

Modelling Deprivation of the 50-plus Population of the Czech Republic Based on the Share Survey

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Abstract

In the paper, two composite indicators – the indices of material and social deprivation – are analyzed based on the Survey of Health, Ageing and Retirement in Europe exploring the population aged 50 and over. A finite normal mixture model for the social deprivation index and a finite mixture of Bernoulli and normal distributions are used to model the distribution of the indices of deprivation for the Czech Republic in 2013. Applying a logistic regression model, the parameter of Bernoulli distribution is supposed to be dependent on explanatory variables. In terms of material deprivation, the situation in the Czech Republic is comparable to other European countries, the social deprivation index, showing, however, higher values.

Keywords

Material deprivation, social deprivation, composite indicators, normal mixed model, logistic regression

JEL code

C21, I31

INTRODUCTION

Improving the quality of life of the population and reducing deprivation and social exclusion are the ambitious goals of the European Union (EU) and other developed countries. Unfortunately, we are not able to accurately measure these serious issues so that they can be subjected to quantitative analysis. In order to address this complex problem, it is important to quantify subjectively and/or emotionally perceived experience, such as life satisfaction and quality, or material and social deprivation (Bellani and D'Ambrosio, 2011). For this purpose, we use either questionnaires that ask directly about respondents' subjective feelings, or composite indicators describing a given phenomenon by means of objective variables rather than subjective judgements. Usually, the result of such an effort is a measurement scale, composite indicator or index. More items from different areas of interest are included and the composite indicator is the result of weighting procedure. The result depends on both inputs – the choice of questions and the weights. There exists a relatively large spectrum of indicators focusing on different populations, areas of interest and data sources. Moreover, there is no widely accepted measure of the quality of life or deprivation of different

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type or origin. A potential danger when applying and interpreting the above mentioned indicators consists in confusing them with the underlying phenomenon itself. They are just useful constructs, descriptions or quantifiers, reflecting reality, not copying it nor being identical.

As for material deprivation, there are more composite indicators that include other characteristics than just income, allowing to reliably reflect the situation in households. The study covers a sample of the population aged 50 and above. For the targeted group (the elderly population above 50 in particular), social exclusion and isolation along with material deprivation pose a real problem worth critical attention. The indices analyzed in this paper are adapted to the target population.

The aim of the present research is to describe and model deprivation indices for the Czech Republic included in the fifth wave of the Survey of Health, Ageing and Retirement in Europe (SHARE) conducted in 2013, comparing outputs to other European countries.

1 LITERATURE SURVEY

The investigated indices refer to older populations. Due to aging of the European population, general criteria and benchmarks need to be modified, putting more emphasis, for example, on health and retirement, highlighting both negative (deprivation or other disadvantage) and positive (life activity and satisfaction) socio-economic, cultural and psychological factors.

The United Nations Economic Commission for Europe uses the Active Ageing Index (AAI, 2018) as a tool to measure the untapped potential of older people for active and healthy aging worldwide. It monitors and compares the levels of independent living of the elderly, their participation in paid employment and social activities as well as the ability to actively age.

In the SHARE survey, many questions concerning the social and material situation or quality of life are usually asked. The life satisfaction variable CASP (CASP19, 2018), for example, was designed to capture the impact of factors that affect the quality of life of old people. The general scale consists of four sub-scales whose initial letters make up the abbreviation CASP, namely Control, Autonomy, Self-Realization and Pleasure. The CASP values are positive integers in the range from 12 to 48; see Hyde (2003) and CASP19 (2018).

Loneliness and isolation seem to accompany aging of many people. A 20-item scale – the revised UCLA Loneliness Scale – was developed to measure such feelings on an integer scale of 3 (not lonely) to 9 (very lonely) (Russell et al., 1978, 1980). As part of the SHARE survey, this scale was used in the present paper to be compared to the analyzed indices, especially that of social deprivation.

