Forest Policy and Economics 73 (2016) 68–77

Contents lists available at ScienceDirect

Forest Policy and Economics

journal homepage: www.elsevier.com/locate/forpol

Local consequences of national policies - A spatial analysis of preferences for forest access reduction

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ARTICLE INFO

Article history:
Received 8 July 2015
Received in revised form 5 August 2016
Accepted 30 August 2016
Available online 8 September 2016

Keywords:
Preference heterogeneity
WTP
Recreation
Spatial heterogeneity
Self-selection
Choice experiment

ABSTRACT

Stated preference studies eliciting welfare economic consequence of national policies, are often not considering the spatial variation in supply and demand. This spatial variation may however cause large distributional heterogeneity of policy changes. In this study, we use a choice experiment to test whether peoples' preferences for restrictions in forest access is influenced by spatial heterogeneity in local forest presence and quality conditions. Combining survey data with GIS information we assess the size of local forest cover, distance to nearest forest and forest quality indicators in a radius of 2.5 km from respondent's residence. We demonstrate that a nationally framed policy implementing access reductions to protect wildlife may have heterogeneous welfare consequences which can be described by a general disutility for access reductions and dependency on local forest attributes. Further, geo referencing the residence of all invited respondents allows us to test whether forest cover, distance and other forest attributes are different between respondents and non-respondents. No evidence of self-selection is identified.

1. Introduction

Ecosystem service (ES) values are heterogeneously distributed across the landscape as a consequence of spatial variation in both supply and demand. Spatial variation in supply of ES may be caused by locational differences in the abundance and quality of ecosystems, and spatial variation in demand may be caused by heterogeneity in individuals' preferences of ES. This, in turn, may also influence their choice of residential location. Large spatial variation in ES increases the need for understanding the sources of spatial value heterogeneity, to design spatially explicit policies that target efforts toward locations that maximize human welfare. This is increasingly recognized in the environmental economic literature (Broch et al., 2013; Campbell et al., 2009; Czajkowski et al., 2016).

One area where this spatial component becomes particular important is when analysing the distributional consequences of national, or even international agreements. While such policies typically emerge from overall political goals, they may have uneven consequences when implemented at a local scale. Likewise, people's preferences for national policies may be highly shaped by local conditions. Consequently, the issue that we address in the current paper is to what extend people's local surroundings affects their stated preferences for a national policy. We do so by looking at a Danish case of reducing access to forests with the aim of conserving wildlife. Thus while people obtain a utility of increased wildlife, they at the same time bear the cost of less access. We hypothesize that both quantitative and qualitative spatial characteristics in a respondent's surrounding affect the utility of avoiding access reduction, i.e. the distance and amount of forest cover and the quality in terms of forest species.

The importance of local surroundings is extensively studied in the revealed preference literature (e.g. Jensen et al., 2014; Zandersen et al., 2007a). Often the geographical scope of such analyses is rather limited. Within the stated preference literature considerations of spatial heterogeneity have mainly focused on including distance-decay effects and substitution (Bateman et al., 2006; Hanley et al., 2003; Jorgensen et al., 2013; Loomis, 2000; Moore et al., 2011), geopolitical thresholds (Bakhtiari et al., 2014a; Johnston and Duke, 2009), an a recent study by Czajkowski et al. (2016) analyses forest management decisions. A few studies have explicitly included site/choice-specific maps in the survey information (Johnston et al., 2002; Schaafsma et al., 2013), and Johnston and Ramachandran (2014) has addressed spatially explicit hotspot areas. Our study contributes to the existing literature by first of all, analysing spatial dependency of an environmental good which is widespread throughout a country, and not related to single sites. This is of particular importance for an environmental good like forests. We combine detailed spatial data with data from a choice experiment (full study described in Jacobsen et al., 2012) and are thus able to test the influence of the quantitative and qualitative characteristics.

In the following we will start by describing and motivate for the hypotheses addressed, followed by a method and a data section. After

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http://dx.doi.org/10.1016/j.forpol.2016.08.010

a result section, the results are discussed in which we also address the limitations and pitfalls that working with spatial data may have.

1.1. Hypotheses

In this paper we test two different sets of hypotheses. First, we hypothesize that peoples' utility is influenced by how close they live to forest and the quantity of local forest cover. Restricting access reduces the local recreational opportunities, but at varying degrees depending on the local quantity and quality of forests. Danish forest are scattered across the country, and recreation is an important component of the forest ecosystem value. About 70 million adults visit the approximately half million hectares of forest every year (Jensen, 2012). More than half of the recreational visits are within 3 km of distance from people's residence (DØRS, 2014), and the importance of the recreation opportunities in local forests is further supported by several studies pointing at the significance of distance for frequency of visits ((Degenhardt et al., 2011; Jensen and Koch, 2004; Tyrväinen, 2001). With this in mind we would therefore expect that policies reducing access will have a larger impact on utility for people living close to forests relative to people who live far away from forests. This distance-decay is a well-known finding also in the valuation literature from both the stated and revealed preference literature (Bateman et al., 2006; Bateman, 2009; Brouwer et al., 2010; Hanley et al., 2003; Hanley et al., 2003; Johnston et al., 2002; Moore et al., 2011; Panduro and Thorsen, 2014; Pellegrini and Fotheringham, 2002; Termansen et al., 2013). We would also expect the availability of substitutes (e.g. expressed by the quantity of forest in an area) to matter for the value of a recreation site which is confirmed by more studies (Jorgensen et al., 2013; Schaafsma et al., 2012; Schaafsma et al., 2013). The magnitude of the utility loss of access restrictions may therefore also depend on the total area available for recreation to the respondent, implying that there is a higher utility loss for larger areas, but at a diminishing rate as the supply of forest cover saturates individual recreational preferences and an increasing amount of forest substitution opportunities arise.

Second, we hypothesize that the quality of local forests impacts the disutility of an access reduction. The underlying reason is that some areas are more important than others due to their characteristics as also investigated by Johnston and Ramachandran (2014) in terms of hotspots. For forest recreation, several studies indicate that people prefer broadleaved forests over coniferous forests for recreation purposes (Jensen and Koch, 1997; Nielsen et al., 2007; Termansen et al., 2013) while others find no difference (Edwards et al., 2012; Zandersen et al., 2007a). The possibility to observe wildlife in forests is another parameter which we expect will increase the quality of the recreational experience and thus utility (Jacobsen et al., 2012). Also the extent of access rights (e.g. entry times, extent of where to walk, allowed activities, etc.) influence the recreational opportunities and mobility, and is in Denmark mainly framed by forest ownership (public vs. private) (Campbell et al., 2014). In public forests access opportunities are larger than in private (cf. description in (Campbell et al., 2014), and consequently access restrictions here may imply a larger utility loss than in private forests. Finally, in densely populated areas, recreational use of the forest may become partially rival as crowding effects may appear (Vedel et al., 2009). Bakhtiari et al. (2014b) find that people are willing to increase travel distances to recreational sites to avoid crowding, and therefore we would expect increased crowding potential to be associated with higher utility loss.

