

Workforce Structural Shifts Effects by Sectors of Technical Advancement in Visegrad Group Regions

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Abstract

The study discusses problems of structural effects in workforce changes and the role of specialization in knowledge/technology intensive sectors. The subject of research covers workforce structure in sectors distinguished according to technological advancement, i.e. high-tech, mid-high, mid-low and low-tech industries as well as knowledge-intensive services, less knowledge-intensive services and other sectors. The analysis covers both, the level and structure of workforce. Shift-share analysis (SSA) constituted the research tool applied in analysing workforce number structural changes as one of the tools for investigating structural changes occurring in regional space in a given time range. SSA allows for analysing fluctuations in employment rate characteristic in a given region at the background of reference area (e.g. European Union), as well as their assessment in the context of the occurring structural and competitive changes. The scope of research covers the structure of workforce in NUTS 2 regions of the Visegrad Group countries in the period 2009-2012. The objective of the paper is to identify and assess structural effects of workforce changes in Visegrad Group regions and the classification of studied regions by workforce structure.

Key words: workforce structure, Visegrad Group Nuts 2 regions, *shift-share* analysis, high-tech sectors, knowledge-intensive services

JEL Classification: C10, J21, R11

1 Introduction

Currently, the major challenge faced by the European Union member states is the optimization of regional development potential in order to ensure:

- smart growth – based on knowledge and innovation,
- sustainable development – to support economy using the existing resources more efficiently, more environmentally friendly and in a more competitive manner,
- social inclusion oriented growth, focused on supporting high-employment economy, ensuring social and territorial cohesion (*A strategy for smart...*, 2010).

Smart growth, both sustainable and supporting social inclusion, means three mutually related priorities of the European Union development strategy *Europe 2020*. Therefore, the European regions wishing to meet this challenge have to take up intensive activities aimed at regional policy optimization and the development of effective regional growth strategies.

Economic structure is one of the crucial, endogenous factors responsible for the development of regional economy (Gorzelać, 2003, Chojnicki and Czyż, 2004, Molle and Cappelin, 1988). It can be either growth oriented or constitute a barrier for regional development. Therefore, one of the core assumptions underlying regional policy and also facilitating the implementation of *Europe 2020* priorities strategy should be the development of economic structure enhancing regional development.

The study presents the analysis of workforce sector structure as the reflection of regional economic structure. Today the significance of economy sectors, based on the implementation of knowledge and innovation, keeps growing. Therefore, the study analyses workforce structure in economy sectors distinguished in accordance with the intensity of research and development activities, also referred to as technological intensity, defined as the relation of expenditure on research and development to added value or total production value in the sector (*Science and technique* in 2007, 2009, Wojnicka, 2006, Zielińska-Głębocka, 2012). Such approach has the advantage of originality, since traditional research covers four crucial economy sectors including: farming, industry, market and non-market services (Aslesen and Isaksen, 2007, Bishop, 2008, Włodarczyk, 2011). Proper development of workforce structure, by technological intensity sectors, can support the implementation of priorities included in *Europe 2020* strategy.

The spatial range of conducted analyses was limited to NUTS 2 regions of Visegrad Group countries. The research time span covers the period 2009-2012. The objective of the study is to identify and assess the structural effects of workforce changes in the studied regions in order to distinguish the key sectors for regional development and also to classify the European regions in terms of aggregated structural effects.

The set objective was carried out using the classical Dunn's shift-share analysis and the dynamic recurrence model suggested by Barff and Knight (Barff and Knight, 1988, Esteban-Marquillas, 1972, Perloff, Dunn and others, 1960, Suchecki, 2010), allowing to identify positive and negative structural effects of workforce number changes in a region and to distinguish the key sectors responsible for employment growth.

2 Information Resources and Research Methods

Workforce structure, developed by Eurostat and OECD (*Science and technique* in 2007, 2009), constituted the background for the conducted analyses in the cross-section of the following research and development intensity sectors:

1. HMH (high and medium high-technology manufacturing),
2. LML (low and medium low-technology manufacturing),
3. KIS (knowledge-intensive services),
4. LKIS (less knowledge-intensive services),
5. OTHER (other sectors).

The economy sectors were distinguished based on NACE - the Statistical Classification of Economic Activities in the European Community of 1997, updated and amended in 2008.

