

### Decomposition of changes in structure and trends in employment in Czechia at NUTS 2 level



Małgorzata Markowska<sup>1\*</sup>

<sup>1</sup> Wrocław University of Economics, Komandorska 118/120, 53-345 Wrocław, Poland

\* Corresponding author: malgorzata.markowska@ue.wroc.pl

**Abstract:** Observing the structure of employment and its trends constitute the fundamental baseline to assess the successes and failures of both national and EU social and economic policies in terms of evaluating effectiveness of support to regions framed by both competitiveness and cohesion issues. The study presents the assessment of structural changes of employment in the system of traditional three economic sectors using the measure of structures dissimilarity along with its decomposition and trends. The Czech NUTS 2 level regions were used for the study and the analysed period covered the years 2008–2014. The *U* measure of changes in structure of components was applied on data on employment (NACE classification). The results confirmed the current trends of (i) tertiarization in old industrial regions; (ii) the increasing share of employment in the industrial sector shown by some rural regions, and (iii) the growing fragmentation of the spatial pattern of socio-economic development.

Key words: structural changes, economy sectors, employment, NUTS 2 level regions

### Highlights for public administration, management and planning:

• The indicator of changes in employment structure at a mesoregional level has been proposed and applied to the Czech Republic.

• The results obtained are confirmed by existing in-depth studies and therefore indicate suitability of the indicator for description of the dominant patterns in employment structure as a basis for cross-country comparative analyses.

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### 1. Introduction

The turbulent environment and permanent changes form modern economic reality. The change, i.e. the fact that something becomes different than it has been so far results in the modification of some part within the identified entity (Griffin 2005). The following basic dimensions of changes can be distinguished in the context of an economy functioning e.g. (Götz 2012): economic sector system (the share of sectors, branches or sections in generating e.g. GDP), macroeconomic production functions (labour, capital, technology), business prosperity, economic situation and economic climate. Observing changes, detecting their direction, the

assessment and measurement of trends constitute an interesting challenge for macro, mezzo and micro scale research. The existing situation in companies, public institutions and business environment, and also the everyday life practice of households have impact on the condition and functioning of regional economy which, indeed, remains closely connected with its macro-environment.

In many regions, as a result of either the dynamics or stagnation of business development, and also, e.g., of the policy carried out by the state (regional) authorities, the direction of structural changes varies, whereas the relevant

'vectors' sometimes keep changing each consecutive year.

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The study discusses the assessment of structural changes in terms of employment in the system of traditional three economic sectors using the measure suggested by Chomatowski & Sokołowski (1978) and its decomposition by means of U measure application. The Czech Republic NUTS 2 level regions were covered by the study in the period 2008-2014 - due to the availability of comparable data. In order to address the overall assessment of the share of three sectors in the regional employment structure changes, the following questions have to be answered:

- is the average share of the individual sectors different, i.e. statistically is the average U value significantly different from zero?
- is the significant trend observed in share of the observed sectors (i.e. statistically in U values)?
- what is the measure decomposition of structures' dissimilarity performed in accordance with U measure indications?

The study begins with brief theoretical consideration on economic structure and then moves on to the statistical methods used to decompose the trends in employment structure.

Particular attention is devoted to data availability and rationale for the use of NUTS 2 level in the study. Finally, results are presented while pointing out to the major trends in development of employment structure of Czech regions.

### 2. Economic structures

The concept of structure is used in the dual meaning. The first refers to the configuration of points in the multidimensional space, whereas the second one reflects the sequence of non-negative numbers adding up to 1. Our analysis covers the latter structures (Markowska & Sokołowski 2016). In our opinion this is the case when the structure presents a certain calculation effect possible only as a result of comparing a part with an entity. The existence of a non-trivial structure is determined by at least two structure components. The structure represents a 'shape' or a form. The actual, rather than just 'calculation' type of changes occur in the values of the structure components - representing 'size', 'quantity', 'value', 'magnitude'. Size changes do not have to alter the changes in shape if the changes of both components present the same proportions. Shape alterations, however, cannot occur without size changes (Penrose 1954; Walesiak 1983; Markowska & Sokołowski 2016, Markowska 2016).