The provision of environmental amenities such as recreational opportunities also influences the residential choice of individuals. Spatial sorting makes it more likely that people who are keen users of outdoor recreation sites of good quality will chose to live closer to areas where the provision level of recreational opportunities is high (Baerenklau, 2010; Klaiber and Phaneuf, 2010; Kuminoff et al., 2013). Both the direct effect from access reductions on individual utility and the indirect from the possibility of spatial sorting is expected to lead to larger utility losses of reduced access rights in areas with high recreational quality and opportunities.

By testing these two sets of hypotheses in a stated preference (SP) context we examine the spatial patterns of local forest recreational experience similar to those employed in the travel-cost and hedonic pricing literature (e.g. distance to forest, broadleaved forest cover). Further, compared to earlier inclusion of spatial factors in SP models, we incorporate space through the respondent's actual residential location and local environment. Only a few SP studies have used the exact spatial residence of a respondent. Instead they are often based on more crude measures such as respondents indicating their residential location on a map in using internet questionnaires (Abildtrup et al., 2013; Jorgensen et al., 2013) or are relying on larger geographical units, e.g. postal code level or county level (e.g. Broch et al., 2013).

Finally, the possibility of spatial sorting might generate a potential self-selection bias in the participation of questionnaires asking for preferences for nature. Individuals that value recreation relatively more and therefore have located themselves in forest rich areas may be more likely to respond to a valuation questionnaire about forest and wildlife (Bateman et al., 2006). We test this by comparing participation rates in areas with different forest cover and local forest characteristics.

In the next section we first describe the estimation method and data followed by a section where we present and discuss results.

2. Methods

The empirical basis for the study is a choice experiment (CE) valuing different attributes related to improving conditions for wildlife, including access reduction. This is described in detail in Jacobsen et al. (2012). In addition to the responses from the CE, we include a set of spatial variables characterising the location of each respondents' residence.

Based on McFadden's random utility model (McFadden, 1973; McFadden, 1974), we describe the utility (U) which individual i derives from alternative j by a deterministic term V_{ij} and a stochastic termε_{ij} where the latter cannot be observed by the analyst. Letting x_j describe a vector of attributes of alternative j, and β a vector of corresponding parameters, the deterministic part of the utility function

V_{ij}can be formulated as

$$U_{ij} = \beta' x_j - \beta_p\, cost_j \tag{1}$$

The attributes in x_j are given in Tables 1 and 2. It consists of *wildlife*, *acc* and *cost* which are the evaluated main attributes in the choice experiment. *Wildlife* represents improvements for both general and endangered wildlife but these are not in focus of the present study and for further information on these attributes we refer to Jacobsen et al. (2012). The *acc* represents reductions in access (in two levels; full year or half year) and *cost* is an annual tax increase for the household of the respondent.

x_j also consists of a set variables which are included as interactions with the main attributes as motivated in Section 1.1 to analyse how they affect these attributes. A variable *forest* is representing the quantity of forest in the vicinity of the respondents and represents the availability of substitutes. By taking the natural logarithm to *forest* we capture the diminishing marginal utility. The distance decay function, taking into account that a policy on reducing access will have larger impact for on the utility of those living close to forests, is represented by the variable (*dist*). We need to allow for non-zero intercept, and therefore we include both a linear and a log effect. The quality parameters enter the equation linearly.

We assume that an individual will choose the alternative k over another alternative j, if $Uk > U_{ij.}$ We follow a standard random parameter logit approach (see e.g. Train, 2003, p. 138), allowing estimation of repeated choices for the individual. All main attributes are estimated as random parameters with an assumed normal distribution except

Table 1
Attributes and levels in the CE questionnaire.

Attributes	Level (status quo option indicated by *)	Variable names
Access to forest roads and paths	• Almost everywhere*	
	• Reduced access (no access in 25% of all forests from April to November)	Reduced access on 25% (dummy)
	• No access (no access in 25% of all forests all year)	No access on 25% (dummy)
Increases in population size of a threatened species (dormouse)	• Threatened with extinction*	
	• Rare, but not threatened with extinction	Endangered wildlife – rare (dummy)
	• Common	Endangered wildlife – common (dummy)
Increases in population size of general wildlife in the specific habitat	• Population size as of today*	
	• Population increase by 25%	General wildlife + 25% (dummy)
	• Population increase by 50%	General wildlife + 50% (dummy)
Annual income tax increase	0*, 100, 250, 500, 1000, 2000	Price in DKK

(*100 DKK equates approx. 13 Euro*).

the cost. Consequently, the probability P of choosing and alternative k from a set of J alternatives can be described by

$$P_{ik} = \int \frac{\exp(\beta' x_{ik})}{\sum_j^J \exp(\beta' x_{ij})} f(\beta) d\beta \tag{2}$$

Where $f(\beta)$ is a density function.

The utility of any of the attributes can be converted to a monetary equivalent in terms of willingness to pay (WTP) by calculating the marginal rate of substitution between two attributes, one being measured in monetary terms using Eq. (3).

$$\text{WTP} = -\frac{\beta x}{\beta cost} \tag{3}$$

This also makes it possible to ignore the scale parameter (which any logit specification is subject to), as it cancels out by looking at the relationship between two parameters. For further information about how to perform random parameter logit estimation we refer to Train (2009) or Haab and McConnell (2002).

3. Data

3.1. Questionnaire

The empirical foundation of the current study is based on a stated preference study (Jacobsen et al., 2012; Jacobsen et al., 2013) which estimates WTP for conserving wildlife in Denmark and avoided access reductions in order to conserve wildlife. Data were collected through a postal questionnaire sent out to a random sample of the Danish population (age 18–70) in May 2005. The questionnaire was developed by the help of two focus groups, wildlife expert interviews, individual respondent interviews and a pilot test of the final questionnaire. The data consist of different subsamples, focussing among other things on different habitats (forest, lakes and fields). Further descriptions of the subsamples can be found in (Jacobsen et al., 2012; Jacobsen et al., 2013). For the current study, we used the subsample focusing on the forest habitat. This sample consists of 496 respondents, being fairly representative of the population. We identified 21 serial non-respondents, i.e. respondents who chose the status quo alternative in all choice sets (von Haefen et al., 2005) and stated that the reason for only choosing status quo was a reluctance to pay more tax. We perceive this as protest behavior and excluded these respondents from the sample. Our effective sample thus consists of 475 respondents. The overall response rate was 48%. For all invited respondents (responses and non-responses) we know the location of their residence, allowing us to estimate spatial variables of their local forest characteristic.