The analysis covered 35 regions from Visegrad Group countries distinguished in accordance with NUTS 2 classification (The Nomenclature of Territorial Units for Statistics). The necessary statistical data were obtained from the Eurostat database.

A shift-share analysis is a research tool facilitating the identification of total workforce number changes rate and by sectors of R&D activities intensity in the reference area adapted as the area of 237 EU regions (the analysis does not include 35 EU regions due to statistical data unavailability). The time span of conducted research covers the period 2009-2012 (in accordance with NACE Rev. 2 of 2008 classification). The unavailability of data for 2008 referred to as many as 85 out of 282 EU regions.

In the course of the conducted research structural and geographic analysis of workforce was applied by R&D activities intensity in NUTS 2 regions of V4 countries using the classical Dunn's shift-share analysis (SSA) and the dynamic competitiveness model suggested by Barff and Knight. Recursive dynamics introduced by R.A. Barff and P.L. Knight III, consists in the realization of classical SSA method for each pair of subsequent period, to be followed by the aggregation of subsequent time effects.

The shift-share analysis of workforce number growth rate in NUTS 2 regions allows for:

1. the identification of individual structural effects of workforce number changes in the sectors distinguished in accordance with R&D activities intensity for the analysed regions;
2. the identification of key sectors for employment stimulation;
3. determining structural effect for each region and year – equal the weighted average of deviations between average growth rates in sectors and the EU growth rate (average growth rate in a sector is identical in all studied regions);
4. determining aggregated structural effects.

A structural effect informs that an average employment change rate can present interregional differences due to the occurring differences in workforce structure. Positive structural effect means that the workforce number change rate, in a particular region, was more favourable than in other EU regions constituting the reference area in terms of workforce sector structure type characteristic for a given region.

Structural effects were recursively determined for each pair of the analysed years and then aggregated in accordance with Barff-Knight concept.

The following research procedure was applied:

1. Comparing the workforce structure of V4 and EU28 countries, as well as determining interregional dispersion of Visegrad group countries in the period 2009-2012.
2. Identifying the effects of structural employment changes in 35 regions of Visegrad Group countries in the period 2009-2012 with regard to reference area defined as the regional space of the European Union member states.
3. Assessing the dependence occurring between structural effects of employment changes and workforce shares in sectors distinguished by technological intensity in the regions of V4 countries.
4. Classifying the studied NUTS 2 regions in terms of sector oriented workforce structures by applying cluster analysis in the period 2009-2012, using the following scheme (information review about the distance measures and classification methods is presented e.g. in the studies by Anderberg (1973), Hartigan (1975)):

- determining the diversification between the analysed regions using Euclidean distance square,
- hierarchical classification of regions using Ward's method,
- determining the number of classes based on basic classification results presented on a dendrogram and on a diagram of node distance against node stages,
- classifying regions using *k*-means method and characterizing the obtained classes.

3 Shift-share Analysis of Workforce in the Sectors Distinguished by R&D Activities Intensity in the Period 2009-2012

Workforce structure in NUTS 2 regions of Visegrad Group countries constitute the basis of conducted research. The validity assessment of analyses conducted at regional level was performed based on analysing the interregional diversification of the studied workforce structures in particular V4 countries. The interregional dispersion was assessed separately for each technological intensity sector and for outlier years of the studied period. Table 1 presents the values of adequate variation coefficients for workforce share variability in particular sectors.

Tab. 1 Interregional variation coefficients of workforce shares in sectors distinguished by technological intensity in the regions of V4 countries in 2009 and 2012 (%)

Sectors	Czech Republic		Hungary		Poland		Slovakia	
	2009	2012	2009	2012	2009	2012	2009	2012
HMH	35,7	32,5	47,4	48,2	37,0	36,6	41,6	32,2
LML	29,2	30,2	21,4	21,6	17,9	20,7	36,3	34,0
KIS	22,7	21,7	15,8	16,5	13,0	12,0	28,0	27,2
LKIS	9,7	10,8	10,8	14,1	7,4	9,0	9,9	6,0
OTHER	14,1	15,9	19,8	21,2	22,8	23,3	25,6	26,7

Source: author's compilation based on Eurostat database

As the analysis of tab. 1 shows all Visegrad Group countries were characterized by the largest interregional diversification of workforce shares occurring in high and medium high-technology manufacturing, featuring the lowest workforce share (from 4,8% in Poland up to 9,5% in the Czech Republic in 2009 and from 4,9% in Poland up to 10,5% in the Czech Republic in 2012), whereas the lowest one was recorded in the sector of less knowledge-intensive services, where workforce share was lower only from knowledge-intensive services and presented a relatively high level in all studied countries. The lowest workforce share in the sector of less knowledge-intensive services occurred in Poland in 2009 and 2012 amounting to 26,1% and 26,4% respectively, whereas the highest one was observed in Hungary – 30% in both compared years.

