ACCOUNTING FOR **PREFERENCE HETEROGENEITY** FOR ENVIRONMENTAL IMPROVEMENTS.

THE CASE OF **COASTAL AND MARINE WATERS OF LATVIA**

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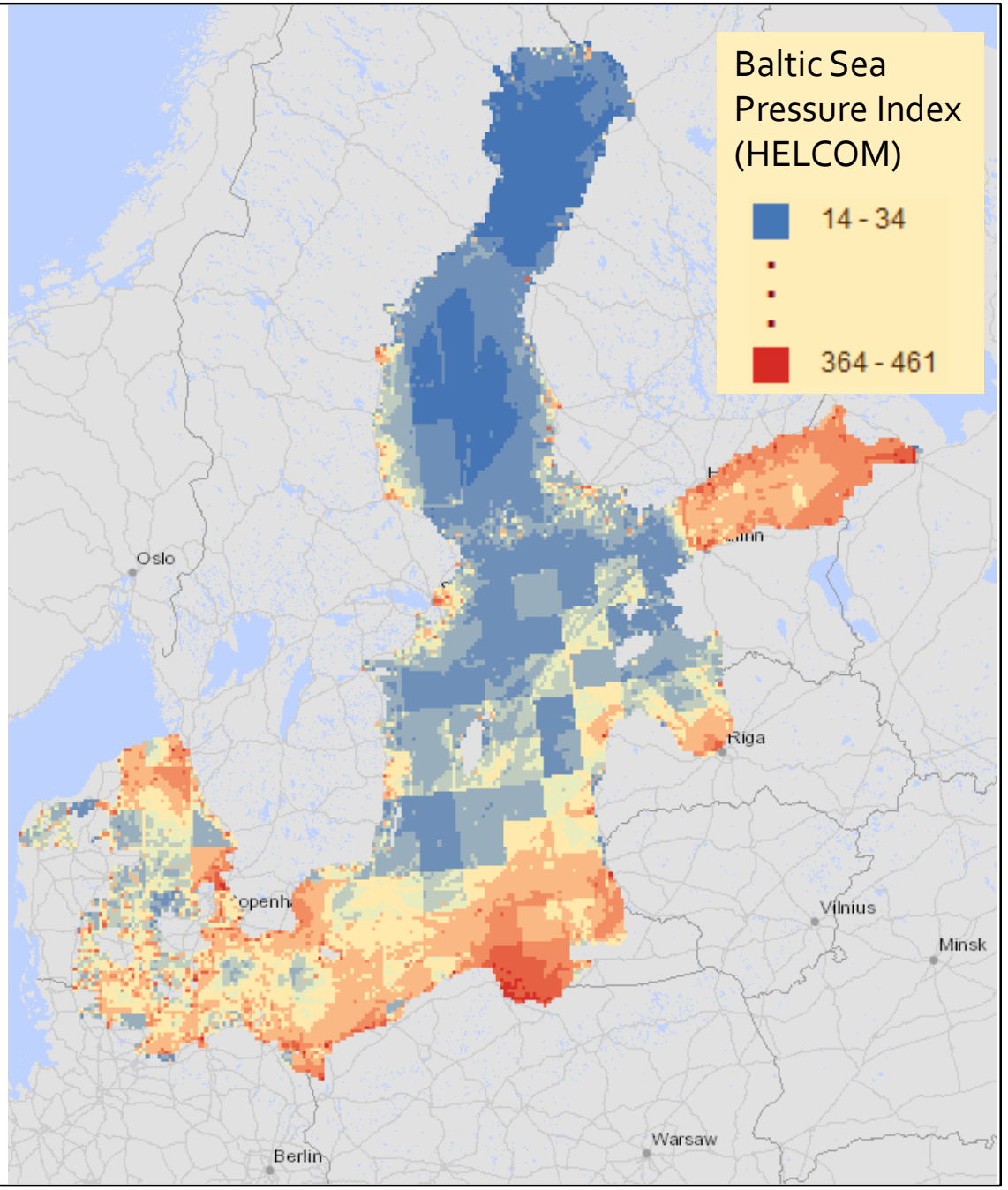
Baltic Sea in danger

