents[10]	908	477	919	912	1018	994	1005	908
Ben-Akiva-Lerman's pseudo-R^2	0.29	0.72	0.35	0.65	0.44	0.50	0.56	0.22

Note: ***, ** and * indicate 1%, 5% and 10% significance levels, respectively.

[8] Note, that the travel cost in equation (1) enters with a minus sign.
[9] This is expected, as the number of observed sites per country varied substantially. Note that the probability of correct predictions increases for countries with fewer available sites (correlation coefficient -0.7).
[10] Several observations were excluded due to missing socio-demographic characteristics necessary to calculate weights, and extreme number of reported numbers of trips (over 90) which led to numerical problems and non-convergence of the models.

Additionally, in Table 3b we present the site choice models, which instead of alternative-specific constants include general water-quality characteristics of the sites. We use this approach to investigate the welfare changes associated with improving water quality of a recreational site, rather than the recreational value of individual sites. The model was estimated jointly for all countries, with coefficients for sites' quality attributes assumed to be the same across countries. This restriction was necessary to assure identification of the model – for some countries water quality characteristics either do not vary or, if they do vary, the number of sites is too small, which may result in the spurious parameters problem.[11] Such specifications mimics the approach used by Czajkowski et al. (2015a), in which effect of (perceived) environmental quality was assumed homogeneous across countries. The model allows travel cost, the alternative specific constant associated with not making a trip, and the error component to be country-specific.[12]

The results show that all travel cost coefficients are significant, positive and of similar magnitude to the ones reported in Table 3a. The Blue Flag quality indicator is significant and has an expected sign, indicating that people prefer sites awarded the Blue Flag status. Additional water quality indicators (compliance with EU Bathing Water Directive) were generally not significant and highly sensitive to model specification (such as additional explanatory variables or transformations of explanatory variables), with coefficients changing significance and signs. We believe this to be a manifestation of the spurious parameters problem, resulting from too little variation in the data to reliably capture the effect of compliance with mandatory or excellent levels of the EU Bathing Waters Directive. Finally, the model also includes population densities at different sites to control for the urban vs. rural character of a site. These coefficients indicate that individuals on average prefer sites with higher population in 3 km radius, but lower population in 6 km radius. This would describe small towns, but with relatively high population (and therefore possibly better infrastructure). Lastly, we note that the error component was insignificant for more countries than in Table 3a – it is likely to be a result of including more explanatory variables associated with observed conditions.

[11] Consider, as an example, the case of Estonia, which has only 5 recreational sites identified – estimation of the effects of 6 site-specific characteristics on the site choice is then obviously impossible. For other countries number of sites is higher so these effects can be technically identified, but still, they may be highly inaccurate.

[12] We also considered adding country-specific scale, but such model was not identified, given the available data. Alternatively, we considered a specification in which all parameters are constant across countries and the scale varies, but it was inferior to the specification reported in Table 2b.

Table 3b: The results of the site choice models with site characteristics as attributes

	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Sweden
Travel cost (in 100 Euro)	1.5872*** (0.0755)	1.7631*** (0.1550)	0.3372*** (0.0259)	0.2064*** (0.0322)	1.9766*** (0.1261)	0.3824*** (0.0559)	0.6648*** (0.0844)	1.3046*** (0.0527)
Blue flag status	0.5093*** (0.0513)							
Compliant level - mandatory (base level: non-compliant)	-0.1487 (0.1037)							
Compliant level - guided (base level: non-compliant)	-0.1807* (0.0997)							
Logarithm of the population density within 3 km	0.7526*** (0.0527)							
Logarithm of the population density within 6 km	-0.2750*** (0.1043)							
Logarithm of the population density within 10 km	0.0299 (0.0789)							
No trip (ASC)	3.6851*** (0.1734)	1.7758*** (0.2058)	3.2849*** (0.1435)	4.5357*** (0.2139)	1.5081*** (0.1966)	2.5931*** (0.1569)	3.3301*** (0.3065)	-0.3677 (0.4536)
Standard deviation of the error component	2.1350*** (0.6296)	-	-	-	2.6715*** (0.4098)	-	2.8401*** (0.6659)	3.8321*** (0.7262)
Model diagnostics								
Log-likelihood	-13,161.11							
Number of parameters	26							
Number of respondents	7141							
Ben-Akiva-Lerman's pseudo-R^2	0.4200							

Note: ***, ** and * indicate 1%, 5% and 10% significance levels, respectively.