Picture 1 also presents the average workforce structure in the EU NUTS 2 regions. As one can notice, in 2009 and 2012 the average regional workforce share in high and medium high-technology manufacturing was higher than the average one in EU28 in all V4 countries, excluding Poland. In low and medium low-technology manufacturing, in both analysed years, the workforce share in all V4 countries was higher than the average for EU28 regions. An opposite situation was observed in knowledge-intensive services sector, where an average workforce share in EU28 regions (38% and 39,1%) was definitely higher than in V4 countries' regions. In case of

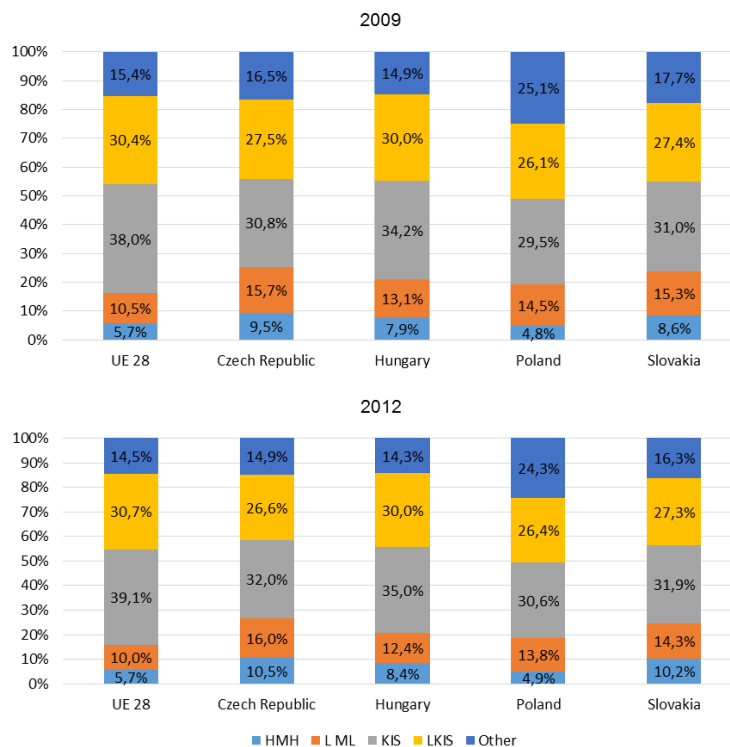
the so-called other sectors the EU28 workforce share was lower than the average one in V4 regions only in Hungary. Poland was characterized by the definitely highest workforce share in this sector (25,1% and 24,3% in 2009 and 2012 respectively).

The values of interregional variation coefficients in particular sectors (see tab. 1) allow for making the general conclusion that V4 countries are characterized by a significant diversification of workforce structure in V4 countries' sectors. Moreover, picture 1 illustrates that NUTS 2 regions of V4 countries are characterized by different structures and they are also different in relation to average workforce shares in EU28 regions.

Structural transformations are generally of an evolutionary nature, which can also be observed in case of workforce structures in technological intensity sectors. Workforce structures in V4 regions changed in the period 2009-2012, however, these changes were relatively small.

Picture 2 presents regional structural effects of workforce number changes occurring in V4 countries in the period 2009-2012 in relation year to year. Structural effects were determined using the classical shift-share analysis adopting the regional space of 28 European Union countries as reference area.

The conducted research indicates that the scope of structural effects variability regarding workforce number changes in the period 2009-2012 was similar in case of Czech, Hungarian and Slovak regions and was placed in the range from about - 0,5 to over 0,4. Czech regions were characterized by the significantly lower values of structural effects (from about -0,8 to almost 0,2). One can also observe that in all V4 countries' regions the highest values of structural effects occurred in the period 2011-2012, whereas the lowest ones in almost all Czech, Hungarian and Slovak regions in the period 2009-2010, i.e. at the beginning of the researched period.