The Indices of Deprivation (ID) provide a set of relative deprivation measures grouped into seven domains for small areas (Lower-layer Super Output Areas) across England for each year (last one 2015). The index is based on the principle of distinct dimensions of deprivation which can be recognized and measured separately, and then are combined into a single complex measure – the overall Index of Multiple Deprivation – using the following weights Income Deprivation (22.5%), Employment Deprivation (22.5%), Education, Skills and Training Deprivation (13.5%), Health Deprivation and Disability (13.5%), Crime (9.3%), Barriers to Housing and Services (9.3%) and Living Environment Deprivation (9.3%) (Ralston, 2014).

The material deprivation index is regularly published by the Czech Statistical Office for the Czech Republic (CZSO, 2018) and by Eurostat for the whole European Union (EUROSTAT, 2018). According to the standard procedure, households that meet three or four out of nine selected material indicator criteria are marked as deprived. In the Czech Republic in 2013, age groups of 50–64 and 65+ had 15.1 and 16.6 percent of deprived households, respectively, satisfying three such criteria items, and 6.6 and 5.3 percent, respectively, meeting four of them. In terms of composite indicators (Saisana et al., 2005), constant weights (equal to 1/9) are used, the indicator equaling the relative frequency of positive items with the deprivation threshold set at $3/9 = 0.33$ or $4/9 = 0.44$.

The Scottish index of multiple deprivation (in its present 2016 form – SIMD 16) is applied by Scottish local authorities and central government in the most needy areas. The index includes the following domains: current income, employment, health, education, skills and training, housing, geographic access and crime (Ralston, 2014).

If we compare criterion domains used in the above-mentioned scales and analyzed indices (Tables 1 and 2), many common features can be identified.

2 METHODOLOGY

When employing statistical procedures in insurance, zero-inflated models and a mixture of Bernoulli and Poisson distributions are commonly used (Dalrymple et al., 2003) to model the number of insurance claims. In the present study, we apply similar approach to material deprivation.

In the analyzed data set, there are too many zeros for modelling continuous distributions. Therefore, in our model of material deprivation index Y_{mat} , we combine the Dirac measure (discrete part of $Y_{mat} = 0$) with a mixture of normal densities (for positive values of $Y_{mat} > 0$). Let $\pi_0(\mathbf{x}) = P(Y_{mat} = 0|\mathbf{x})$ denote the probability of zero deprivation, given the vector of $m \geq 1$ explanatory variables $\mathbf{x} = (x_1, x_2, \dots, x_m)'$. The logistic regression model is applied in the form:

$$\text{logit}(P(Y_{mat} = 0|\mathbf{x})) = \text{logit}(\pi_0(\mathbf{x})) = \beta_0 + \beta_1x_1 + \beta_2x_2 + \dots + \beta_mx_m,$$

where $\beta = (\beta_0, \beta_1, \dots, \beta_m)'$ is an $(m + 1)$ -dimensional vector of unknown regression parameters. Using this notation, the normal mixture model with K_{mat} components is given by:

$$f_{mat}(y_{mat}|\mathbf{x}) = \pi_0(\mathbf{x}) + (1 - \pi_0(\mathbf{x})) \sum_{j=1}^{K_{mat}} \pi_j f_{j, mat}(y_{mat}), \tag{1}$$

where $0 \leq \pi_j \leq 1, j = 1, 2, \dots, K_{mat}, \sum_{j=1}^{K_{mat}} \pi_j = 1$ and $f_{j, mat}, j = 1, 2, \dots, K_{mat}$ are normal component densities specified by the component parameters (μ_j, σ_j^2) . In the model, there are $(m + 1)$ logistic regression parameters, $2K_{mat}$ component parameters and $K_{mat} - 1$ component probabilities, which makes a total of $m + 3K_{mat}$ unknown parameters.

For the social deprivation index Y_{soc} we use the normal mixture model with density f_{soc} given by:

$$f_{soc}(y_{soc}) = \sum_{j=1}^{K_{soc}} \pi_j f_{j, soc}(y_{soc}), \tag{2}$$

where K_{soc} is the number of components, $0 \leq \pi_j \leq 1, j = 1, 2, \dots, K_{soc}, \sum_{j=1}^{K_{soc}} \pi_j = 1$ and $f_{j, soc}, j = 1, 2, \dots, K_{soc}$ denoting normal component densities. In the model, we have $2K_{soc}$ component parameters and $K_{soc} - 1$ component probabilities. It means $3K_{soc} - 1$ unknown parameters altogether.

