Spatial heterogeneity of willingness to pay for forest management

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Study description

- Spatial distribution of welfare measures for environmental improvements provide important information for improving the economic efficiency of land management

- We investigate public's preferences for the implementation of forest management program in Poland

- Data from Discrete Choice Experiment was used to obtain estimates of individual's willingness to pay (WTP)

- Spatial econometrics methods are applied to Geographical Information System (GIS) dataset to model these WTP estimates

Methodology (1)

- Mixed Logit model in WTP-space was estimated on Discrete Choice Experiment dataset

- Non-cost parameters follow normal distribution and cost parameter is log-normal.

- We allowed for full covariance matrix.

- Expected individual specific WTP were obtained using posterior means of individuals random parameters with following formula:

$$E(\alpha_n \mid y_n, X_n, \theta) = \int \alpha_n \frac{p(y_n \mid X_n, \theta, \alpha_n, \beta_n^{\text{cost}}) f(\alpha_n, \beta_n^{\text{cost}} \mid \theta)}{p(y_n \mid X_n, \theta)} d(\alpha_n, \beta_n^{\text{cost}})$$

Methodology (2)

- Predicted expected individual specific WTP were used in the spatial lag model:

$$WTP = \tau c + \rho \mathbf{W'}\mathbf{WTP} + \mathbf{\gamma'}\mathbf{Z} + e$$

- Regression kriging used to provide visual illustration of spatial distribution of individual-specific WTP

Dataset (1)

- Discrete Choice Experiment conducted on representative sample of 1001 Poles.

- 4 attributes:
  - Passive protection of most ecologically valuable forests (Levels: 50% (SQ), 75%, 100%)
  - Amount of litter (Levels: No change, 50% reduction, 90% reduction)
  - Infrastructure (Levels: No change, Infrastructure in 50% additional forests, Infrastructure in 100% additional forests)
  - Cost (Levels: 0, 10, 25, 50, 100 PLN)

- 4 alternatives (including Status Quo), 26 Choice Tasks

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Protection of ecologically valuable forests	**Status quo** Passive protection of **50%** of the most ecologically valuable forests (1.5% of all forests)	**Status quo** Passive protection of **50%** of the most ecologically valuable forests (1.5% of all forests)	**Status quo** Passive protection of **50%** of the most ecologically valuable forests (1.5% of all forests)	**Substantial improvement** Passive protection of 100% of the most ecologically valuable forests (3% of all forests, 100% increase)
Litter in forests	**Status quo** No change in the amount of litter in the forests	**Partial improvement** Decrease the amount of litter in the forests by half (50% reduction)	**Status quo** No change in the amount of litter in the forests	**Partial improvement** Decrease the amount of litter in the forests by half (50% reduction)
Infrastructure	**Status quo** No change in tourist infrastructure	**Status quo** No change in tourist infrastructure	**Partial improvement** Appropriate tourist infrastructure in an additional 50% of the forests (50% increase)	**Substantial improvement** Appropriate tourist infrastructure available in twice as many forests (100% increase)
Cost	0 PLN	10 PLN	25 PLN	100 PLN
Your choice	☐	☐	☐	☐

Dataset (3)

- CORINE Land Cover and Polish Information System of State Forests were used to obtained high quality GIS dataset.

- Data were available for 10x10 km squares. In total 3307 such squares cover area of Poland

Dataset (4)

Variable name	Description	Source
Area of coniferous forests	Sum of areas of all coniferous forests [km^2]	Corine Land Cover
Area of deciduous forests	Sum of areas of all deciduous forests [km^2]	Corine Land Cover
Area of mixed forests	Sum of areas of all mixed forests [km^2]	Corine Land Cover
Average Euclidean distance to forest	It is average distance from any point in 10x10 km square to the nearest forest	Corine Land Cover
Area of forests with age > 120	Sum of areas of all forests older than 120 years [km^2]	Information System of State Forests
Area of forests with no. of species > 6	Sum of areas of all forests with no. of tree species greater than 6 [km^2]	Information System of State Forests
Built-up area	Built-up area [km^2]	Corine Land Cover

Forest area in
squared kilometers

- [0.00,6.30)
- [6.30,12.44)
- [12.44,18.10)
- [18.10,24.12)
- [24.12,32.13)
- [32.13,41.35)
- [41.35,56.55)
- [56.55,96.60]