Situation	Components (size: value, quantity)		Remarks		
(structure)	1	2			
Stabilization – no changes	no changes	no changes	-		
	increase	increase	Both by relatively the same size		
	decrease	decrease			
Higher share (first	increase	no changes	-		
component)	no changes	decrease	-		
	decrease	decrease	Higher for the second component		
	increase	increase	Higher for the first component		
Lower share (first	decrease	no changes	-		
component)	no changes	increase	-		
	decrease	decrease	Higher for the first component		
	increase	increase	Higher for the second component		

#### Table 1 – Changes in structure – hypothetical options (two components) (Source: Markowska 2016)



The assessment of structure changes can result in three options: stabilisation, increase and decrease of a particular component/components share in the entire structure. However, for each of them several variants are possible. Table 1 presents the simplest situation, i.e. for two structure components (e.g. structure by gender or ownership sectors).

For example, the effect of changes assessment, indicating structure stability, can result from the actual absence of changes in both components, but also the simultaneous increase (decrease) of both components by relatively the same value (Markowska 2016).

# **3.** The assessment of particular structure components' share and its changes

The study by Markowska & Sokołowski (2016) presents the measures of structure component share in its changes while comparing structures in two objects (or periods), both in terms of size and shape, which determine the component's share in changes. Therefore, if assumed that changes in structure are caused by size changes, the following measure of component *i* share in changes of structure can be suggested when

comparing structures in two objects / periods / 1 and 2 numbered moments (this numeration is primarily needed for time data). Our analysis covers changes observed in moment 2 against moment 1 (Markowska & Sokołowski 2016):

$$U_{i} = \frac{x_{2i} - x_{1i}}{\sum_{i=1}^{m} |x_{2i} - x_{1i}|}$$
(1)

where:

*i* – number of the structure component,

m – number of components in the structure,

 $x_{1i}$  – value of i-th structure component in the first moment (period),

 $x_{2i}$  – value of i-th structure component in the second moment (period).

The sum of *Ui* modules equals 1. The measure takes the value which defines the component share in the changes, as well as the sign informing about the occurring increase or decrease. This measure takes the structure 'size' effect into account.

Section code	Full name	Section code	Full name
А	Agriculture, Forestry and Fishing	К	Financial and Insurance Activities
В	Mining and Quarrying	L	Real Estate Activities
С	Manufacturing	М	Professional, Scientific and Technical Activities
D	Electricity, Gas, Steam and Air Conditioning Supply	Ν	Administrative and Support Service Activities
E	Water Supply; Sewerage, Waste Management and Remediation Activities	0	Public Administration and Defence; Compulsory Social Security
F	Construction	Р	Education
G	Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	R	Arts, Entertainment and Recreation
Н	Transportation and Storage	S	Other Service Activities
I	Accommodation and Food Service Activities	Т	Activities of Households as Employers; Undifferentiated Goods- and Services-Producing Activities of Households for Own Use
J	Information and Communication	U	Activities of Extraterritorial Organisations and Bodies

Table 2 – Statistical Classification of Economic Activities (Source: NACE Rev. 2, 2008)

#### Specification Year 2008 2009 2010 2011 2012 2013 2014 Total Česká republika 5002.2 4934.0 4884.9 4872.6 4890.0 4936.9 4974.0 Praha 645.6 660.1 656.9 635.2 647.7 649.4 648.0 Střední Čechy 599.3 601.5 602.1 610.3 623.7 626.2 633.5 Jihozápad 594.8 582.1 573.7 575.7 572.4 576.0 580.6 Severozápad 519.8 509.6 506.2 504.2 492.5 507.5 504.8 Severovýchod 709.8 690.4 690.3 688.3 684.2 689.5 703.1 Jihovýchod 784.8 770.7 770.1 766.9 769.7 792.8 795.9 579.4 554.1 556.5 Střední Morava 562.3 542.5 550.5 556.8 Moravskoslezsko 568.8 557.6 543.6 540.7 542.9 544.3 549.1 Agriculture, forestry and fishing Česká republika 158.8 153.8 151.2 145.6 149.2 149.6 136.7 Praha 0.7 2.7 2.2 1.8 2.5 2.2 1.5 Střední Čechy 18.2 17.4 18.1 17.4 17.6 15.7 16.2 Jihozápad 31.4 27.4 31.0 29.8 28.8 27.0 27.2 Severozápad 13.3 11.6 11.5 13.0 10.9 13.3 10.0 Severovýchod 26.2 25.2 23.2 26.0 27.0 25.8 24.8 Jihovýchod 38.5 35.8 32.8 28.5 31.5 33.0 31.1 Střední Morava 18.6 22.7 22.0 18.1 20.7 19.5 15.4 Moravskoslezsko 11.8 11.0 10.4 11.0 11.6 11.2 11.1 Industry Česká republika 2027.2 1903.1 1855.7 1873.4 1864.2 1851.9 1892.1 Praha 118.8 130.5 118.6 109.1 124.0 129.6 122.6 Střední Čechy 227.5 241.4 221.5 218.7 223.0 212.7 216.6 Jihozápad 254.7 238.8 233.2 243.4 239.2 242.7 243.0 Severozápad 223.6 216.7 216.5 215.3 205.6 200.7 198.4 Severovýchod 336.8 311.2 306.0 308.4 298.1 297.7 315.1 Jihovýchod 332.2 302.9 294.5 296.2 300.5 306.0 311.0 Střední Morava 265.0 239.9 233.7 246.5 243.1 257.9 242.8 Moravskoslezsko 254.7 235.6 235.9 230.6 219.7 231.8 227.6 Services Česká republika 2878.0 2945.2 2816.2 2877.1 2853.6 2876.6 2935.4 Praha 526.1 526.9 536.1 524.3 521.2 517.6 523.9 Střední Čechy 339.7 356.6 362.5 374.2 384.5 395.9 401.2 309.5 Jihozápad 308.7 315.9 302.5 304.4 306.3 310.4 Severozápad 282.9 281.3 278.2 275.9 276.0 290.8 299.1 Severovýchod 346.8 354.0 361.1 353.9 359.1 366.0 363.2 Jihovýchod 414.1 432.0 442.8 442.2 437.7 453.8 453.8 Střední Morava 295.8 299.7 286.8 285.9 293.0 291.8 283.2 Moravskoslezsko 302.3 311.0 301.4 293.8 300.7 313.4 310.4