- Particularly endangered by human activities
- Surrounded by nine countries:
  - densely populated in coastal areas
  - using marine waters extensively
- Limited water exchange because of the very narrow and shallow oceanic connection
- Accumulation of nutrients, hazardous substances and invasive species
- One of the most threatened marine environments in the world (World Wide Fund for Nature, 2011)



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Marine Strategy Framework Directive

- A regulatory framework to protect the EU marine waters
- The aim: to achieve Good Environmental Status (GES) in EU marine waters by 2020
- It sets out qualitative descriptors what the environment will look like when GES is achieved
- Every EU state determines what each descriptor means in practice and how to achieve GES

Need for cost-benefit analysis

- To support the selection of the measures for achieving GES, the Directive requires an impact assessment, including a cost-benefit analysis.

- The aspects of the marine environment for which improvements are needed can be easily identified.
- The costs of the improvement actions can be readily estimated.

- But the valuation of the benefits from these actions is challenging.

- Our general aim: to evaluate the welfare benefits to citizens from improving environmental status of the Baltic Sea and reaching GES.
- We take the example of Latvia.

Study objectives

1. To provide welfare value estimates for environmental improvements and reaching GES in the Latvian costal and marine waters
2. To identify the variation in preferences for the improvements related to differences in socio-demographics
3. To propose a statistically efficient approach of explaining the socio-demographic-related variability in preferences

Methodology – a discrete choice experiment

- Scientists from the Latvian Institute of Aquatic Ecology identified the descriptors with respect to which the Latvian marine waters fail to reach GES.
- The attributes refer to these descriptors.

	Program A	Program B	No additional actions
Reduced number of native species	No such areas	On small areas	On large areas
Water quality for recreation	Bad	Good	Bad
New harmful alien species establishing	Rarely	Almost none	Often
Your yearly payment	5 LVL	2 LVL	0 LVL
Your choice:	○	○	○
			Status quo

Attribute (improvement) levels
No such areas, On small areas
Good, Moderate
Almost none, rarely
10, 5, 2 LVL

- A coercive payment mechanism (e.g., tax)
- 12 choice tasks per respondent, randomized
- The design optimized for Bayesian D-efficiency of a multinomial logit model with priors from a pilot study and personal interviews

Survey administration

- 1,247 Latvians
- Representative for the general population of Latvia with respect to the nationality, gender, age, place of residence (administrative region) and education level

Computer Assisted Web Interviews (CAWI)	Computer Assisted Personal Interviews (CAPI)
over the internet	at the place of residence
606 respondents	641 respondents
in the age of 18-54	in the age of 35-74

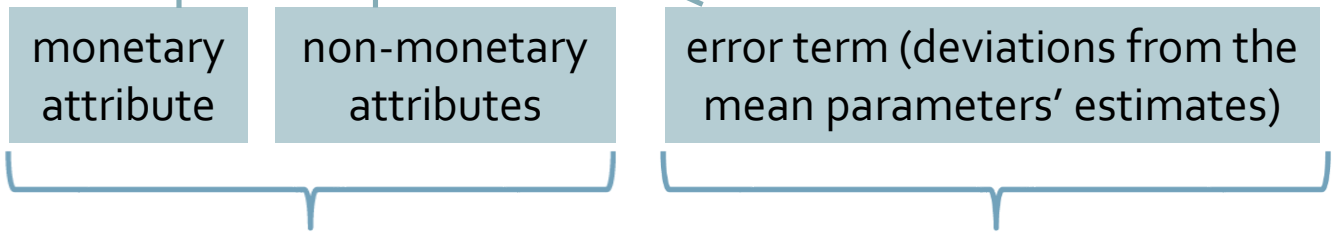
- The questionnaires did not differ between CAWI and CAPI.
- The combined approach was used in order to maintain the sample representativeness and reduce the costs of data collection. Internet interviews are recommended when the use of Internet exceeds 60% – this is not the case for Latvians above 55 years old.