0   50   100
km
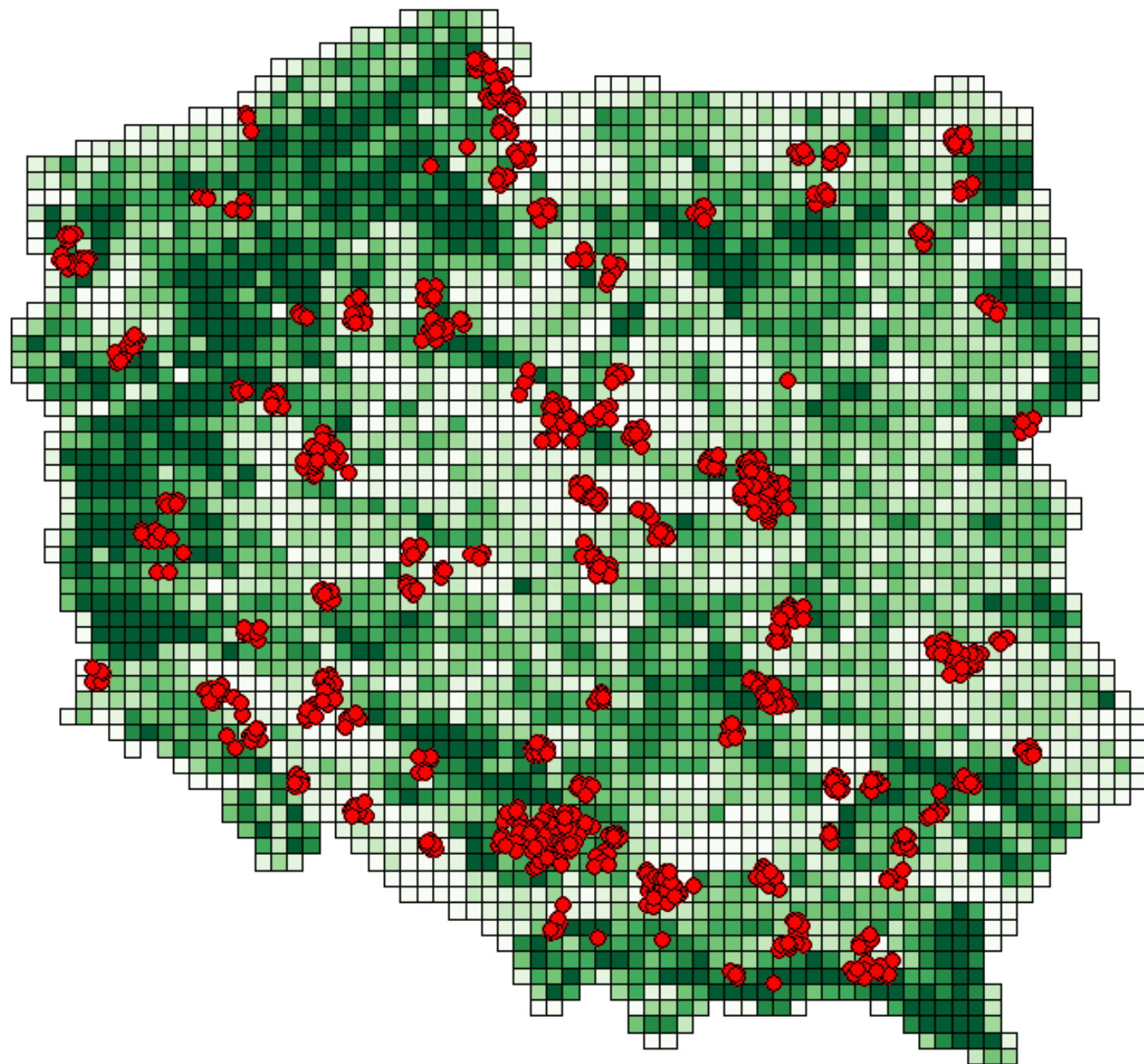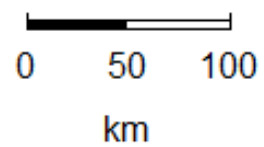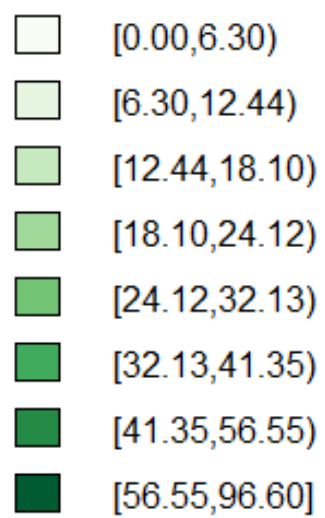
Variable	Mean		Std. Dev.	
	coef.	st. err.	coef.	st. err
NAT_1 (passive protection of most valuable forests – partial improvement)	9.8917***	(0.3436)	11.8622***	(0.5881)
NAT_2 (passive protection of most valuable forests – substantial improvement)	13.5450***	(0.4791)	17.3510***	(0.8286)
TRA_1 (the amount of litter in forests – partial improvement)	11.5526***	(0.3746)	12.8895***	(0.6352)
TRA_2 (the amount of litter in forests – substantial improvement)	17.6876***	(0.5818)	21.4890***	(0.9262)
INF_1 (tourist infrastructure – partial improvement)	6.2377***	(0.2740)	6.1410***	(0.3710)
INF_2 (tourist infrastructure – substantial improvement)	8.6357***	(0.3161)	8.6104***	(0.4837)
SQ (alternative specific constant for the no-choice alternative)	-13.7474***	(0.9304)	30.9090***	(1.7497)
$COST$	-1.5776***	(0.0338)	1.0971***	(0.0400)