Along with the questionnaire, respondents were given an information sheet describing current status of wildlife and access.[2] The first part of the questionnaire concerned the respondents' attitudes to nature and wildlife and level of recreational use and wildlife experiences. From this part we use the responses to create an indicator of whether or not the respondent uses the forests. Following, respondents were presented to a choice experiment, and finally debriefing questions and questions about respondent's socioeconomic characteristics.[3]

Each respondent received six choice sets for two out of three habitats. From the full set of combinations of attributes, we excluded alternatives identical to the status quo, and dominant alternatives. We used a modified Fedorov candidate set search algorithm to obtain a d-efficient design for a multinomial logit analysis (see Jacobsen et al., 2012 for further details). Every choice set consisted of three alternatives, the first alternative always representing the status quo. The attributes describing each alternative included i) initiatives to increase population size of wildlife in general, i) initiatives to increase population size of endangered wildlife, and the attribute in focus in this paper: iii) access reductions for the public in order to improve living conditions for wildlife. Respondents were explained that the increased expenses due to improvements would be financed by income taxes. Today, all similar public actions are funded in this way, giving credibility to the choice of payment vehicle in this specific context. The full set of attributes and levels are described in Table 1 and an example of a choice set can be seen in Fig. 1.

3.2. Spatial variables

Postal addresses of invited respondents were geo-referenced in order to obtain coordinates of the respondents' residence. Combining these coordinates with a forest layer, spatial variables describing the forest in the respondent's local areal were calculated using ArcGIS desktop 10.1.[4] See Fig. 2 for the location of survey recipients and forest cover.

The spatial variables included a measure of proximity to the nearest forest, calculated as the Euclidian distance from the coordinates of the residence to the edge of the nearest forest. Furthermore, an endowment measure of the area of forest in a radius of 2.5 from the respondent's

[2] The information given to the respondents regarding access was: with the current regulations there is generally unrestricted access in forest on roads and paths. It is however possible to provide better protection for wildlife by restricting access to some parts of the forest throughout the year or only in breeding season, typically ranging from April to October. Access reductions limit the opportunities to experience and view wildlife in the forest but act to improve the quality of wildlife habitat.

[3] A translated version of the questionnaire can be obtained from the authors upon request and is also available electronically from the journal's homepage.

[4] The forest layer was created by combining forest layers from FOTdanmark, The Danish Nature Agency (fredskov) and the National Forest Inventory (NFI). These were corrected for excessive forest using a field block layer from the Danish Geodata Agency (DGA) and all forest patches containing <2 ha were removed from the layer. Addresses were obtained from AWS suite sourced from the Registry of Building and Housing.

Table 2
Descriptive statistics for spatial variables.

Variable	Mean	Std. dev.	Quartiles Min	25%	50%	75%	Max	Variable name
Ha of forest within a circle of 2.5 km from a respondents home	203.54	206.9	0	60	137	296	1358	Forest
Meter from nearest forest edge to respondents home	478.17	405.06	0	192.77	385.63	689.07	3026.16	Dist
No. of indicator species in 10 × 10 km grid where respondent is located	40.32	23.83	0	21	37	50	116	Species
Population density in the municipality of the respondent	1089.74	2030.39	18.37	76.23	279.91	630.27	10,473.77	Pop
Share of broadleaved forest in 2.5 km circle	0.61	0.27	0.01	0.39	0.67	0.8	1	Broadleaved
Share of public forest in 2.5 km circle	0.4	0.35	0	0.04	0.34	0.75	1	Public

property was computed. The radius of 2.5 km was found to be a relevant measure as half of all forest visits in a representative Danish survey are within 3 km from people's residence (DØRS, 2014). Radiuses of 5, 10 and 15 km were also tested, and resulted in similar overall results but typically with lower estimate precision indicating that these radiuses were a poorer proxy. Further, using the forest owner information reported in the National Forest Inventory (summary statistics provided in Nord-Larsen et al., 2015) and combining this with maps from the Danish Geodata Agency (DGA, 2014) and residence owner information from the Danish Registry of Buildings and Housing database (OIS, 2010) we obtained information on ownership of the forest located within 2.5 km radius of the residence (i.e. private or. public). Information on the prevalence of wildlife was created by combining respondent geo-referenced residences with a spatial layer of indicator forest species (reported in Petersen et al., 2016). Population density measures describing the congestion level were obtained from Statistics Denmark (Statistics Denmark, 2014). Further, we used information about the share of broadleaved forest cover level at the municipality level. Table 2 shows the descriptive statistics for the spatial variables.

4. Results

Table 3 presents results for the analysis of the importance of local forest conditions for three different models. Model 1 is an attribute only model, similar to the one employed in Jacobsen et al. (2012) but here we focus only on the forest habitat. This model is used as a reference model. Models 2 and 3 examine our first hypothesis dealing with the relationship between preferences and **presence** (local forest cover and distance to forest). Model 4 examines our second hypothesis related to the **quality** conditions of local forests.

The results from the simple model without spatial variables previously examined in (Jacobsen et al., 2012) remain stable across the inclusion of interaction terms showing a negative utility for access reductions as expected.

Model 2 assumes that the disutility of access reduction depends on the amount of forest cover by including an interaction term between access and the logged variable that measures forest cover in hectares. The interaction term is significant and negative and thus indicates that we cannot reject our hypothesis that respondents living in forest dense areas also require a larger compensation to accept reduced access to forests, compared to respondents in low-density forest areas. With regard to distance we find that the utility loss increases as the distance between respondents' residence and the nearest forest increases. Both parameter estimates for the log functional form of distance are insignificant. Failure to identify functional forms that require estimation of more than one parameter is a common problem in choice models with large heterogeneity. Consequently, we also estimated a simpler model, assuming a linear relation between distance to forest and utility loss, while maintaining the log functional form for local forest cover (results not shown). However, results here were similar showing that the utility loss increases by distance. This result is opposed to our prior expectations and will be discussed in Section 5.

Focusing on the importance of forest cover, we estimate Model 3, which only includes the log to the forest cover interacted with the access reductions. Here we see the same pattern as before, namely that a larger compensation is required for respondents living in forest dense areas. Looking at the size of the estimates we see that while

Forests	Current situation	Initiative 1	Initiative 2
Population of dormouse	Threatened	rare, but not threatened	Common
Population of general wildlife in forests	No change	No change	+50%
Access at roads and paths	Most often everywhere	Full year: No access in ¼ of all forests	April-October: No access in ¼ of all forests
Additional annual income tax for your household	0 DKK	0 DKK	100 DKK.
Choose only one of the alternatives:	☐	☐	☐

Fig. 1. Example of a choice card, translated from Danish. The first two attributes were varied in order, and "population of general wildlife" in "forests" was presented with pictograms for a subsample. All these versions enter in the current study, and differences are not analysed further.