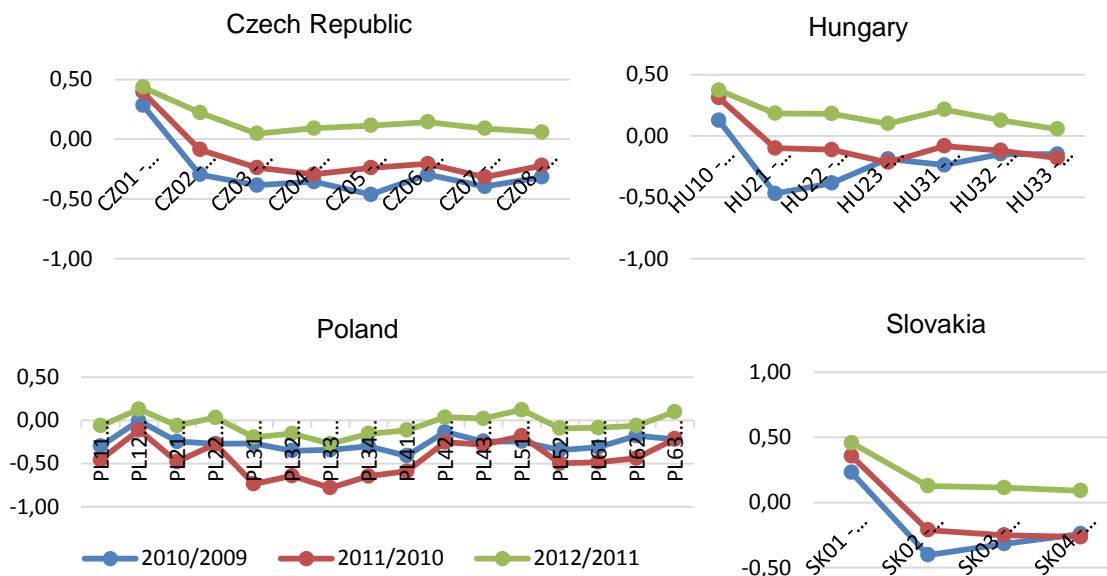


Picture 1 Average regional workforce structure in technological intensity sectors in EU28 and V4 countries

Source: author's compilation based on Eurostat database

Positive structural effects of workforce number changes inform that workforce structure has positive impact on these changes, since it turned out to be more development oriented than in other regions of the reference period, in this study regarded as NUTS 2 EU28 regions. The higher the positive values of structural effects the stronger the impact exerted by a particular employment structure on employment growth, comparing to other regions. By analogy, negative structural effects mean that the workforce structure of a given region inhibits employment development to a greater extent than in case of the other regions covered by the reference area and thus restrains the development of the entire economy in the region.

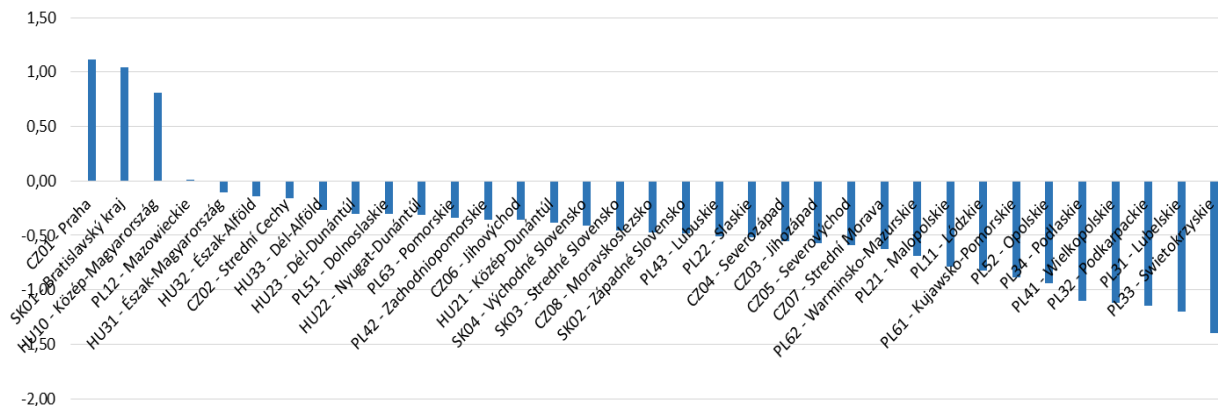
The period 2009-2012 is characterized by the global economic crisis and by the gradual improvement of economic situation in particular European countries and regions. Therefore, in the period 2011-2012 the majority of analysed regions recorded higher positive influence of structural factors on employment changes than during the deeper crisis. In previous years non-structural factors, referred to as competitive ones, had higher impact on employment changes (employment decline during the economic downturn).