WTP scores for NAT_2

- [-2.57, 9.96)
- [9.96, 11.94)
- [11.94, 13.41)
- [13.41, 14.62)
- [14.62, 15.56)
- [15.56, 16.62)
- [16.62, 17.59)
- [17.59, 18.69)
- [18.69, 20.24)
- [20.24, 24.98]

The Baltic Sea

Russia

Lithuania

Belarus

Germany

The Czech Republic

Ukraine

Slovakia

0 50 100

km
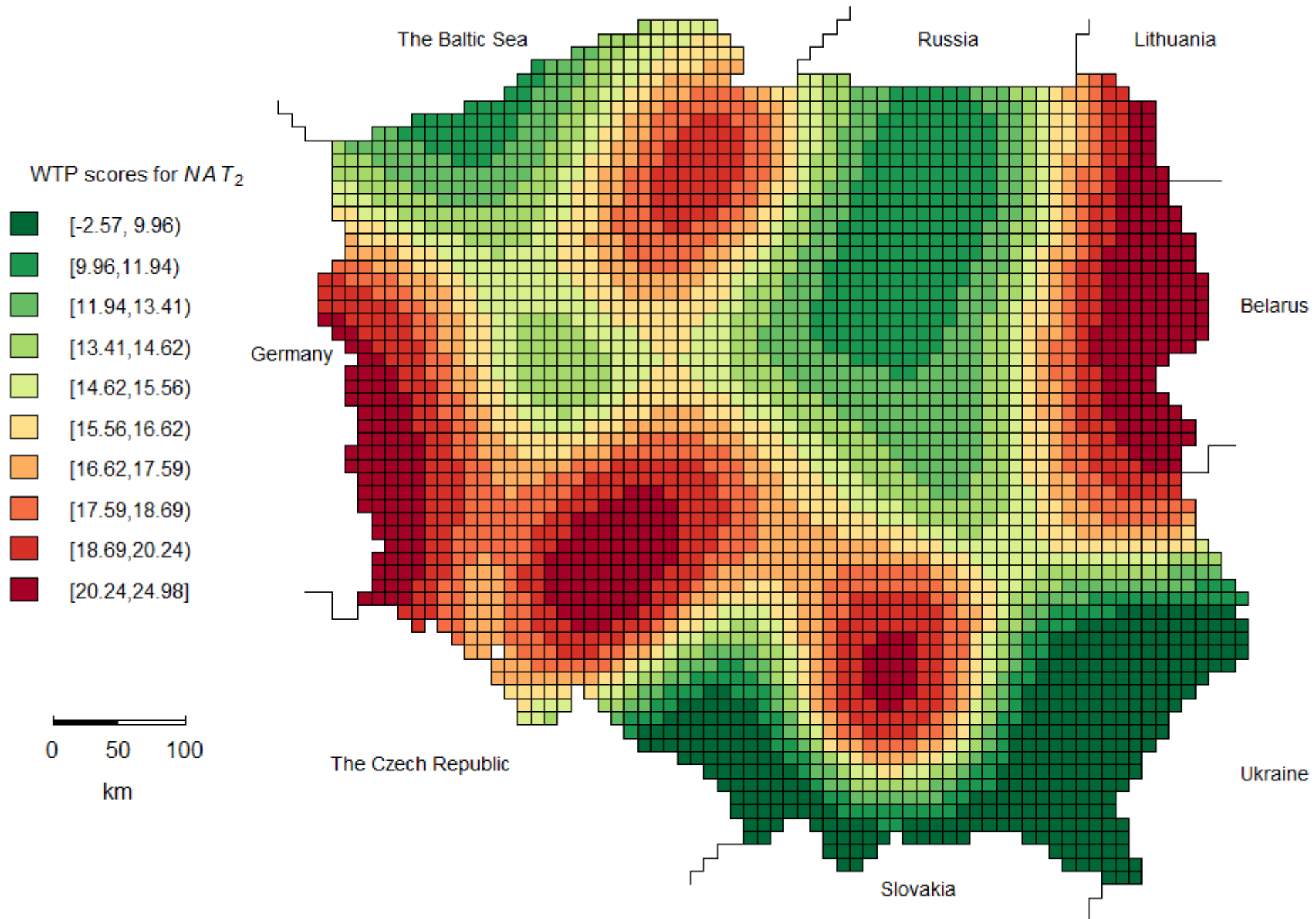
	NAT_1	NAT_2	TRA_1	TRA_2	INF_1	INF_2
Constant	14.9043***	21.0248***	5.1349***	7.4821***	13.2227***	21.3849***
	(2.0156)	(2.9433)	(0.8522)	(1.2240)	(2.1499)	(3.5729)
Area of coniferous forests	-0.0846***	-0.1239***	-	-	-0.0760**	-0.1349***
	(0.0282)	(0.0413)			(0.0300)	(0.0501)
Area of deciduous forests	-0.4702***	-0.6914***	-0.1211***	-0.1929***	-0.4368***	-0.7444***
	(0.0931)	(0.1366)	(0.0404)	(0.0582)	(0.0992)	(0.1656)
Area of mixed forests	-0.2848***	-0.4184***	-0.0868***	-0.1348***	-0.2697***	-0.4541***
	(0.0682)	(0.1000)	(0.0313)	(0.0451)	(0.0728)	(0.1214)
Area of forests with age >120	1.3470***	1.9699***	0.3036**	0.4950**	1.1797***	2.0481***