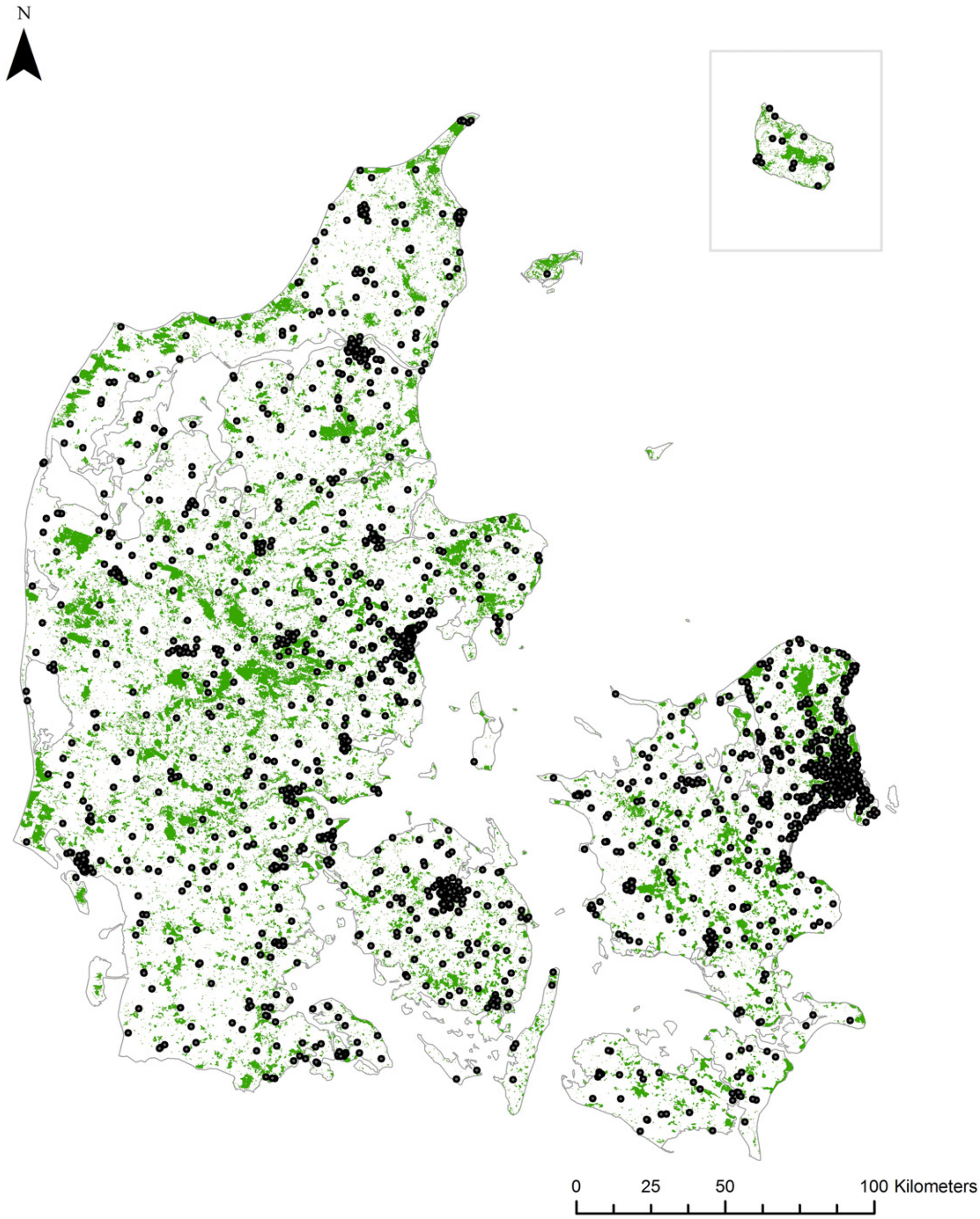

Fig. 2. Location of Danish forest cover and survey recipients.

local forest cover matters for the valuation of access reduction, the access reduction per se matters more,[5] indicating that the national restriction in access dominates local access restrictions.

As a monetary equivalent to people's preferences we can calculate the average WTP for avoiding access reduction based on model 3 by using Eq. (3). The results are shown in Table 4. As expected, the WTP to avoid access reduction in general (i.e. national access reductions not local) is reduced when local forest attributes are accounted for in the model. WTP for avoiding reduced access is independent of the forest cover close to a respondent's residence, whereas WTP for avoiding no access at all depends on forest cover as seen by the quartiles.

Fig. 3 shows the individual marginal WTP for avoiding access recalculated to reductions *per hectare* depending on local forest cover. As is seen the marginal WTP per hectare decreases, though the aggregate WTP increases, cf. Table 4. Though the per hectare estimates reveals little variation in the figure, the underlying aggregated WTP contains variation as is also seen by the large standard deviation in Table 3 for the main effects. Thus while forest cover may explain some variation, it definitely does not explain all the heterogeneity seen.

Model 4 extends model 2 by including quality indicators of the local forest environment in order to test our second hypothesis, though we simplify it by only having distance as a linear effect. The results show

[5] E.g. the average level of forest is 203 ha, so for no access $0{,}0587 * \log(203) = 0{,}135 < 1.377$.

Table 3
Parameter estimates for a random parameter logit models with different interactions between access attributes and spatial variables.

	Model 1 (non-spatial)		Model 2 (forest + distance)		Model 3 (forest)		Model 4 (quality)	
	–		–		–		–	
	Mean	Std. Err.	Mean	Std. Err.	Mean	Std. Err.	Mean	Std. Err.
Price	−0.257***	0.015	−0.258***	0.015	−0.258***	0.015	−0.258***	0.015
Asc	−0.166	0.198	−0.172	0.199	−0.176	0.198	−0.170	0.198
Endangered wildlife-rare	1.669***	0.224	1.674***	0.226	1.672***	0.225	1.683***	0.224
Endangered wildlife-common	1.299***	0.211	1.307***	0.213	1.304***	0.211	1.314***	0.212
General wildlife + 25%	1.370***	0.216	1.379***	0.217	1.373***	0.217	1.377***	0.216
General wildlife + 50%	0.971***	0.213	0.971***	0.215	0.966***	0.213	0.968***	0.213
Reduced access on 25%	−1.151***	0.190	−1.762*	1.010	−1.143***	0.201	−1.455***	0.515
No access on 25%	−1.556***	0.199	−2.305**	1.034	−1.138***	0.207	−1.413***	0.545
Reduced access × log(forest)			−0.019	0.022	−0.0077	0.021	0.019	0.027
No access × log(forest)			−0.074***	0.024	−0.059***	0.024	−0.036	0.030
Reduced access × dist			−1.114*	0.629			−0.784**	0.397
No access × dist			−1.787***	0.640			−1.205***	0.416
Reduced access × log(dist)			0.207	0.209				
No access × log(dist)			0.319	0.214				
Reduced access × broadleaved							2.397***	0.708
No access × broadleaved							1.816***	0.759
Reduced access × public							−0.455	0.466
No access × public							−0.400	0.503
Reduced access × species							−0.019**	0.008
No access × species							−0.008	0.008
Reduced access × pop							0.001	0.001
No access × pop							−0.001	0.001
	Std. dev.	Std. Err.	Std. dev.	Std. Err.	Std. dev.	Std. Err.	Std. dev.	Std. Err.
Endangered wildlife-rare	2.343***	0.231	2.378***	0.235	2.366***	0.234	2.371***	0.234
Endangered wildlife-common	2.709***	0.261	2.778***	0.264	2.729***	0.260	2.750***	0.261
General wildlife + 25%	2.578***	0.247	2.601***	0.251	2.593***	0.249	2.560***	0.248
General wildlife + 50%	2.535***	0.219	2.570***	0.222	2.549***	0.220	2.542***	0.217
Reduced access on 25%	1.990***	0.214	1.963***	0.213	1.979***	0.213	1.895***	0.212
No access on 25%	2.024***	0.250	1.944***	0.243	1.978***	0.247	1.917***	0.237
No. of respondents	475		475		475		475	
No. of obs	8394		8394		8394		8394	
No. of choice sets	6		6		6		6	
Log likelihood	−2310.91		−2302.28		−2307.72		−2293.80	
McFaddens (pseudo R2)	0.2469		0.2497		0.2493		0.2525	
No. of draws	2000		2000		2000		2000	