Picture 2. The values of structural effects regarding workforce number changes in the regions of V4 countries

Source: author's compilation based on Eurostat database

Picture 3 presents aggregated structural effects of workforce number changes in 35 regions of V4 countries in the period 2009-2012.



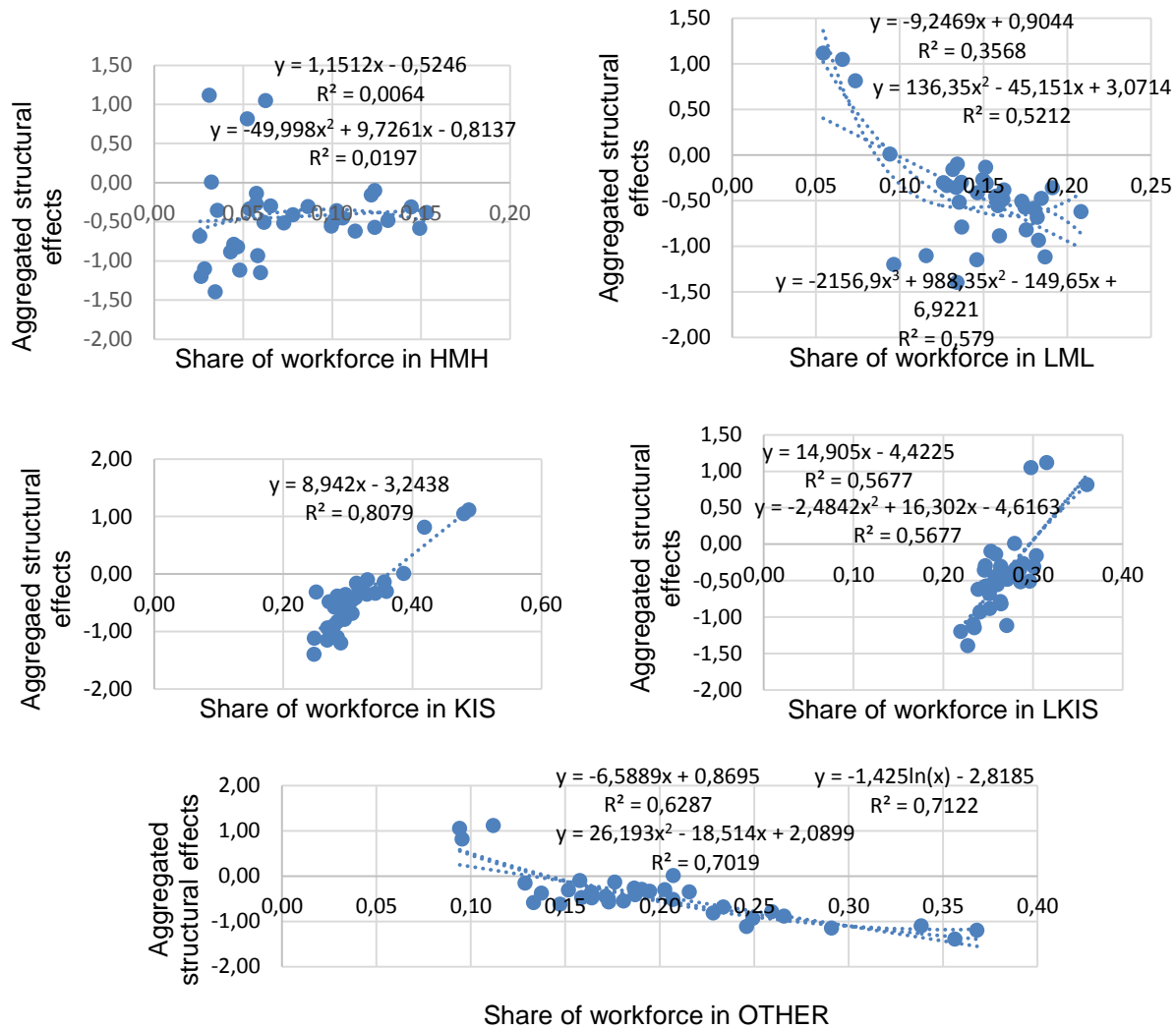
Picture 3 The values of aggregated structural effects of workforce number changes in a descending order in technological intensity sectors of V4 countries' regions