There are no exact rules for determining the number of components. Based on the histogram, we use two components to be included in the social deprivation index. For the material deprivation index, we took the AIC criterion along with the numerical stability of the solution into account. From this point of view, the choice of three components is an acceptable compromise.

For all calculations, statistical computing R software (R Core Team, 2013) was used. In order to obtain parameter estimates, the mixtool package (Benaglia et al., 2009) was applied. Maximum likelihood estimates were evaluated, bootstrap being used (1 000 replications drawn from the data) to estimate the standard deviations. GLM function with a binomial link function was employed to estimate a logistic regression model. ANOVA was applied to test the significance of explanatory variables.

In the SHARE survey, the weights of the individual data are provided for both the cross-section and longitudinal origin. In the analysis of deprivation, cross-section weights for the fifth wave of the survey can be included.

3 RESULTS

3.1 SHARE database and indices of deprivation

The Survey of Health, Ageing, and Retirement in Europe (SHARE, 2018; Börsch-Supan, 2016) is a multidisciplinary, cross-national panel database of microdata of the European population aged over 50. Currently, data from six waves (between 2004 and 2015) are available, the module of deprivation (based on Adena et al., 2015) was included only in the fifth wave in 2013. The survey in the 5th wave took place in 14 European countries and Israel (IL) – apart from the Czech Republic (CZ), also in Austria (AT), Belgium (BE), Denmark (DK), Estonia (EE), France (FR), Germany (DE), Italy (IT), Luxembourg (LU), the Netherlands (NL), Slovenia (SI), Spain (ES), Sweden (SE) and Switzerland (CH).

Values of the two composite indicators for social and material deprivation from the above-mentioned module are used to model the distribution of both indices for the Czech Republic in 2013. The index of material deprivation is an aggregate measure of material conditions of Europeans aged over 50 years, comprising a set of 11 criterion items that refer to two broad domains: the inability to meet basic needs and financial difficulties (Table 1). The index includes only the information based on the situation of households, its value being equal for all members of the household. The index of social deprivation utilizes 15 survey questions representing a social dimension (Table 2), combining information on items related to participation in everyday life, social activities and the quality of the neighborhood; 8 criteria apply to households, 7 to individuals (Table 2, items 1, 5–11 and 2–4, 12–15, respectively).

Alternative answers yes (in case of problems) or no (if there are no problems) are weighted to the composite indices. Both indicators are transformed into a <0, 1> scale from none (0) to the highest (1) degree of deprivation.

Both indicators can be used together to identify Europeans suffering from both material and social deprivation, this joint index diagnosing the so-called severe deprivation. In the SHARE project, the threshold for material or social deprivation is set for the lower quartile of all data (across the European

Table 1 Material deprivation index criteria

- 1 Your household does not eat meat, fish or chicken more often than three times per week because you cannot afford it.
 - 2 Your household does not eat fruits or vegetables more often than three times per week because you cannot afford to eat it.
 - 3 Can your household afford to regularly buy necessary groceries and household supplies?
 - 4 Could your household afford to go for a week-long holiday away from home at least once a year?
 - 5 Could your household afford to pay an unexpected expense without borrowing any money?
-
- In the last twelve months, to help you keep your living costs down, have you
- 6 continued wearing clothing that was worn out because you could not afford replacement?
 - 7 continued wearing shoes that were worn out because you could not afford replacement?
 - 8 put up with feeling cold to save heating costs?
 - 9 gone without or not replaced glasses you needed because you could not afford new ones?
 - 10 postponed visits to the dentist?
-
- 11 Was there a time in the past 12 months when you needed to see a doctor but could not because of the cost?

Source: SHARE Release Guide 6.0.0 (2018)

population) to indicate the upper limit of 25 percent of the lowest values. These values for material and social deprivation are, 0.220 and 0.224, respectively. They both are lower than country-specific values for the Czech Republic, namely 0.261 and 0.375. The data for the Czech Republic show that material and social thresholds were exceeded by 26 (0.7) and more than 50 (0.7) percent of respondents, respectively. Severe deprivation occurs if people are deprived both materially and socially. In the whole data set, 11 percent of severely deprived respondents were identified, the relative frequency in the Czech Republic being only 4.6 percent.