*,**,*** indicates significance at the 95%,99%,99.9% levels respectively.

that there is an additional loss from reduced access when the local forest inhabits a large variation of forest indicator species, but with no additional utility loss related to no-access to the forest. We find that a higher share of broadleaved forest cover in the local forest reduces the compensation required for accepting an access reduction. Both of these results are in contrast to our a priori expectation. No evidence of a utility difference in the access reduction related to public versus private forest or living in a densely populated area, creating possibilities for crowding effects was found.

The found relations between WTP and local forest conditions in the form of forest cover and proximity to forest, and quality indicators that may lead to spatial variation in the utility loss from an access reductions, may lead to the relevant question of whether this is a results of a sample-selection bias caused by a overrepresentation of respondents devoted to forest recreation in areas with high density of forest cover. Therefore, we test whether forest cover and distance is different between respondents and non-respondents. As criteria for difference, we used a Kolmogorov-Smirnov test and a Wilcoxon rank-sum test at a 1% test level. For both variables we find no indication of self-selection bias, which is also supported by the graphical representation of the distributional differences in Fig. 4. Similar results were found for the quality parameters, see Appendix Fig. A1 for graphical results.

Table 4
Average WTP (DKK/household/year) for avoiding 25% access reduction all year round (no access) and from April–October (reduced access), depending on the forest cover within 2.5 km from the respondents home.

	Model 1 *WTP in DKK*	Model 3 *WTP in DKK*
Avoiding reduced access - main effect	449	443
Avoiding no access - main effect	606	534
Additional WTP for avoiding reduced access per additional log(ha) of forest within 2.5 km radius	–	N.S.
Additional WTP for avoiding no access per additional log(ha) of forest within 2.5 km radius	–	68
The average respondent's WTP for avoiding reduced access	449	450
The average respondent's WTP for avoiding no access	606	586
WTP for avoiding no access for different forest cover quartiles (25%,50%75%)	606	574,582,590

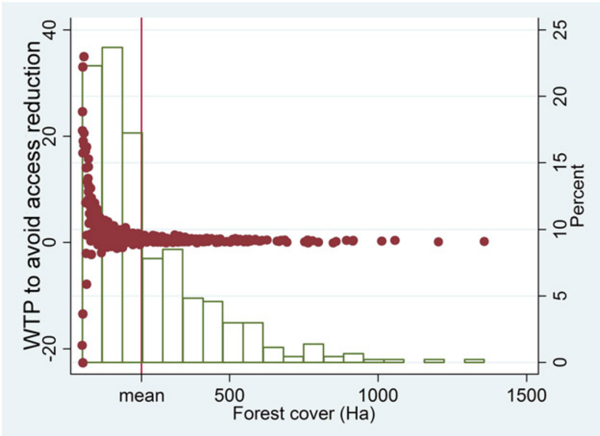

Fig. 3. Individual marginal WTP for avoiding access reductions per hectare depending on local forest cover (dots, left axis). The columns show the distribution of the forest cover (right axis) and the mean forest cover (203 ha) is denoted by a vertical line. 4 outliers are excluded for illustration purpose. WTP is measured in DKK/household/year.

5. Discussion

In this paper we have examined whether local forest recreation opportunities influence WTP measures of a nationally stated policy to conserve wildlife through access reductions. Combining survey data with GIS information on respondents' local forest characteristics in a random parameter logit framework has enabled us to handle preference heterogeneity as explained by spatial heterogeneity in the forest landscape of the respondents. This provides insight to the spatial welfare implications of policy decisions and such an approach can potentially guide the local implementation of national policies.

The Danish forest landscape is far from homogeneous. Values related to local forest access may be highly dependent upon factors such as the composition and configuration of the local forest environment, access routes to the forest and proximity to residential locations. Overall our results suggest that a nationally framed policy which implements access reductions to protect wildlife can be characterised by a general disutility for access reductions and a utility component depending on local forest environment characteristics. This leads to heterogeneous welfare consequences. Analysing the distributional consequences of such national policies therefore requires that both national and local levels are considered.

5.1. The importance of the analysed spatial variables

Our main finding is that people living in an area with a dense forest cover require higher compensation for accepting access reductions to conserve wildlife, and that this compensation is marginally decreasing as the local forest cover increases. The consequence is that the required compensation per hectare is reduced the larger the forest cover in the surroundings. A larger forest cover implies larger recreational opportunities, and potentially also better recreational substitution possibilities within and between forest sites. This result is in line with our expectation (considering access a normal good) and also in line with previous findings in the travel-cost literature where e.g. (Termansen et al., 2013) find marginal improvement in visitor attraction with the size of the forest. When the aim is to increase overall welfare, efforts should be targeted toward areas that have a relatively dense forest cover as the compensation per ha is declining. When growing population density increases the number of affected individuals, the targeting should however trade-off forest size with the negative welfare consequences of imposing access reduction in high density population areas, suggesting that access reductions should take place in large, remote forest areas - from a welfare economic point of view.