Source: author's compilation based on Eurostat database

Picture 3 shows that in the period 2009-2012 workforce structures in sectors distinguished by the intensity of R&D expenditure generated employment growth and thus were of development oriented nature only in case of the following regions: Czech Praha, Slovak Bratislavský kraj, Hungarian Közép-Magyarország and Polish Mazowieckie. The impact of workforce structure, which stimulated employment and economy development in the strongest way, occurred in the regions of Praha and Bratislavský kraj. In case of Mazowieckie region workforce structure had only an insignificant influence on enhancing employment growth in the region (the value of aggregated structural effect was 0,01). It is worth noticing that workforce structures which stimulated development were observed in metropolitan regions or these including metropolises in case of each V4 country. Ten out of 16 Polish regions were included among ten regions in which employment structure has the strongest inhibiting impact on economic development. Workforce structures responsible for generating the highest economic regression were characteristic for the following regions: Świętokrzyskie, Lubelskie and Podkarpackie (the values of aggregated structural effects for these regions are respectively: -1,4; -1,2; -1,15). An extensive regional diversification of aggregated structural changes in workforce number should be emphasized.

Picture 4 presents the dependencies between workforce shares in particular technological intensity sectors in 2012 and aggregated structural effects of employment changes in V4 countries' regions. Regression lines are shown on the correlation graphs and also the equations of functions approximating the analysed dependence along with determination coefficient values specifying their adjustment level to the dispersion of empirical points.

The conducted research shows that workforce share in high and medium high-technology manufacturing is not significantly correlated with aggregated structural effects values and thus does not play the role of the key sector responsible for regional development enhancement. It results, among others, from the definitely lowest share of this sector in the total number of workforce in the regions under analysis.



Picture 4. Aggregated structural effects vs. workforce share in sectors distinguished by R&D expenditure intensity in V4 countries' regions

Source: author's compilation based on Eurostat database

Workforce shares in knowledge-intensive services are most strongly positively correlated with structural effects, which means that this sector is of key importance for regional development stimulation. Another development oriented sector, even though slightly less significant, is the one representing less knowledge-intensive services. In case of low and medium low-technology manufacturing and the so-called other sectors a negative dependence between workforce share and structural effects of workforce changes was observed, however of stronger intensity in case of the so-called other sectors. It means that the key economy development inhibiting factor is an extensive workforce share in the so-called other sectors which cover: farming, hunting, forestry, fishing, mining, energy, gas, water production and supply, construction. The sectors are of non-development nature and thus their extensive expansion can restrain economic growth, which in crisis circumstances can hinder overcoming its effects.

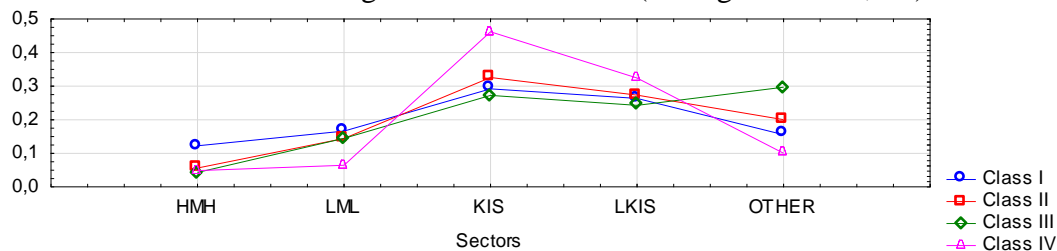
Table 2 presents the results of V4 countries' regional classification in terms of workforce structure in the analysed economy sectors. The classification allowed identifying the regions featuring structures either stimulating or inhibiting regional growth.