	(0.3118)	(0.4571)	(0.1401)	(0.2016)	(0.3317)	(0.5540)
Average euclidean distance to forest	-2.1218***	-3.1376***	-0.5427***	-0.8298***	-2.0968***	-3.5062***
	(0.4822)	(0.7071)	(0.1902)	(0.2736)	(0.5148)	(0.8590)
Age	-0.0824***	-0.1210***	-0.0216**	-0.0351***	-0.0585***	-0.0940***
	(0.0191)	(0.0280)	(0.0090)	(0.0129)	(0.0204)	(0.0340)
Higher education	-	-	-0.6453*	-0.9342*	-	-
			(0.3403)	(0.4893)		
Income	1.0972***	1.6240***	0.5170***	0.7710***	1.1743***	1.9320***
	(0.3081)	(0.4516)	(0.1473)	(0.2118)	(0.3287)	(0.5485)
ρ	0.2071***	0.2134***	0.3712***	0.3672***	0.3437***	0.3267***
	(0.0397)	(0.0396)	(0.0356)	(0.0357)	(0.0364)	(0.0369)

Summary

- We observe two effects:
  - The further away individual lives from forests the less he is willing to pay
  - The more forest cover in an individual's neighborhood the less he is willing to pay
- Positive impact of area of forests older than 120 years on WTP
- Strong spatial clustering of preferences
- Additionally spatial clusters are investigated using latent class analysis