With regard to the effect of distance, we find that WTP for avoiding access reduction increases with distance, which is in contradiction with our hypothesis of distance decay. However, larger welfare losses with increased distance to the nearest forest could prevail if there are few available recreational substitutes such that access reductions essentially remove available recreational opportunities in the local area. An alternative explanation could be that for individuals living right next to (or in) the forest, access reductions may act to increase the tranquillity of the forest and promote residential privacy as forest use is reduced. Another reason may be related to the fact that the policy of access reduction is motivated to avoid disturbances and thus improve wildlife conditions. Having a reserve close to your home may create benefits in itself, for instance by promoting opportunities to view wildlife from bird watching towers increasing wildlife populations in nearby areas with maintained access and increasing the non-use value from living in a rich nature. Johnston and Ramachandran (2014) also argue for such differences in quality being possible reasons for variation in demand. However, we believe that it is unlikely to explain the observed effect fully. Another explanation may lie within the spatial data quality. This is discussed in the caveat section below.

Turning to the proxies for the quality of local forests our results generally indicate that these have no impact on the welfare consequences of access reductions. We find no difference between public and private forest ownership. One possible explanation is that although private and public forests provide different access rights, these are not well-enforced and the ownership not well known. Jensen (2003) reports that only around 2/3 of the sampled respondents knew the ownership of the forest they visited. Further, 25 pct. of the respondents only have access to private forest within 2.5 km from their home. If valuation answers partly mirror local conditions as we hypothesize, then the reference will be made to whatever forest that is contained in the local area. This may cause respondents to a lesser extent to distinguish between the ownership of a set of forest sites. Likewise, we see no evidence of local welfare reductions from reducing access in forests with high crowding potential.

With regard to forest cover composition, we find that living in a community with a high share of broadleaved forest cover reduces the compensation required to accept access reductions. The result is against our expectation. This also goes for the variable that describes species richness in a forest area. The interaction terms indicate that species rich areas introduce negative welfare consequences for a partial access reduction but not for a complete access reduction. The utility loss from reduced access is in correspondence with our expectation as access reduction may reduce the opportunities to observe wildlife in the forest. Finding no utility loss from full access restrictions is contrary to expectations. If the utility loss from access reductions originates from restricting opportunities to observe wildlife in the forest, we would expect the utility loss to increase with stricter access reductions. However, since wildlife protection has potential implications for both the use-value of observing species while being in the forest as well as non-use values from knowing that species are preserved in the local community, our results may reflect that non-use values of wildlife protection dominate the utility loss from reduced access. We presume that imposing stricter access reduction increases the benefit to wildlife, and as a consequence the non-use value of preservation increases with the stringency of the regulation.

5.2. Self-selection

Our results confirm that welfare consequences of imposing access reductions to conserve wildlife are spatially sensitive to forest size. It therefore seems straight forward to assume that these results are biased through self-selection where individuals living in areas of e.g. large forest cover also value these higher, and hence are more likely to answer

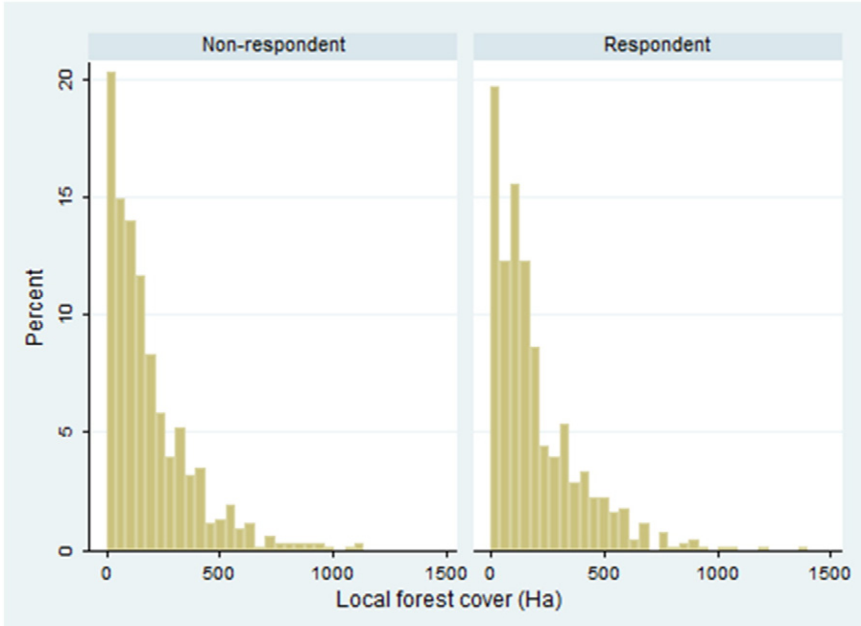

Fig. 4. Distribution of forest cover and distance to forest for non-respondents and respondents.

and return a valuation questionnaire dealing with forest access. Testing the distributional differences for all our spatial variables produces a clear indication that this is not the case. We see no evidence of spatially dependent self-selection for any of the spatial variables included in this analysis, lending credibility to the identification of our results and the validity of using sample results in stated preference studies, without correcting aggregation procedures for potential self-selection bias more generally as suggestion in (Bateman et al., 2006).

5.3. Caveats

The Danish forest landscape varies markedly for different locations. Next to the forest landscape itself, many other landscape characteristics such as the presence of lakes, proximity to the coast line, forest bordering other open space recreational areas may be part of the recreational and aesthetic enjoyment of the forest landscape (e.g. Zandersen et al., 2007b). This will not be fully captured in the rather crude spatial variables analysed in this paper. Using spatial data unavoidably include choices of how to measure spatial context, which can be questioned. For instance, the spatial extent of what is perceived as the local neighbourhood and the distance that individuals are willing to travel for forest recreation differs between individuals and different landscape settings just like the areas that matter for them when valuing access restrictions differs. Respondents might think of access restrictions at their favourite holiday outing, the forest around their summerhouse, the forest where they grew up or something completely different. However, Jensen (2003) estimate that only a median of 8% have been on holiday for their last forest visit, indicating that the majority of forest visits are departing from the home, so it is not likely to dominate the results found here.

In this analysis we have used an Euclidean distance measure between respondent residence and the nearest forest. Implicit in our distance measure is an assumption that proximity to forest is an important indicator of the use value of a given forest site. In some cases this assumption may be unwarranted and respondents may prefer recreational visits to other forest areas. Further, the actual distance travelled to reach a forest depends on the access paths to the forest influenced by factors such as the road network, paths and fences within and surrounding the forest, which may cause this to deviate from the Euclidean distance measure. Future research may benefit from exploring different measures such as e.g. actual distance travelled (Sen et al., 2014). However, it is not likely to have a large impact on the current study as forests typically have many access points and the road network is dense.

For simplicity, we have excluded non-forest landscape characteristics that may act as substitutes and complements to forest recreation and which may also affect the quality of the recreational experience.