Tab. 2 The results of V4 countries' regional classification using *k*-means method regarding workforce sector structure in 2012

Classes	Country (% of regions): regions	Number of regions	The average share of workforce in sectors (in %)				
			HMH	LML	KIS	LKIS	OTHER
I	Czech Republic (87,5%): Strední Čechy, Jihozápad, Severozápad, Severovýchod, Jihovýchod, Strední Morava, Moravskoslezsko Hungary (42,9%): Közép-Dunántúl, Nyugat-Dunántúl, Észak-Magyarország Slovakia (50%): Západné Slovensko, Stredné Slovensko	12	12,3	16,6	29,2	26,3	15,6
II	Hungary (42,9%): Dél-Dunántúl, Észak-Alföld, Dél-Alföld Poland (50%): Łódzkie, Mazowieckie, Śląskie, Lubuskie, Zachodniopomorskie, Dolnośląskie, Warmińsko-Mazurskie, Pomorskie Slovakia (25%): Východné Slovensko	12	5,6	14,4	32,6	27,3	20,0
III	Poland (50%): Małopolskie, Lubelskie, Podkarpackie, Świętokrzyskie, Podlaskie, Wielkopolskie, Opolskie, Kujawsko-Pomorskie	8	4,3	14,5	27,3	24,3	29,7
IV	Czech Republic (12,5%): Praha Hungary (14,2%): Közép-Magyarország Slovakia (25%): Bratislavský kraj	3	4,9	6,5	46,2	32,4	10,0

Source: author's calculations based on Eurostat database using the statistical package STATISTICA 9 PL

Picture 5 presents average workforce shares in particular economy sectors in the distinguished regional classes presenting similar employment structures. Class IV, the least numerous one, covers the regions featuring growth stimulating workforce structures. This class includes 3 metropolitan regions: Praha, Közép-Magyarország and Bratislavský kraj, characterized by the highest workforce share in knowledge-intensive services (average value 46,2%).



Picture 4 Average workforce share in sectors distinguished by R&D expenditure intensity in 2012 in the obtained classes of V4 countries' regions

Source: author's calculations based on Eurostat database using the statistical package STATISTICA 9 PL

Class II includes the regions featuring workforce structures which inhibit growth. It covers 8 Polish regions characterized by the highest, average workforce share in the so-called other sectors amounting to 29,7%.

4 Conclusions

The conducted research, covering workforce structures in sectors distinguished by research and development activities intensity in NUTS 2 regions of Visegrad group countries in the period 2009-2012, using dynamic shift-share analysis, allowed to present the following conclusions:

1. In the analysed period V4 countries were characterized by the distinctive diversification of interregional workforce structure. The largest dispersion was observed in each analysed country with reference to workforce share in high and medium high-technology manufacturing, whereas the lowest one in the sector of less knowledge-intensive services.
2. In 2009 and 2012 the average regional workforce structure in Poland was most different from both, E28 and the other V4 area countries' employment structures. Polish regions were, on average, characterized by much higher workforce share in the so-called other sectors and lower in the sector of knowledge-intensive services.
3. Structural effects of workforce number changes were definitely most favourable in all regions of Visegrad group countries in 2011-2012, i.e. in the period of global economic crisis symptoms regression. It confirms the fact that the impact of workforce structure on employment changes was more intensive at that time.
4. Aggregated structural effects of employment changes in the period 2009-2012 presented definitely more favourable values for three metropolitan regions, such as: Praha, Bratislavský kraj and Közép-Magyarország. Workforce structures in these regions were most stimulating for employment development.
5. The analysis of dependence between aggregated structural effects and workforce share in particular technological intensity sectors indicates that knowledge-intensive services represent the most stimulating sector in terms of regional growth, whereas the so-called other economy sectors act as an inhibitor.
6. 4 classes of regions similar in workforce structure in 2012 were distinguished. Class IV covers 3 metropolitan regions featuring the most favourable aggregated structural effects. Knowledge-intensive services represent the dominating sector in this class of regions, whereas other sectors were observed as the most marginalized in comparison to the remaining classes. This type of workforce structure stimulates regional growth. Class III covered only Polish regions with workforce structures having an inhibiting effect on regional growth. In these regions aggregated structural effects were the least favourable while definitely the largest workforce share occurred in the so-called other sectors.

The obtained research results allow to identify the desirable directions of workforce structure changes in particular regions of Visegrad Group countries. Analogous regional and structural research regarding workforce number by sectors of R&D expenditure intensity should be continued, further statistical information should be collected and enriched by comparative analyses of structural, competitive and allocation effects changes in particular sub-periods and conducted by the use of dynamic shift-share analysis.

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