Table 4 presents the results of the negative binomial Poisson (NB-P) models that were used to estimate the number of trips. The model specification mimics that described by Czajkowski et al. (2015a), except for the travel cost replaced with the measure of inclusive value obtained from the site choice model, that is in line with the approach outlined in the section 2.2. The results show that the Negative Binomial Poisson model performs well and offers a significant improvement over the NB-2 model, with the exception of Poland (not significant) and Estonia. For Estonia the NB-P model is not significantly better than a simple Poisson regression (it is likely due to the lowest number of observations; LR test statistics for the comparison with simple Poisson regression are provided in model diagnostics). The estimated coefficients for the per trip consumer surplus variable are significant and positive, ranging from 0.002 to 0.0296. The coefficients associated with the other covariates differ more substantially between countries. These differences can occur for various reasons, such as cultural differences, different recreational habits, or different substitutes available for recreation. Finally, the differences between the estimates of the parameters θ and P for different countries indicate that there are differences not only in the mean number of trips, but also in the shape of their overall distributions.

Table 4: The results of the country-specific count data (number of trips) models

	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Sweden
Constant	0.2658 (0.2994)	-1.743*** (0.4651)	0.2047 (0.1549)	-3.7789*** (0.5916)	-1.3370*** (0.3346)	-0.9394*** (0.3293)	-2.3540*** (0.3098)	-1.5700*** (0.4507)
Per trip consumer surplus	0.0141*** (0.0022)	0.0296*** (0.0060)	0.0020*** (0.0005)	0.0158*** (0.0015)	0.0293*** (0.0029)	0.0126*** (0.0011)	0.0113*** (0.0009)	0.0072*** (0.0009)
Male	-0.0070 (0.0801)	-0.1987 (0.2072)	0.1026** (0.0449)	-0.0651 (0.1857)	-0.0025 (0.1365)	-0.2959** (0.1371)	-0.3044** (0.1300)	0.2833** (0.1106)
Income (in 10,000 euro)	0.0275 (0.0458)	0.1695 (0.1582)	-0.8572*** (0.2802)	4.4558*** (1.2584)	17.646*** (5.9377)	5.1006*** (0.9652)	0.8899*** (0.2676)	0.2013*** (0.0608)
Number of children	-0.0483 (0.0455)	0.0381 (0.1236)	-0.1033*** (0.0296)	0.1341 (0.1029)	0.0878 (0.0853)	-0.1582* (0.0862)	-0.0482 (0.0680)	0.1533** (0.0700)
Age (in 100 years)	0.0635 (0.2873)	-3.456*** (0.7544)	0.5547*** (0.1779)	0.5696 (0.7125)	-2.3018*** (0.4415)	-3.4045*** (0.4345)	-1.1132** (0.4338)	-0.0100 (0.3599)
High school education	0.4589** (0.1880)	0.1632 (0.7229)	-0.1123* (0.0675)	0.1925 (0.3125)	0.3344 (0.2039)	0.4323** (0.1881)	0.6097*** (0.1900)	0.1401 (0.1520)
Vocational education	0.3139** (0.1540)	0.4804 (0.3515)	-0.0806 (0.0886)	0.1116 (0.2488)	0.3653* (0.1885)	0.7782*** (0.1917)	0.5390 (0.3788)	0.5156*** (0.1888)
University education	0.5338*** (0.1459)	0.9159** (0.3728)	0.0576 (0.0690)	-0.1356 (0.3649)	0.6312*** (0.2165)	0.9980*** (0.2183)	1.1559*** (0.2121)	0.5184*** (0.1386)
Occupation related to the Baltic Sea	-0.0909 (0.1683)	0.5536 (0.3476)	0.2543*** (0.0870)	-0.5554 (0.7930)	0.7509*** (0.2100)	0.8719*** (0.3077)	0.2543 (0.2372)	0.1534 (0.2017)
$\log(\theta)$	3.1772*** (0.3421)		-0.6896 (0.5008)	1.8304*** (0.0889)	1.6790*** (0.0935)	1.5953*** (0.0760)	0.3772*** (0.1271)	1.7941*** (0.1754)
P	0.7749*** (0.1986)	-	4.7236*** (0.7189)	1.4521*** (0.1038)	1.6076*** (0.0748)	1.3186*** (0.0786)	-	1.5912*** (0.1113)
Model diagnostics								
Log-likelihood	-1,953.98	-219.24	-1,465.24	-753.44	-1,642.08	-1,281.73	-876.40	-2,145.74
LR test statistic: P = 2 (1 d.f.)	37.71***	<0.01	58.99***	9.93***	21.82***	65.23***	0.05	11.72***
Number of parameters	12	10	12	12	12	12	11	12
Number of respondents	908	477	919	912	1018	994	1005	908

Note: ***, ** and * indicate 1%, 5% and 10% significance levels, respectively.