#### Table 3 - Employment in Czech regions in the years 2008-2014 (thous.) (Based on: Eurostat, 2015)

## 4. Data – source and diversification in Czech regions

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There are several geographical levels in the European Union, at which statistical data are collected and aggregated, later to be used by official public statistics (e.g., Eurostat 2017). NUTS 2 level in the EU consists of more than 270 regions. At this level, the structural funds are allocated and comparative analyses are performed.

 Table 4 – The test of mean values against the constant reference value (U measure) – results

Variable	Mean	Standard	t		р
		deviation			
A1	0.0087	0.0698		0.3054	0.7723
11	0.1174	0.6776		0.4244	0.6889
S1	-0.0262	0.4122		-0.1599	0.8822
A2	-0.0337	0.0869		-0.9504	0.3855
12	-0.1538	0.3765		-1.0006	0.3630
S2	0.5659	0.1204		11.5120	0.0001
A3	-0.0549	0.1705		-0.7885	0.4661
13	-0.0719	0.5177		-0.3404	0.7474
S3	0.1496	0.4868		0.7529	0.4854
A4	-0.0336	0.2055		-0.4000	0.7057
14	-0.3629	0.3064		-2.9017	0.0337
S4	-0.0422	0.6102		-0.1695	0.8720
A5	-0.0119	0.1389		-0.2099	0.8421
15	-0.1297	0.5845		-0.5435	0.6102
S5	0.1873	0.4887		0.9387	0.3910
A6	-0.1328	0.3113		-1.0452	0.3438
16	0.1032	0.4909		0.5149	0.6286
S6	0.1783	0.4035		1.0825	0.3284
A7	-0.0878	0.2359		-0.9113	0.4039
17	-0.0286	0.5607		-0.1250	0.9054
S7	-0.1328	0.4295		-0.7573	0.4830
A8	-0.0002	0.0389		-0.0098	0.9926
18	-0.1260	0.5346		-0.5773	0.5888
S8	-0.0340	0.5626		-0.1480	0.8882

Symbols: 1/ sectors: A – agriculture, I – industry, S – services; 2/ regions: 1 – Praha, 2 – Střední Čechy, 3 – Jihozápad, 4 – Severozápad, 5 – Severovýchod, 6 – Jihovýchod, 7 – Střední Morava, 8 – Moravskoslezsko.

It was adopted in the study that the sector of agriculture covers section A, the sector of industry – sections B-E and F, and the sector of services – sections G-I, J, K, L, M-N, O-Q and R-U. The age group refers to people aged 15-64. Eurostat database constituted the source of

statistical data about employment in the particular activity sections in eight Czech NUTS 2 level regions (Regions 2011).

In 2008 the employment in the Czech Republic amounted to slightly more than 5 million, whereas in 2014 it presented the 99,4% level from 2000 – 4,97 million. In three Czech regions the comparison of employment number in the assessed period allows indicating that the level of employment increased in three regions: Střední Čechy (from 599,3 thous. to 633,5 thous.), Jihovýchod (from 754,8 thous. to 795,9 thous.), Praha (from 645,6 thous. to 648,0 thous.), and a decline in the other five regions – down to 96% of the situation from 2008 in Střední Morava.