Table 2 Social deprivation index criteria

- 1 Less than one room per person in the household
- 2 Poor reading or writing skills
- 3 Poor computer skills or never used a computer
- 4 Not feeling part of the local area
- 5 Vandalism in the local area
- 6 Local area not clean
- 7 No helpful people in the local area
- 8 Difficult access to the bank
- 9 Difficult access to grocery shop
- 10 Difficult access to a pharmacy
- 11 Waiting too long to see a doctor
- 12 Not attending any course in the past 12 months
- 13 Not taking part in any organization in the past 12 months
- 14 People cannot be trusted
- 15 Feeling left out of things

Source: SHARE Release Guide 6.0.0 (2018)

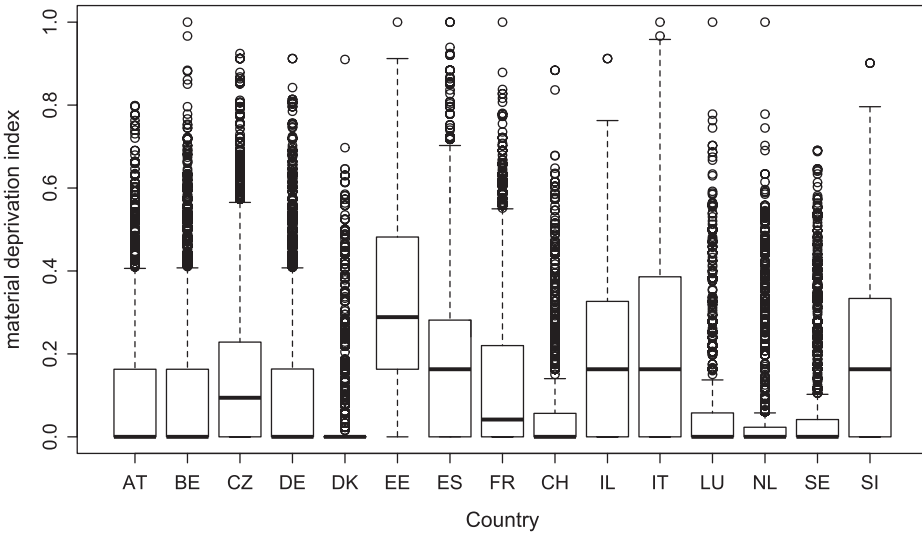
3.2 Deprivation statistics – the European Union

The empirical distribution of sample values is highly country-specific. Box plots for material and deprivation indices are shown in Figures 1 and 2, respectively. For material deprivation, median values are equal to zero, more than half of Austrian, Belgian, Danish, Swiss, Luxembourg, Dutch and Swedish respondents reporting no deprivation. The highest median is reported by Estonia followed by a group of countries with similar median values (Spain, Italy, Slovenia and Israel).

Social deprivation index outcomes are different, all lower quartiles being positive. The lowest and highest median values were recorded in Denmark and the Czech Republic, respectively.

It is possible to compare the analyzed indices to CASP and UCLA Loneliness scales. There is a relatively high negative correlation between CASP and the indices, respectively, -0.404 and -0.559 for social and material deprivation. Dependence between the loneliness variable and the analyzed indices, on the other hand, is expected to be relatively high, Spearman's correlation coefficient (due