4. Interpretation of the results

The models presented in section 3 allow us to calculate the mean consumer surplus (CS) per trip, predict the number of trips, and calculate the mean consumer surplus associated with the possibility to make the predicted number of trips.[13] These results are presented in Table 5.

[13] Following Hausman et al. (1995), the mean CS per trip was calculated according to formula (4) presented in section 2.2. This simply becomes the marginal rate of substitution of the inclusive value for money. The former is calculated using formula (3), which uses alternative specific constants that were excluded from Table 3a for brevity, whereas the latter is equal to the coefficient for travel cost in Table 3a (marginal utility of income). The predicted number of trips was calculated as the mean of the negative binomial P model (Greene 2008), as explained by formula (6). The mean consumer surplus associated with all trips a consumer makes was calculated following (Bujosa Bestard and Riera Font 2010) according to formula (8). All values were averaged over individuals to obtain means.

We find that Sweden and Finland have the highest CS per trip (246-268 EUR) as well as for all trips jointly (422-641 EUR). On the other hand, Estonia has the lowest CS of only 4 EUR for all trips. This result is partly driven by the low number of trips in Estonia, and partly by the low value per trip. Note that there is no simple relationship between mean value per trip and mean value associated with all trips, as the two measures are obtained from different weighting methods (mean over trips vs. mean over consumers).[14]

The total consumer surplus is presented in the fourth row and can be compared with the results of a simpler (non-spatially-explicit) approach of Czajkowski et al. (2015a), presented in the last row. For Denmark, Latvia, Lithuania and Sweden the results are very close. For Estonia, Poland and Germany, the current approach produces lower estimates, whereas for Finland they are higher. Overall, we find that the total CS associated with the recreational use of the Baltic Sea accounts to 11.4 billion EUR annually. This result is relatively close to 14.8 billion EUR, as estimated by Czajkowski et al. (2015a), however, our new estimates are based on spatially-explicit econometric approach and hence can be considered more reliable; they indicate a somewhat different distribution of recreational benefits among countries.

Table 5: Estimated economic benefits associated with recreational use of the Baltic Sea

	Denmark	**Estonia**	**Finland**	**Germany**	**Latvia**	**Lithuania**	**Poland**	**Sweden**
Mean CS – per trip (EUR)	57.07 (6.89)	22.93 (2.79)	245.95 (17.59)	104.67 (16.80)	62.51 (5.49)	102.42 (13.68)	101.74 (9.19)	268.15 (41.35)
Predicted number of trips	4.33 (0.30)	0.21 (0.02)	2.11 (0.17)	0.70 (0.08)	2.68 (0.19)	1.65 (0.13)	0.58 (0.04)	5.33 (0.35)
Mean CS – all trips (EUR)	175.05 (16.97)	4.03 (0.46)	422.30 (25.67)	38.35 (4.11)	81.49 (6.85)	102.79 (8.46)	39.20 (2.71)	640.63 (59.34)
Total consumer surplus (billion EUR)	0.747	0.004	1.780	2.578	0.133	0.241	1.196	4.727
Total consumer surplus by Czajkowski et al. (2015a) (billion EUR)	0.722	0.150	1.043	5.142	0.108	0.192	2.066	4.433

4.1. Identifying hotspots of recreational value

The results allow us to calculate the total yearly welfare per site, which is an indication and illustration of recreational hotspots and associated site values per country around the Baltic Sea. The welfare loss per site is calculated as the mean change in consumer surplus according to formula (9) multiplied by adult population of each country.