The employment in Czech regions ranged from 519,8 thous. (Severozápad) to 784,8 thous. (Jihovýchod) in 2008 and from 507,5 thous. (Severozápad) to 795,9 thous. (Jihovýchod) in 2014 – see tab. 3. Further analyses of regional economic variability in Czechia can be found in (Hampl et al. 2002; Viturka 2005; Hampl 2005; 2007; Blažek 2005; Blažek & Csank 2007a, 2007b; Hlaváček 2013; Lux & Horváth 2017), or structural dynamics in (Sorm & Terrell 2000; Makhija 2003; Tsenkova 2006; Drahokoupil 2009; Koutský 2011; Blažek et al. 2011; Drucker & Feser 2012; Lux & Horváth 2017) and regional specialization in (Duranton & Puga 2000; Ženka & Čadil 2009; Kemeny & Storper 2012).

#### 5. Results and their interpretation

The below discussion presents the results of seeking answers to the above questions about the possibility of identifying major trends in U measure values and whether the average share (mean U value) is significantly different from zero. Test application for mean value (comparing it to zero) allowed determining whether within the analysed period any significant, focused change in the share of a given structure component was recorded. Due to the fact that data series have few values 0,10 was adopted as the significance level. Taking the obtained results into account a high variation of values should be indicated, not only in the sense of its level, but also its direction (sign).



Table 4 shows that the results indicating significance were obtained in two cases only (in terms of testing the relevant share in changes).

In Střední Čechy region the employment in services was gradually increasing and exerting the significant impact on the employment structure change. In Severozápad region an average decline in employment was recorded in the studied period and this phenomenon was of major influence on the changes in employment structure. In both cases the impact of "permanently oriented" nature was observed.

Testing trends in measure changes represents the next stage of the study. Estimation results of the trend models and significance testing of slope coefficients are presented in Table 5.

Table 5 - Coefficients of U measure trend for CzechNUTS 2 level regions

Region	Sector	Intercept	Slope coeff.	p value for the slope coeff.	
	А	0.0996	-0.0260	0.1243	
Praha	I	0.3053	-0.0540	0.7793	
	S	-0.0200	-0.0020	0.9878	
Ctřadní	А	0.0407	-0.0210	0.3615	
Čechy	I	-0.6040	0.1287	0.1716	
Cecity	S	0.5988	-0.0090	0.7827	
liha	Α	0.0014	-0.0160	0.7383	
JINO-	Ι	-0.5370	0.1328	0.3352	
zapau	S	-0.4300	0.1657	0.1740	
Course	А	0.0081	-0.0120	0.8382	
zánad	Ι	-0.5120	0.0426	0.6186	
zapau	S	-0.9410	0.2566	0.0633	
Severo- východ	Α	0.0138	-0.0070	0.8520	
	Ι	-0.9320	0.2292	0.0969	
	S	0.1757	0.0033	0.9810	
Jiho- východ	Α	-0.1730	0.0114	0.8972	
	Ι	-0.7480	0.2433	0.0078	
	S	0.3236	-0.0420	0.7149	
Střadní	Α	0.1286	-0.0620	0.3234	
Morava	Ι	-0.6410	0.1750	0.2235	
Worava	S	-0.0410	-0.0260	0.8287	
Moraysko	А	-0.0170	0.0049	0.6537	
slezsko	I	-0.6890	0.1610	0.2444	
5162510	S	-0.2260	0.0547	0.7298	

Symbols: 1/ sectors: A – agriculture, M – industry, S – services.

Figures 1 and 2 provide the illustration of results for the data presented in Table 5. The data on fig. 1 show that the significantly growing shares in structure changes, generated by changes in size referred to industry and services only.



## Fig. 1 – Correlation between the intercept and the slope coefficient of the U measure trend

Symbols: 1/ sectors: A – agriculture, I – industry, S – services; 2/ regions: 1 – Praha, 2 – Střední Čechy, 3 – Jihozápad, 4 – Severozápad, 5 – Severovýchod, 6 – Jihovýchod, 7 – Střední Morava, 8 – Moravskoslezsko.



Fig. 2 – Time series and significant trends Symbols: S4 (U4) – services in Severozápad, M5 (P5) –

industry in Severovýchod, M6 (P6) – industry in Jihovýchod.

Fig. 2 presents the selected trends of shares in structure changes – the significant ones. The illustrated trends show a growing tendency – the share were generally increasing, however, in the

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evaluated period they were also changing, showing ups and downs of the relevant values.