6. Concluding remarks

Often stated preference studies eliciting welfare economic consequence of national policies do not take the spatial variation in supply and demand into account. However, this spatial variation may cause large distributional heterogeneity of policy changes. Therefore this study has examined whether peoples' WTP for avoiding restricted forest access is influenced by spatial heterogeneity in local forest conditions. Using survey data combined with GIS information about respondents' local forest conditions, we have demonstrated that WTP for avoiding access reduction depends on the forest cover in the surroundings of a respondent's home. We have also analysed distance to the nearest forest and various quality indicators (broadleaved, ownership, species richness, crowding potential) finding that some of these matters, but not always as expected. This might be due to multiple spatial factors affecting each other and the good in question and further analyses of such multicollinearity are suggested. Further, we have shown that self-selection to respond to the questionnaire is not affected by the local forest cover and distance to the forest supporting the use of sample results in stated preference studies.

Acknowledgement

The authors acknowledge the support from the Danish National Research Foundation (DNRF096) to the Centre for Macroecology, Evolution and Climate and also to the Danish Ministry of Environment for support to the data collection.

Appendix A. Appendix

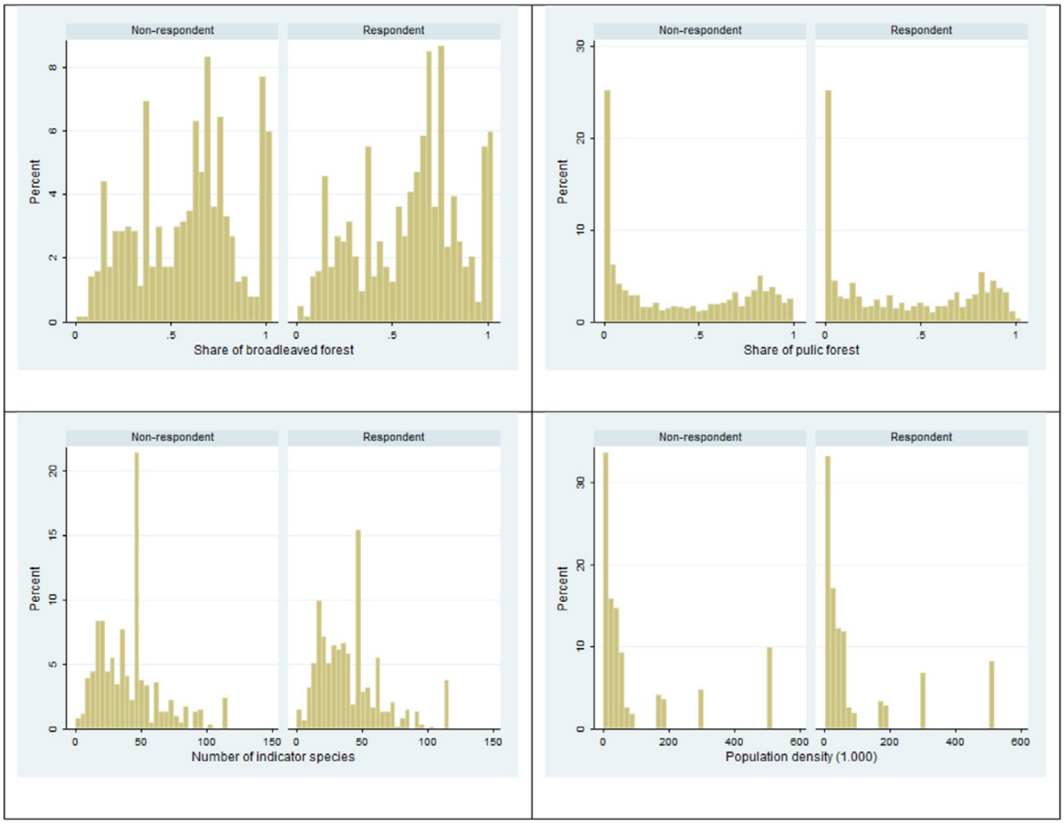

Fig. A1. Distribution of share of broadleaved, and public forest, number of indicator species and population density for non-respondents and respondents.

Appendix B. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.forpol.2016.08.010.

References

Abildtrup, J., Garcia, S., Olsen, S.B., Stenger, A., 2013. Spatial preference heterogeneity in forest recreation. Ecol. Econ. 92, 67–77.
Baerenklau, K.A., 2010. A latent class approach to modeling endogenous spatial sorting in zonal recreation demand models. Land Econ. 86, 800–816.
Bakhtiari, F., Jacobsen, J.B., Lundhede, T.H., Strange, N., Thorsen, B.J., Boman, M., 2014a. Valuation of biodiversity protection across borders: limits to the public good? Fifth World Congress of Environmental and Resource Economists 2014, Istanbul June 28–July 2, 2014
Bakhtiari, F., Jacobsen, J.B., Jensen, F.S., 2014b. Willingness to travel to avoid recreation conflicts in Danish forests. Urban For. Urban Green. 13, 662–671.
Bateman, I.J., 2009. Bringing the real world into economic analyses of land use value: incorporating spatial complexity. Land Use Policy 26 (Supplement 1), S30–S42.
Bateman, I.J., Day, B.H., Georgiou, S., Lake, I., 2006. The aggregation of environmental benefit values: welfare measures, distance decay and total WTP. Ecol. Econ. 60, 450–460.
Broch, S.W., Strange, N., Jacobsen, J.B., Wilson, K.A., 2013. Farmers' willingness to provide ecosystem services and effects of their spatial distribution. Ecol. Econ. 92, 78–86.
Brouwer, R., Martin-Ortega, J., Berbel, J., 2010. Spatial preference heterogeneity: a choice experiment. Land Econ. 86, 552–568.
Campbell, D., Hutchinson, W.G., Scarpa, R., 2009. Using choice experiments to explore the spatial distribution of willingness to pay for rural landscape improvements. Environ. Plann. A 41, 97–111.
Campbell, D., Vedel, S.E., Thorsen, B.J., Jacobsen, J.B., 2014. Heterogeneity in the WTP for recreational access: distributional aspects. J. Environ. Plan. Manag. 57, 1200–1219.
Czajkowski, M., Budzinski, W., Campbell, D., Giergiczny, M., Hanley, N., 2016. Spatial heterogeneity of willingness to pay for forest management. Forthcom. Environ. Resour. Econ. http://dx.doi.org/10.1007/s10640-016-0044-0.
Degenhardt, B., Frick, J., Buchecker, M., Gutscher, H., 2011. Influences of personal, social, and environmental factors on workday use frequency of the nearby outdoor recreation areas by working people. Leis. Sci. 33, 420–440.
DGA, 2014. http://download.kortforsyningen.dk/.
DØRS, 2004. Rekreative værdier [Outdoor recreative values]. In Økonomi og Miljø Danish Economic Councils, pp. 103–192.
Edwards, D.M., Jay, M., Jensen, F.S., Lucas, B., Marzano, M., Montagne, C., Peace, A., Weiss, G., 2012. Public preferences across Europe for different forest stand types as sites for recreation. Ecol. Soc. 17, 27.
Haab, T.C., McConnell, K.E., 2002. Valuing Environmental and Natiral resources: The Econometrics of Non-Market Valuation. Edward Elgar Publishing.
Hanley, N., Schläpfer, F., Spurgeon, J., 2003. Aggregating the benefits of environmental improvements: distance-decay functions for use and non-use values. J. Environ. Manag. 68, 297–304.
Jacobsen, J.B., Lundhede, T.H., Thorsen, B.J., 2012. Valuation of Wildlife Populations above Survival Biodiversity and Conservation. 21 pp. 543–563.
Jacobsen, J.B., Lundhede, T.H., Thorsen, B.J., 2013. The effects of current income and expected change in future income on stated preferences for environmental improvements. J. For. Econ. 19, 206–219.
Jensen, F.S., 2003. Outdoor values in 592 forests and other nature areas. Forest & Landscape. HÃ¸rsholm, Denmark.
Jensen, F.S., 2012. Friluftsliv i skovene 2008 [outdoor recreation in the forests 2008]. Videnblade Planlægning og Friluftsliv 6, 1–64.
Jensen, F.S., Koch, N.E., 1997. Friluftsliv i skovene 1976/77 - 1993/94 [Outdoor recreation in the forests 1976/77 - 1993/1994]. Research Series No. 20. Danish Forest and Landscape Research Institute, Hørsholm. ISBN: 87- 89822-89-7.
Jensen, F.S., Koch, N.E., 2004. Twenty-five years of forest recreation research in Denmark and its influence on forest policy. Scand. J. For. Res. 19, 93–102.
Jensen, C.U., Panduro, T.E., Lundhede, T.H., 2014. The vindication of Don Quixote: the impact of noise and visual pollution from wind turbines. Land Econ. 90, 668–682.
Johnston, R.J., Duke, J.M., 2009. Willingness to pay for land preservation across states and jurisdictional scale: implications for benefit transfer. Land Econ. 85, 217–237.
Johnston, R.J., Ramachandran, M., 2014. Modeling spatial patchiness and hot spots in stated preference willingness to pay. Environ. Resour. Econ. 59, 363–387.
Johnston, R.J., Swallow, S.K., Bauer, D.M., 2002. Spatial factors and stated preference values for public goods: considerations for rural land use. Land Econ. 78, 481–500.
Jorgensen, S.L., Olsen, S.B., Ladenburg, J., Martinsen, L., Svenningsen, S.R., Hasler, B., 2013. Spatially induced disparities in users' and non-users' WTP for water quality improvements—testing the effect of multiple substitutes and distance decay. Ecol. Econ. 92, 58–66.
Klaiber, H.A., Phaneuf, D.J., 2010. Valuing open space in a residential sorting model of the twin cities. J. Environ. Econ. Manage. 60, 57–77.