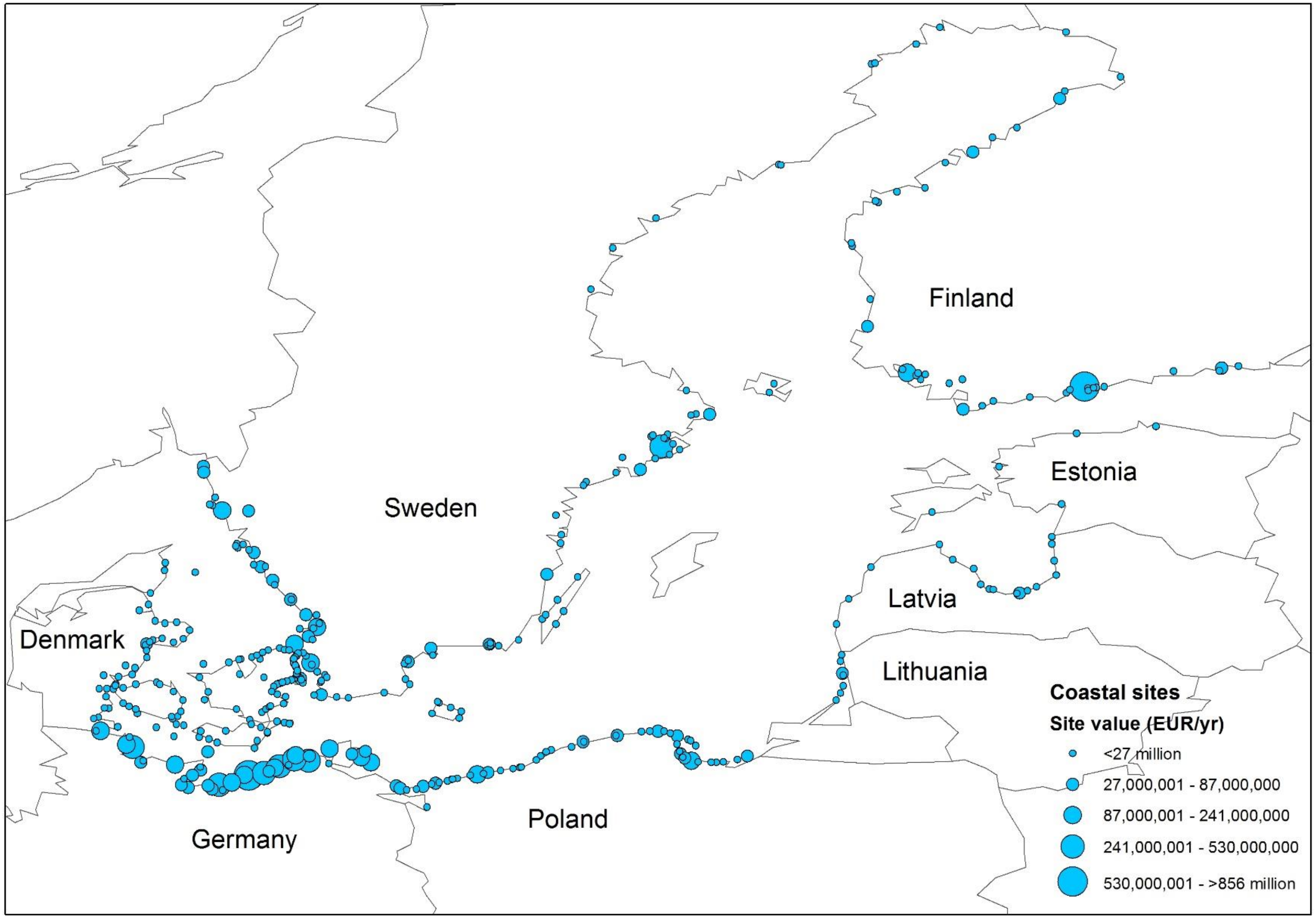
[14] This is also a reason why total CS is not equal to per trip CS multiplied by predicted number of trips, along with the total CS being a nonlinear function of the per trip CS.