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The application of U measure allows identifying the share of particular sectors in the changes of employment structure. It should be kept in mind that the U measure itself does not inform about the changes approached as size. If e.g. 10+10+10 value structure is assumed, which changes into 20+20+20, then the shares in changes for every component remain 1/3 (since each of them went up by the same value, i.e. by 10). The change, however, refers to size rather than shape.

The measure of differentiation (dissimilarity) can be decomposed to the particular structure components by applying the following formula:

$$\mathbf{W}_{i} = \boldsymbol{W} \cdot \left| \boldsymbol{U}_{i} \right| \tag{2}$$

This measure shows the change in shape adjusted by the relative change in size. The application i.e. calculation of the measure (2) for changes in employment structure in the sectors of Czech regions, in the period 2008-2014, allowed determining measure decomposition for structures' dissimilarity (measuring these changes intensity) to be followed by trends estimation and their significance testing – see Table 6.



## Fig. 3 – Correlation diagram between the coefficients of trend equations - W<sub>i</sub> measure

Symbols: 1/ sectors: A – agriculture, I – industry, S – services; 2/ regions: 1 – Praha, 2 – Střední Čechy, 3 – Jihozápad, 4 – Severozápad, 5 – Severovýchod, 6 – Jihovýchod, 7 – Střední Morava, 8 – Moravskoslezsko. Fig. 3 presents the correlation diagram between the coefficients of the trend equations. The occurrence of a clear negative correlation between the intercept and the slope coefficient of the analysed trend can be observed. The regions and structure components, characterized by a high starting point in the share of structural changes were, almost always, reducing this share. The regions and components for which the trends presented in Table 6 were statistically significant are marked in red on the figure.

The above observations correspond to the conclusions resulting from Fig. 1.

Table 6 –	Coefficients	of W <sub>i</sub>	measure	trend	for	Czech
regions						

Region	Sector	Inter-	Slope	p value for
		cept	coeff.	the slope
				coen.
	А	0.00160	-0.00024	0.2323
Praha	I	0.01322	-0.00119	0.3882
	S	0.00362	0.00017	0.7940
C+žodní	А	0.00053	0.00002	0.7592
Čechy	I	0.00908	-0.00124	0.2622
Cechy	S	0.01225	-0.00160	0.1719
	А	0.00327	-0.00055	0.0178
Jihozápad	I	0.01281	-0.00218	0.0683
	S	0.00633	-0.00083	0.1389
Courses	А	-0.00004	0.00049	0.0460
Severo- západ	I	0.00316	0.00022	0.8448
zapau	S	-0.00220	0.00187	0.1403
Severo-	А	0.00137	-0.00008	0.5893
	I	0.01041	-0.00082	0.6809
vychou	S	0.00611	-0.00049	0.0783
Jihovýchod	А	0.00270	-0.00025	0.3757
	I	0.01470	-0.00260	0.1180
	S	0.01107	-0.00195	0.0471
C+žodní	А	0.00240	0.00001	0.9889
Morava	I	0.01506	-0.00174	0.4851
	S	0.00164	0.00058	0.4471
Moroveko	А	0.00067	-0.00007	0.2411
IVIUI dVSKO-	I	0.00957	-0.00060	0.7153
SIEZSKU	S	0.00628	0.00003	0.9760

Symbols: 1/ sectors: A – agriculture, I – industry, S – services.

The significant trends, however, are not grouped as it takes place in case of U measure, since not just the share in changes, but also the effect of this share is considered here, which results from



the overall structure transformations (rather than this particular component only).

### 6. Conclusions

The implementation of both intraregional and interregional policy in the turbulent and changing environment requires an ongoing observation along with flexible approach and adjustment to the occurring changes. In terms of structural changes in employment, the conclusions confirm the three basic trends: (a) the significance of tertiarization in old industrial regions in Czechia, and effect of changes in industry to exportoriented, low-value production (Ženka et al. 2015); (b) the increasing share of employment in the industrial sector shown by some rural regions (Hruška 2015 Ed.); and (c) the growing fragmentation of the spatial pattern of socioeconomic development (cf. Blažek & Netrdová 2012).

It seems that in case of the job market, apart from determining both unemployment and employment rate, presented in various perspectives (e.g. by gender or age), the identification of changes occurring in employment structure - both in terms of shape and scale - represents an indispensable process for e.g. an effective allocation of funds and the properly carried out educational policy.

The approach suggested in the presented article allows detecting basic structural trends, which turn out extensively helpful in the course of the decision making process and offer a valuable supporting tool in monitoring the changes which take place on the regional job market.

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