Random Utility Model (McFadden, 1974)

FOUNDATION OF PREFERENCE MODELLING BASED ON DISCRETE CHOICE DATA

- Utility of consumer *n* from choosing alternative *j* in choice task *t* (U_{njt}):

$$U_{njt} = \alpha c_{njt} + bX_{njt} + e_{njt}$$



- A consumer derives utility from: observable characteristics of the good and unobservable factors (random component)

- How much an average consumer is willing to pay (WTP) for the improvement related to attribute *k*? $-\frac{b_k}{\alpha}$

General results

in WTP space (in LVL, 1 LVL = 1.43 EUR)

- Large and significant standard deviations – respondents differ in preferences (unobserved preference heterogeneity)
- Strong preference towards the status quo
- Latvians are willing to pay the most for better water quality for recreation

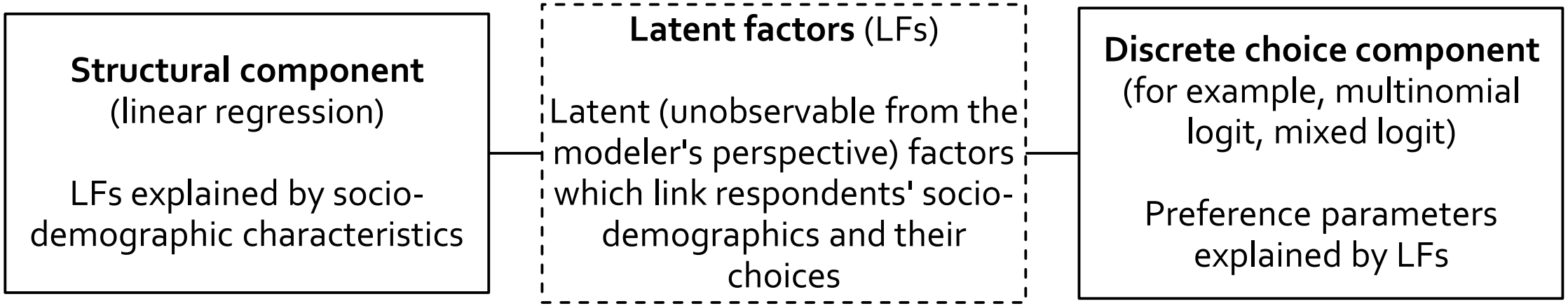
Log-likelihood (constant only)	-15,296.83
Log-likelihood	-7,172.22
McFadden's pseudo R^2	0.5311
Ben-Akiva Lerman's pseudo R^2	0.6981
AIC/n	0.8868
n (observations)	16,212

	Means	St. dev.
Status quo	9.0787***	67.0978***
	(0.7649)	(4.2669)
Reduced number of native species:		
On small areas	0.6135***	0.1117
	(0.1503)	(0.2214)
No such areas	0.4241***	0.7951***
	(0.1583)	(0.2507)
Water quality for recreation:		
Moderate	3.7485***	2.4653***
	(0.2289)	(0.2013)
Good	5.0802***	4.7935***
	(0.3126)	(0.3158)
New harmful alien species establishing:		
Rarely	0.6386***	0.2851
	(0.1570)	(0.2657)
Almost none	0.4268***	0.0920
	(0.1554)	(0.2619)
Cost	-1.2096***	1.0344***
	(0.0605)	(0.0681)

How to explain socio-demographic-related variability in preferences?

Common approaches	Problems
• Interact socio-demographic variables with the choice attributes (e.g., Axhausen et al. 2008; Longo et al. 2008; Kosenius 2010; Ziegler 2012)	• Many socio-demographic variables included often appear insignificant because of being strongly correlated with each other. • Many additional coefficients needed to be estimated substantially lower the number of the degrees of freedom.
• A two-step procedure: – Identify a sub-set of factors which best explain variance of socio-demographics – Use individual factor scores to explain respondents' choices (e.g., Salomon and Ben-Akiva 1983; Boxall and Adamowicz 2002; Milon and Scrogin 2006)	• Not statistically efficient – the factors which best capture the variance in socio-demographics are not necessarily those which provide the most explanatory power in the discrete choice component of the model.