Total annual value of sites ranges from 61.3 thousand EUR in Estonia to more than 800 million EUR in Germany and Finland. For Germany, the relatively few sites combined with a large population magnify the value of sites, despite a relatively low consumer surplus loss per site per average respondent, in comparison with the other countries. For Finland, a comparably very high consumer surplus loss per site per average respondent combined with relatively few sites in the survey produce high maximum site values despite relatively low population. Note that these values only apply to recreational trips undertaken within each country, i.e. no cross-border recreation/tourism is accounted for in this analysis. Table 6 gives an overview of statistics and Figure 1 is a map of recreational site values. Recreational hotspots, defined as the sites across the Baltic Sea that represent the highest recreational values, are situated primarily along the German and Polish coastline, Stockholm in Sweden, Turku and Helsinki in Finland. In Denmark, with many coastal sites and relatively short distances to the coast for the population spread all around the country, site values are necessarily relatively low compared to hot spot areas at Baltic Sea level. Nevertheless, site values in Denmark are very heterogeneous, ranging from around 186,000 EUR to more than 40 million EUR.

Table 6: Estimated total annual recreational site values

Country	Site numbers	Adult population (million)	Mean	Std. Dev	Min	Max
			(EUR/site/year)			
Denmark	135	4.27	3,848,410	5,697,766	186,033	40,500,000
Germany	39	67.21	143,000,000	178,000,000	18,000,000	856,000,000
Estonia	5	1.05	817,615	1,511,649	61,279	3,512,007
Finland	42	4.21	39,500,000	130,000,000	2,802,709	825,000,000
Lithuania	7	2.35	15,900,000	24,100,000	738,790	67,300,000
Latvia	17	1.63	6,621,194	13,400,000	172,166	55,400,000
Poland	49	30.52	21,900,000	28,200,000	869,763	131,000,000
Sweden	94	7.38	26,000,000	51,400,000	565,262	386,000,000

Figure 1: Recreational coastal site hotspots (total value per site/year)



4.2. The effects of improving environmental conditions

Finally, we use the estimated effect of Blue Flag status on the welfare people derive from recreational trips to the Baltic Sea to simulate the welfare change that would result from improvements of water quality and infrastructure. Specifically, we estimate the welfare change that would occur if all coastal recreational sites would comply with the Blue Flag status. The results are summarized in Table 7.[15]

The first row of Table 7 presents the average marginal value (shadow price) of a Blue Flag status. This is based on results of the site choice model and calculated as the marginal rate of substitution of the Blue Flag status for the travel cost. Considerable heterogeneity appears in the results – from 26 EUR in Latvia to 247 EUR in Germany.

Next, we present changes in CS that would occur if all sites complied with the Blue Flag requirements. The results are both in absolute and relative terms, for a single trip and for all trips declared by respondents. We find that the highest absolute change per trip is observed for Finland[16], followed by Lithuania and Germany. For all trips jointly, the highest absolute change in CS is observed for Finland, Lithuania, and Sweden, whereas Germany and Lithuania would witness the highest changes in relative terms.

Finally, the last two rows of Table 7 present the estimates of the welfare change associated with water quality improvements. The estimate described in Czajkowski et al. (2015a) was based on the change of the perceived water quality – the 5-level Likert scale question: "In your opinion, what is, on average, the status of the environment in the XXXish part of the Baltic Sea?" Two effects of a unit increase in assessment of water quality were simulated: the impact on the probability of engaging in the Baltic Sea-based recreation, and on the expected number of trips, which allowed to calculate the resulting increase of total welfare. In this study, we improve this estimate by linking it to a change in a characteristic that can be objectively observed – the Blue Flag status – and we then use respondents' actual behavior to predict its welfare effects.

The estimated welfare change, that is the economic value that people attach to upgrading all sites in their country to the Blue Flag conditions, is 8.93 billion EUR.[17] This is considerably

[15] Note that while Finland does not currently have any sites enrolled in the Blue Flag program, some of its sites could possibly quality for the Blue Flag status already. We therefore acknowledge that the estimated increase in the recreational benefits in Finland could be overestimated, but keep it in the comparison for completeness.

[16] This is likely because currently none of the Finnish sites officially have the Blue Flag status.

[17] This was calculated as the total CS occurring in the case all sites that are currently not certified as Blue Flag status sites complied with the requirements.

more that an earlier estimate of 1.09 billion EUR, although as noted earlier in this paper, the two estimates are not fully comparable, as they are based on different measures of environmental change (actual vs. perceived), different methodology (site-specific vs. single-site approach) and somewhat different samples (as described in in Section 2). Overall, approximately 9 billion EUR per year gain in recreational value is an inspiring number that can be used for policy purposes when compared with the cost of achieving the corresponding water quality conditions in all recreational sites at the Baltic Sea coast.