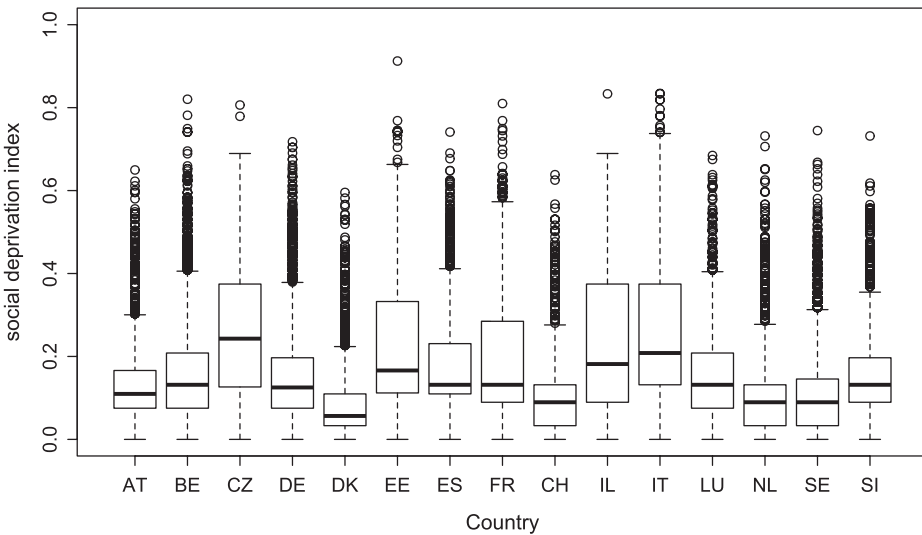
Figure 1 Comparison of distributions of the material index in analyzed countries



Source: Own computations

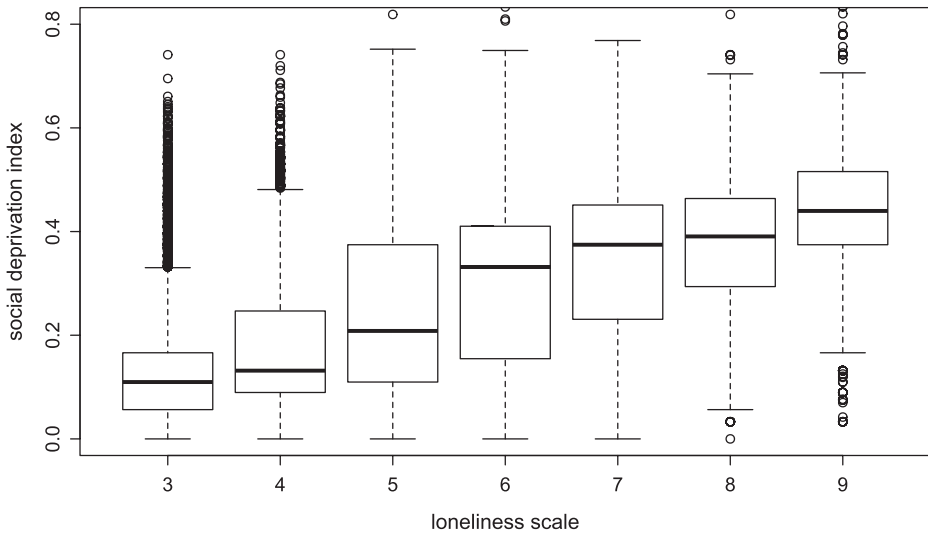
to the discrete distributions) equaling 0.378 and 0.175 for social and material deprivation, respectively. In Figure 3, the nonlinear relationship between the loneliness scale and the social index is obvious. The focus of both the above indicators is similar, while the areas of the index analyzed in this study are much broader.