Our approach for explaining the observed preference heterogeneity



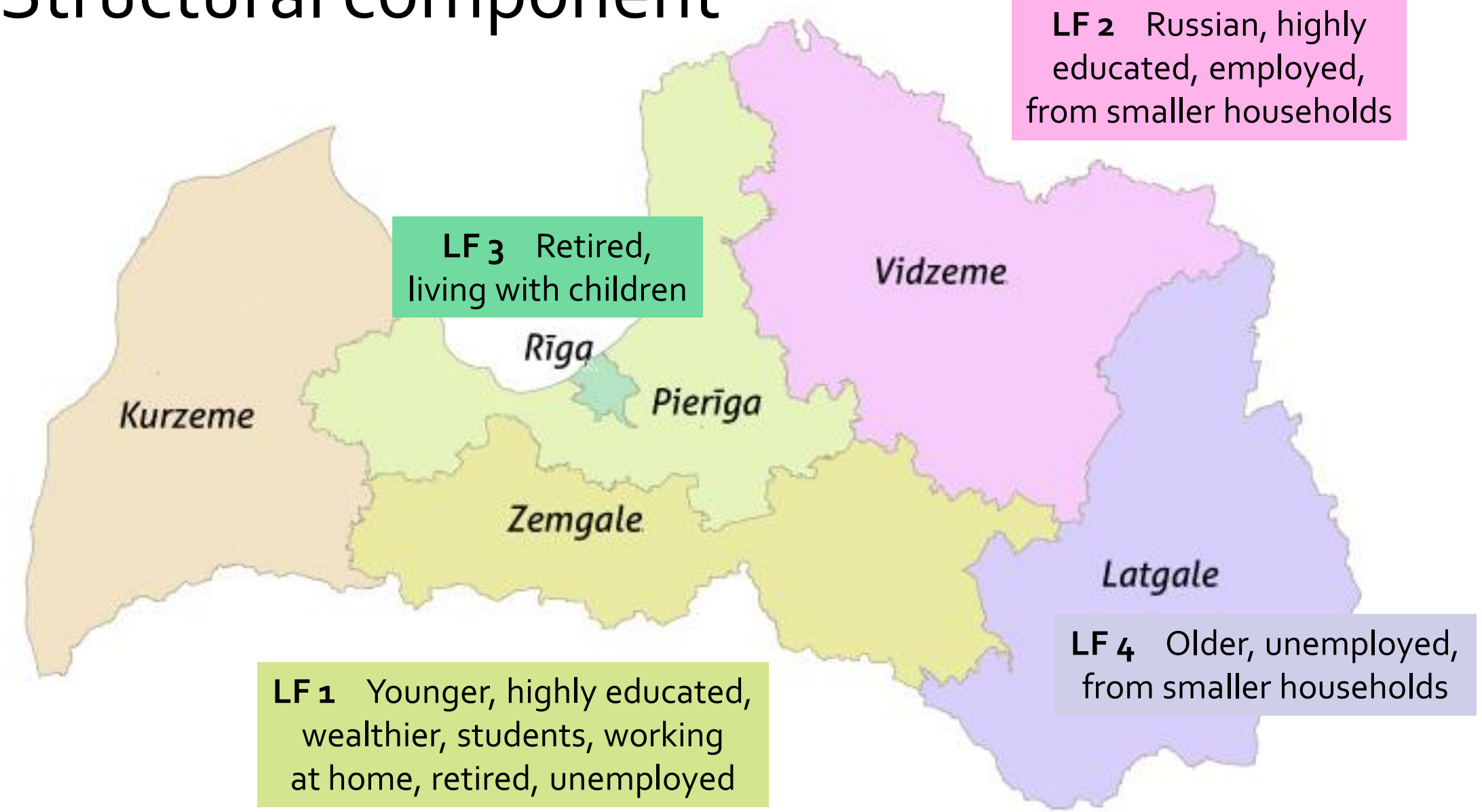
- Linking multiple socio-demographics with preferences
- Identification of the most important factors (LFs) which drive these relationships.
- Our approach fits into the class of "hybrid choice" models (Ben-Akiva et al. 2002) – structural models that incorporate choice and non-choice components.
- Here, we have no measurement component (no attitudinal variables). Instead, we show how this framework can be used to explain the observed heterogeneity in respondents' preferences attributed to their socio-demographic characteristics.