Table 7: Estimated change in economic benefits associated with increase of blue flag attribute

	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Sweden
Marginal WTP for blue flag water quality (EUR)	32.08 (3.55)	28.88 (4.12)	151.02 (19.12)	246.71 (45.22)	25.76 (3.20)	133.18 (23.60)	76.60 (12.11)	39.03 (4.20)
Per trip mean CS change (blue flag quality on all sites) - absolute	8.80 (0.97)	3.84 (0.76)	81.23 (11.29)	40.27 (7.81)	4.50 (0.60)	44.40 (8.30)	11.12 (1.79)	27.54 (3.04)
Per trip mean CS change (blue flag quality on all sites) - percentage	2.82%	3.32%	6.91%	1.74%	3.33%	5.92%	1.83%	12.10%
All trips mean CS change (blue flag quality on all sites) - absolute	47.93 (3.74)	2.72 (0.60)	247.16 (37.17)	63.14 (10.63)	38.48 (5.61)	316.44 (49.64)	34.60 (2.78)	213.31 (18.53)
All trips mean CS change (blue flag quality on all sites) - percentage	6.20%	36.12%	19.46%	144.98%	33.98%	115.14%	36.47%	35.66%
Total CS change (billion EUR) - absolute	0.205	0.003	1.041	4.244	0.063	0.743	1.056	1.574
Total CS change, Czajkowski et al. (2015a) - absolute	0.054	0.012	0.084	0.411	0.009	0.018	0.167	0.336

5. Conclusions

This paper estimates a spatially explicit discrete choice and count data model for coastal recreation across eight countries around the Baltic Sea. Furthermore, it tests inclusion of site attributes as fixed effects, general water quality attributes based on monitored site-specific data and indicators of population density. The results present the total recreational value per site, spatially identified recreational hotspots, and the potential welfare effects of improving environmental and infrastructure conditions to a level required by the Blue Flag standard at all sites. The total recreational value of Baltic Sea coastal locations cumulates to 11.4 billion EUR with significant variations within and across countries and reveals a significant heterogeneity across sites and countries. The yearly per site value ranges from slightly more than 55 thousand EUR for a site in Latvia to more than one billion for a given coastal site in Germany. The improvement of site qualities to Blue Flag standard has a substantial positive welfare effect of nearly 9 billion EUR, indicating a significant welfare improvement (78%) of enhancing water quality and recreational infrastructure. Through the geographical scale, spatial explicitness and projections our estimations offer an extension and improvement to previous studies on recreational values of the Baltic Sea that also used revealed preference valuation methods (Sandström 1996; Soutukorva 2005; Vesterinen et al. 2010; Czajkowski et al. 2015a).

A number of challenges must be noted in conducting a similar study across eight countries with the data available: too little variation to effectively capture the effects of general water quality on site preferences, either because of too few sites per countries are observed or because of the lack of variance in site characteristics between countries. New types of data may prove relevant and significant when introduced in this type of analysis such as meteorological data, information on water temperatures, presence of algal blooms and other information that people may look for when deciding on visiting a site for recreation. Similarly, information on beach characteristics – whether a beach is a sandy, rocky or grassy, littered, what types of surroundings it has, the degree of naturalness – are known from other stated and revealed preference studies to have a significant impact on welfare. Incorporating such data sources in further analyses could provide a valuable source of additional information and facilitate efficient tourism management for increased social welfare benefits.

In this study, we take into account the impact of Blue Flag status. The Blue Flag status is information that is both easily available to visitors and can be objectively, and without much environmental knowledge, be assessed as indicating real (not perceived) environmental conditions. We show that it has a large impact on value that people attach to different recreation sites, which is a strong indicator that visitors have environmental preferences for the sites. This should be taken into account when constructing policies for the Baltic coastal sites.

In summary, our study estimates the economic value of the Baltic Sea-based recreation at 11.4 billion EUR annually, and describes its distribution among the coastal locations. Identifying recreational hot-spots and areas with possibly untapped potential have clear management applications. In addition, we show how environmental quality affects recreational behavior and simulate welfare changes resulting from its enhancement. Improving water quality and infrastructure boost the recreational value by nearly 9 billion EUR, demonstrating their importance for the management of environmental recreational sites. Overall, it is clear that although the Baltic Sea is a major source of the recreational value for the eight European countries studied, recreational benefits could be nearly doubled, given environmental and basic infrastructure improvements.

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