Figure 2 Comparison of distributions of the social index in analyzed countries



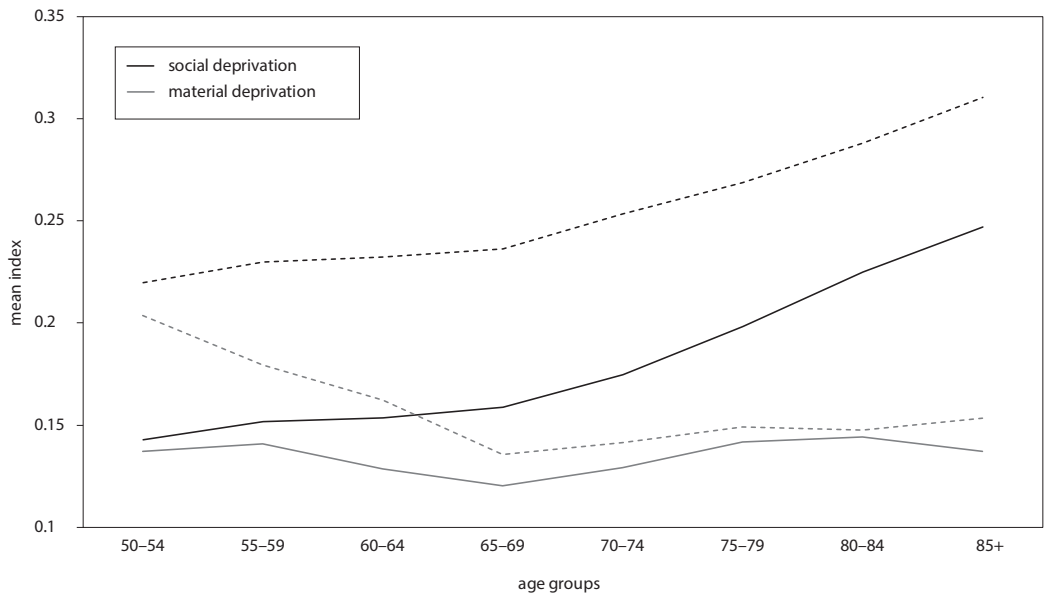
Source: Own computations

Figure 3 Comparison of loneliness scale and social deprivation index

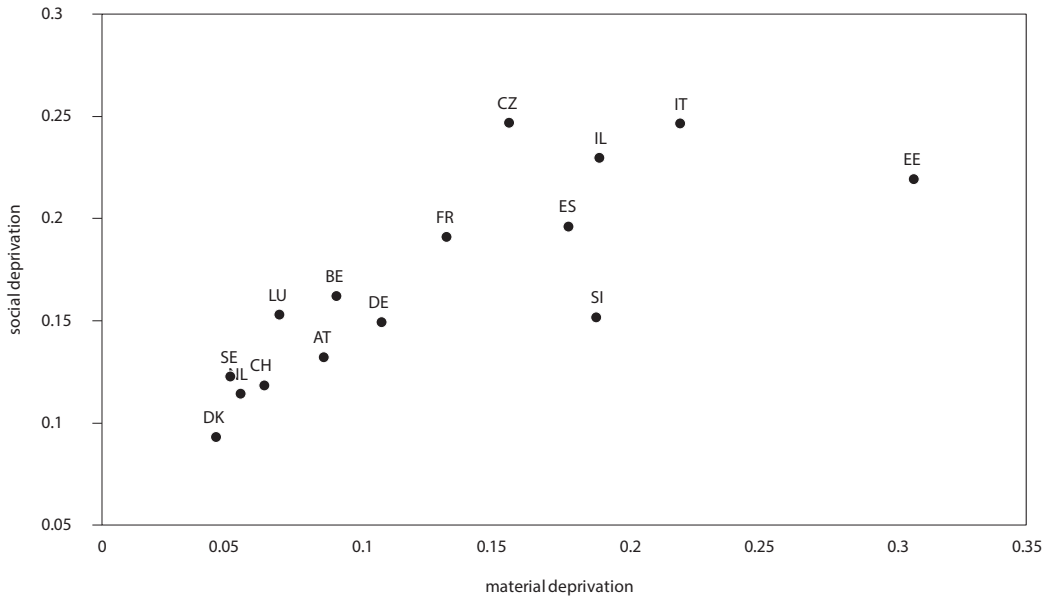


Source: Own computations

Figure 4 Mean indices for the EU (solid lines) and the Czech Republic (dashed lines)



Source: Own computations

Figure 5 Mean indices for European countries

Source: Own computations

Thanks to European welfare states' care for aging populations, the dependence of both indices on age is rather weak, the mean material deprivation index not rising with increasing age. Figure 4 displays data for all countries and for the Czech Republic, grouping respondents into five-year age groups. For the Czech Republic, almost the highest value of mean material deprivation was recorded in the group of active people between 50 and 60 years of age – obviously because of the problems these people face in the labor market – the mean apparently being independent of time. The social deprivation index, on the other hand, signals deterioration in living conditions, its values clearly increasing with age.

Spearman's coefficient of correlation between both indices is equal to 0.39, in the Czech Republic, however, we obtain only 0.22. Both values of coefficient are highly statistically significant because of the research sample size. Mean indices for all countries are given in Figure 5. In the bottom left corner of the chart are the "old" EU members (Denmark, the Netherlands, Sweden, Luxemburg, Austria, Belgium, Germany) and Switzerland. Another, less homogenous group of countries (the worse-off ones) consists of the Czech Republic, Italy, Spain, Slovenia and Israel. France ranks between both groups, Estonia, due to its high material deprivation (Figure 1), being an outlier in the set of the countries analyzed.