Structural component

- Four latent factors – the best specification in terms of the Akaike information criterion
- Latent factors explained by all available socio-demographic characteristics: age, gender, Latvian nationality, household size, number of children, education, occupation, region of residence, personal income

	Age	Male	Latvian	HH size	Children	Education	Occupation (Reference: Full-time)	Region of residence (Reference: Riga)	Income
LF 1	–					+	Stronger for retired, student, at home, and unemployed	Stronger for Pieriga and Zemgale	+
LF 2			–	–		+	Weaker for self-employed	Stronger for Vidzeme, Weaker for Kurzeme	
LF 3					+		Stronger for retired, Weaker for at home	Weaker for Pieriga, Kurzeme, and Latgale	
LF 4	+			–			Stronger for unemployed	Stronger for Zemgale and Latgale	

Structural component



LF 2 Russian, highly educated, employed, from smaller households

LF 3 Retired, living with children

LF 4 Older, unemployed, from smaller households

LF 1 Younger, highly educated, wealthier, students, working at home, retired, unemployed

Discrete choice component

	Means (main effects)	Standard deviations	Interaction with LF 1	Interaction with LF 2	Interaction with LF 3	Interaction with LF 4
Status quo	-3.5095*** (0.3771)	2.9990*** (0.2917)	-4.3609*** (0.5484)	1.4822*** (0.2513)	-4.5935*** (0.4247)	-2.9025*** (0.3411)
Reduced number of native species:						
On small areas	0.2020 (0.1512)	0.2465** (0.1128)	-0.2576 (0.1458)	0.3273*** (0.1149)	0.3674*** (0.1180)	-0.6674*** (0.1232)
No such areas	-0.0627 (0.1614)	0.3285** (0.1277)	-0.1268 (0.1576)	0.4201*** (0.1328)	0.3600*** (0.1317)	-0.9398*** (0.1339)
Water quality for recreation:						
Moderate	1.4048*** (0.1802)	0.2284** (0.1150)	0.6000*** (0.1658)	1.2529*** (0.1243)	-0.3683** (0.1476)	-0.2648 (0.1797)
Good	1.5130*** (0.2228)	0.1685 (0.2123)	0.8892*** (0.2129)	1.7457*** (0.1542)	-0.5066*** (0.1869)	-0.5292** (0.2375)
New harmful alien species establishing:						
Rarely	0.5638*** (0.1510)	0.1821 (0.1242)	0.1182 (0.1327)	0.2914*** (0.0977)	0.2852*** (0.1090)	-0.1930 (0.1089)
Almost none	0.1276 (0.1486)	0.3720*** (0.0927)	0.3553*** (0.1267)	0.1935 (0.1002)	0.1065 (0.1120)	-0.3997*** (0.1152)
Cost	1.0611*** (0.0741)	1.4931*** (0.0607)	-2.8743*** (0.1371)	1.8234*** (0.0839)	0.8001*** (0.0490)	2.2912*** (0.1239)
			Younger, highly educated, wealthier, students, working at home, retired, unemployed	Russian, highly educated, employed, from small households	Retired, living with children	Older, unemployed, from small households

Conclusions

- On average, Latvians are willing to pay for marine waters improvements.
- However, a substantial share of them reveals aversion towards **any** new policy.
- Latvian are willing to pay the most for improving the recreational water quality (5 LVL per year), and much less for avoiding loss in marine biodiversity and limiting new occurrences of invasive alien species (0.5 LVL per year).
- Hardly any sensitivity to scope.
- The economic effectiveness of reaching Good Ecological Status in coastal and marine waters of Latvia is doubtful.

Conclusions

- We find substantial preference heterogeneity among Latvians towards the environmental improvements.
- We are able to attribute much of this heterogeneity to socio-demographic differences.
- We identify four unobservable factors correlated with respondents' socio-demographics which affect the respondents' preferences towards the environmental improvements.
- Our approach of explaining the socio-demographic-related preference heterogeneity:
  - places no arbitrary assumptions on which socio-demographic variables to include,
  - simultaneously models the links between socio-demographics and factors unobservable from the modeler's perspective, and the links between these factors and respondents' preferences,
  - allows to limit the number of explanatory variables interacted with the choice attributes,
  - is more statistically efficient than the commonly used approaches.
- Accounting for heterogeneity is important for improving the model fit and obtaining more useful value estimates for policy formation.

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