Kuminoff, N.V., Smith, V.K., Timmins, C., 2013. The new economics of equilibrium sorting and policy evaluation using housing markets. J. Econ. Lit. 51, 1007–1062.
Loomis, J.B., 2000. Vertically summing public good demand curves: an empirical comparison of economic versus political jurisdictions. Land Econ. 312–321.
McFadden, D., 1973. Econometric models for probabilistic choice among products. J. Bus. 53, S13–S29.
McFadden, D., 1974. Conditional logit analysis of qualitative choice behaviour. In: Zarembka, P. (Ed.), Frontiers in Econometrics. Academic Press, New York, pp. 105–142.
Moore, R., Provencher, B., Bishop, R.C., 2011. Valuing a spatially variable environmental resource: reducing non-point-source pollution in Green Bay, Wisconsin. Land Econ. 87, 45–59.
Nord-Larsen, Thomas, Kvist Johannsen, Vivian, Riis-Nielsen, Torben, Thomsen, Iben M., Schou, Erik, 2015. Kjell Suadicani og Bruno Bilde Jørgensen (2015): Skove og plantager 2014, Skov & Landskab, Frederiksberg 85 s. ill.
Nielsen, A.B., Olsen, S.B., Lundhede, T., 2007. An economic valuation of the recreational benefits associated with nature based forest management practices. Landsc. Urban Plan. 80, 63–71.
OIS, 2010. https://www.ois.dk/.
Panduro, T.E., Thorsen, B.J., 2014. Evaluating two model reduction approaches for large scale hedonic models sensitive to omitted variables and multicollinearity. Lett. Spat. Resour. Sci. 7, 85–102.
Pellegrini, P., Fotheringham, A., 2002. Modelling spatial choice: a review and synthesis in a migration context. Prog. Hum. Geogr. 26, 487–510.
Petersen, A.H., Strange, N., Anthon, S., Bjørner, T.B., Rahbek, C., 2016. 'Conserving what, where and how? Cost-efficient measures to conserve biodiversity in Denmark'. J. Nat. Conserv. 29, pp. 33–44. http://dx.doi.org/10.1016/j.jnc.2015.10.004.
Schaafsma, M., Brouwer, R., Rose, J., 2012. Directional heterogeneity in WTP models for environmental valuation. Ecol. Econ. 79, 21–31.
Schaafsma, M., Brouwer, R., Gilbert, A., van den Bergh, J., Wagtendonk, A., 2013. Estimation of distance-decay functions to account for substitution and spatial heterogeneity in stated preference research. Land Econ. 89, 514–537.
Sen, A., Harwood, A.R., Bateman, I.J., Munday, P., Crowe, A., Brander, L., Raychaudhuri, J., Lovett, A.A., Foden, J., Provins, A., 2014. Economic assessment of the recreational value of ecosystems: methodological development and national and local application. Environ. Resour. Econ. 57, 233–249.
Statistics Denmark, 2014. Statistikbanken.dk.
Termansen, M., McClean, C.J., Jensen, F.S., 2013. Modelling and mapping spatial heterogeneity in forest recreation services. Ecol. Econ. 92, 48–57.
Train, K., 2003. Discrete Choice Methods with Simulation. Cambridge University Press.
Train, K.E., 2009. Discrete Choice Methods With Simulation. 2nd ed. Cambridge University Press, Cambridge.
Tyrväinen, L., 2001. Use and valuation of urban forest amenities in Finland. J. Environ. Manag. 62, 75–95.
Vedel, S.E., Thorsen, B.J., Jacobsen, J.B., 2009. First-movers, non-movers, and social gains from subsidising entry in markets for nature-based recreational goods. Ecol. Econ. 68, 2363–2371.
von Haefen, R., Massey, D., Adamowicz, W., 2005. Serial nonparticipation in repeated discrete choice models. Am. J. Agric. Econ. 87, 1061–1076.
Zandersen, M., Termansen, M., Jensen, F.S., 2007a. Evaluating approaches to predict recreation values of new forest sites. J. For. Econ. 13, 103–128.
Zandersen, M., Termansen, M., Jensen, F.S., 2007b. Testing benefits transfer of forest recreation values over a twenty-year time horizon. Land Econ. 83, 412–440.