3.3 Deprivation statistics – the Czech Republic

In this section, we will assess the situation in the Czech Republic. From 5 646 fifth-wave survey respondents, we took those aged 50 and above with information of both types of deprivation. We obtained $n = 3\,954$ respondents with the mean age of 67.8 years (standard deviation = 8.7). The sample includes 2 289 women (57.6 %) and 1 685 men (42.4 %) with age means of 67.5 (8.8) and 68.2 (8.6), respectively.

Table 3 compares the age structure of the 2013 population in the Czech Republic (CZSO, 2018) with that of the research sample data on the 50-plus population divided into labor-active and inactive groups, 50–64 and 56+ years of age, respectively.

Table 3 Comparison of CR and research sample population (2013)

group	50+		50-64		65+	
	population	share (%)	population	share	1 980	2003
population	3 885 926	37.0	2 089 667	53.4	1 796 259	46.3
males	1 762 591	34.1	1 024 944	58.1	737 647	41.9
females	2 123 335	39.7	1 064 723	50.0	1 058 612	50.0
males / females (%)	45/55		49/51		41/59	
sample	3 974		1 542		2 432	
males	1 685		617		1 068	
females	2 289		925		1 364	
males / females (%)	42/58		40/60		44/56	

Source: CZSO, own computations

Table 4 Descriptive statistics of analyzed indices (SD = standard deviation, lq = lower quartile, uq = upper quartile)

Index	Mean	Median	SD	lq	uq
y_{mat}	0.159	0.114	0.186	0.000	0.261
$y_{mat} > 0$	0.267	0.220	0.171	0.163	0.383
y_{soc}	0.248	0.243	0.144	0.126	0.375

Source: Own computations

Descriptive statistics of the sample are presented in Table 4. 1 640 respondents show a zero value of the material deprivation index, indicating no problem in any of the areas studied. The table therefore shows the frequency of zeros, along with all numerical characteristics and separate positive values. In terms of social deprivation, however, only 25 observations are equal to zero.

In the logistic regression model for the material deprivation we use three explanatory variables: gender, household size and NUTS3 regions of domicile (the latter being of particular importance in the Czech Republic). The reference combination of explanatory variables consists of a man living in a two-person household in the Central Bohemian Region. The age variable, both continuous and discrete, was excluded from the research due to its low explanatory power. In Table 5, the estimated parameters are given along with standard deviations, exponential transformations to odds and p-values for the test of zero parameters. All three explanatory variables (gender, household size, domicile) are statistically significant in the model (the ANOVA table not presented herein).

The components in the mixture model (1) with $K_{mat} = 3$ are artificial as the component membership is not observable. Three centers 0.153, 0.372 and 0.495 were identified. They might be interpreted as the component of low deprivation and medium deprivation. The third component (21% of the continuous part of the distribution) with the highest standard error includes those with relatively high deprivation to describe a tail of the material index distribution. The empirical distribution of the continuous part

of the material deprivation index has two local modes, the selected three normal component model allowing for modelling a relatively high positive skewness.

All weights (given in Table 6) should be multiplied by the probability complementary to the $\hat{\pi}_0(\mathbf{x})$ where the vector of explanatory variables \mathbf{x} depends on a particular respondent. We performed 1 000 bootstrap iterations (using *mixtools* package (Benaglia et al., 2009)) in order to estimate standard errors of the estimated parameters.

In the case of the social deprivation index, two subgroups (of low and high deprivation levels) were identified. The levels of deprivation in the mixture components are estimated to reach 0.112 and 0.367, respectively. 98 percent for the low deprivation component and 96 percent of the high deprivation component are below and above the European social deprivation limit 0.224, respectively. The European bandwidth 0.224 well distinguishes both components, the fit corresponds to the empirical frequencies.

Table 5 Logistic regression model results

Coefficients	$\hat{\beta}$	$S_{\hat{\beta}}$	$\exp(\hat{\beta})$	p -value
intercept	0.156	0.115		0.176
gender female	-0.202	0.069	0.816	0.003
hh size 1	-0.403	0.087	0.668	$<10^{-6}$
hh size 3	-0.236	0.105	0.789	0.025
hh size 3+	-0.177	0.132	0.837	0.181
nuts3 Hradec Kralove	-0.560	0.148	0.570	$<10^{-3}$
nuts3 South Bohemian	-0.099	0.161	0.905	0.539
nuts3 Zlin	-0.863	0.163	0.421	$<10^{-5}$
nuts3 Karlovy Vary	-0.152	0.264	0.858	0.564
nuts3 Liberec	0.342	0.228	1.408	0.134
nuts3 Moravian-Silesian	-0.386	0.135	0.679	0.004
nuts3 Olomouc	0.157	0.187	1.170	0.402
nuts3 Pardubice	-0.573	0.210	0.563	0.006
nuts3 Plzen	-0.209	0.183	0.810	0.253
nuts3 Prague	0.075	0.148	1.078	0.609
nuts3 South Moravian	0.055	0.152	1.056	0.718
nuts3 Usti nad Labem	-0.568	0.159	0.566	$<10^{-3}$
nuts3 Vysocina	-0.492	0.193	0.610	0.011

Source: Own computations

Table 6 Estimates of component distribution parameters for both mixture models; point estimate (1st row) and standard deviation (precision, 2nd row)

Material deprivation								
Component 1			Component 2			Component 3		
π_1	μ_1	σ_1	π_2	μ_2	σ_2	π_3	μ_3	σ_3
0.604	0.153	0.068	0.213	0.372	0.070	0.183	0.495	0.164
0.024	0.003	0.002	0.057	0.008	0.012	0.056	0.060	0.022
Social deprivation								
π_1	μ_1	σ_1	π_2	μ_2	σ_2			
0.472	0.112	0.050	0.527	0.367	0.079			
0.008	0.001	0.001	0.008	0.002	0.001			

Source: Own computations

CONCLUSION

In the text, two composite indicators of material and social deprivation for the Czech population aged above 50 based on the SHARE survey are analyzed. The indices of material deprivation published periodically by the Czech Statistical Office contain also results for 50–64 and 65 and above age groups. They are consistent with those based on the SHARE panel data, given the possible comparisons. In the SHARE survey, however, not all questions asked to form the CZSO material deprivation index are included, thus it is not possible to compare both approaches on the level of individual values.

All conclusions are based on the particular composite indicators used in the analysis. The interpretation should be limited to them and their ability to describe deprivation in the population of elderly inhabitants of the EU.

For the Czech Republic, empirical distributions of the two indices are very different. In terms of social deprivation, the distribution is bimodal and the mixture of the two normal components is well applicable. The model identifies two clearly distinct (artificial) subgroups. The material index acquires zero value for over 40 percent of respondents. Therefore, the mixture of one Dirac measure (its parameter being estimated by logistic regression) and three normal distributions was applied to model a discrete part and a continuous, highly positively skewed model.

The Czech Republic seems to be really non-homogenous with respect to the material deprivation index. This fact and the analysis of differences are in agreement with the well-known diversity of region with respect to the quality of life and economic problems.

In terms of material deprivation, the Czech Republic and other European countries are comparable. Values of the social deprivation index, on the other hand, are higher in the Czech Republic, the mean approximately equaling the upper quartile in other European countries. The growth of social deprivation is common to all participating countries, but in the Czech Republic is even steeper (Figure 4). In Figure 5, the position of the Czech Republic in the participating countries is shown. The mean value of a material index is higher than those in a cluster of “old” European countries, but it is lower than for Spain, Italy, Israel or Slovenia and Estonia (see also Figure 1 for medians or quartiles). The median of the deprivation index is the highest from all counties in the survey (Figure 2). The mean for the deprivation index is comparable to the worst values of Estonia, Italy and Israel. It follows, that the problem of social deprivation of elderly population seems to be more serious in the Czech Republic than material deprivation.

The deprivation module being part of the fifth wave of the SHARE research (the only phase that used the questionnaire defining the deprivation indices), the results of the present study, unfortunately, cannot be compared to other stages of the panel survey, thus lacking the time dimension.

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