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Smart Specialization of Workforce Structure in the European Union Countries – Dynamic Analysis Applying Shift-Share Analysis Method[1]

Abstract

The objective of the hereby paper is to present dynamic analysis and assessment of workforce structure in the European Union countries based on structural and geographical shift-share analysis. Workforce structure in economic sectors, distinguished based on R&D work intensity in the European Union countries in the period of 2008-2010, was the subject of diversification and transformations assessment.

Shift-share analysis enabled the decomposition of occurring changes into regional, structural and global effects as well as the identification of the, so called, allocation effect resulting in the classification of the studied countries with regard to combinations of local specialization and competitive advantages.

The performed research also allowed for the identification different kinds of workforce structure characterized by smart specialization (significant share of workforce in high-tech manufacturing sector or high-tech services sector) and the assessment of generated structural and competitive effects.

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1. Introduction

Contemporary socio-economic processes stimulate the importance of economy sectors based on knowledge and innovation. It results in the growing interest in sectors distinguished by research and development intensity level. Workforce level and structure and also their changes in sector and regional system constitute key elements of economy functioning analysis. They may also be used for comparative analysis of changes occurring in regions against the reference area.

In 2010 the European Union approved the *Europe 2020 Strategy* defining objectives aimed at providing support for member states to overcome economic crises successfully and ensure smart, sustainable and facilitating social inclusion development. The specified, by the strategy, smart development consists in knowledge-intensive economy and innovation development. Smart specialization of workforce structure constitutes one of the components of this development.

Innovations, as the major source of smart development, may manifest themselves in improvements occurring in particular sectors and inter-sector shifts. In relation to employment they may result in workforce structure transformation by shifts to more productive sectors and, in this way, exerting a long-lasting impact on economy. Therefore the growing interest, in EU countries research referring to changes in workforce level and structure in sectors distinguished by volume of R&D outlays, seems justified.

Workforce in high-tech manufacturing and knowledge-intensive services presents the domain focused approach covering production and services defined as high-tech in line with criterion of R&D outlays volume against added value. This relation is defined as R&D intensity.

Shift-share analysis (SSA) represents one of the research tools for investigating structural changes occurring in regional space in the given time range. SSA allows for analysing fluctuations in employment rate characteristic for a given country 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. Additionally, SSA results provide information indispensable for the identification of key types of activities in a given region, as well as facilitate the typology of workforce structure with regard to different types of smart specialization and competitiveness.

2. Basic information and applied research methods

The domain focused approach is based on NACE – statistical classification of economic activities in the European Community. The division of high-tech sectors was first published in 1997 by OECD. From 1 January 2008 updated NACE classification (NACE Rev. 2) and the definition of high-tech manufacturing and knowledge-intensive services has changed. Therefore data comparisons before and after 2008 must be carefully performed or these changes must be referred to as a break in data continuity. Therefore it was accepted that the research time range will cover the period of 2008-2010 (in line with NACE Rev. 2).

Prepared by *Eurostat* and OECD workforce structure in the cross section of the following activities types by R&D intensity levels became the basis for conducting analysis: high-tech manufacturing (HTM), mid-high-tech manufacturing, mid-low-tech manufacturing, low-tech manufacturing, knowledge-intensive services (KIS), less knowledge-intensive services (LKIS), other sectors.

27 EU countries were covered by the study. Statistical data, necessary for workforce structure diversification analysis in EU space, were taken from Eurostat Internet database.

Structural and geographic workforce analysis by R&D intensity was conducted in EU member states applying classical and dynamic shift-share analysis and Esteban-Marquillas model using allocation effect[2].

Shift-share analysis is a research tool allowing to determine changes rate of total employment and R&D intensity sectors in each EU country on the background of reference area i.e. EU area.

Shift-share analysis of workforce changes rate in EU countries allowed for:

1. specifying structural and regional effects of workforce number changes in sectors distinguished by R&D intensity,
2. identification of key sectors for regional development,
3. classification of EU countries by positive and negative change effects values: structural and competitive,
4. classification of EU countries by components of allocation effects: specialization and competitiveness.

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[2] For more information about the listed methods check, among others, the following publications: (Dunn 1960, pp. 97-112), (Barff, Knight 1988, pp. 1-10), (Esteban-Marquillas 1972, pp. 249-261), (Suchecki 2010, pp. 162-185), (Malarska, Nowakowska 1992, pp. 75-85).

3. Shift-Share Analysis of workforce in economy sectors distinguished by R&D intensity

Table 1 presents the results of classical SSA analysis for the period of 2009 and 2010 in relation to the previous year and referring to the overall result and structural effects of employment changes in the distinguished sectors. The general declining tendency of employment in the European Union is responsible, on average, for 1,82% of workforce size drop rate in every country and economy sector in 2009, as well as 0,5% in 2010. The global crisis diverted growth oriented tendencies in employment, which were observed in the EU since 2000, and one of its effects was the liquidation of many work places.

Individual structural effects for particular economy sectors are quite diversified. Structural gross effects refer to the average rate of employment changes in selected economy sectors in the EU countries. As the data presented in table 1 illustrate the highest average employment rate drop in 2009 was observed, respectively, in low-tech processing industry sector (-8,04%), mid-high tech (-6,66%) and high-tech (-5,84%) and also in mid-tech industry sector (-5,61%). In 2010 the observed employment rate decline in all sectors was lower. The only sector in which the employment rate increased, in both studied time periods, was the knowledge-intensive service sector – the increase by 1,5% in 2009 and by 0,6% in 2010. The lowest drop rate in workforce number was characteristic for less knowledge-intensive services sector (-1,97% and – 0,43%).

Table 1. Results of classic shift-share analysis with regard to effects of employment changes in sectors distinguished by R&D intensity

Effects of employment changes in EU countries (in %)		2009/2008	2010/2009
Total effect (growth rate of employment in EU)		-1,82	-0,50
Gross structural effect	1. high-tech manufacturing (HTM)	-5,84	-2,81
	2. mid-high-tech manufacturing	-6,66	-1,93
	3. mid-low-tech manufacturing	-5,61	-1,44
	4. low-tech manufacturing	-8,04	-2,62
	5. knowledge-intensive services (KIS)	1,50	0,60
	6. less knowledge-intensive services	-1,97	-0,43
	7. other sectors	-3,87	-1,68
Net structural effect	1. high-tech manufacturing (HTM)	-4,02	-2,31
	2. mid-high-tech manufacturing	-4,84	-1,43
	3. mid-low-tech manufacturing	-3,79	-0,94
	4. low-tech manufacturing	-6,22	-2,12
	5. knowledge-intensive services (KIS)	3,32	1,10
	6. less knowledge-intensive services	-0,15	0,07
	7. other sectors	-2,05	-1,18

Source: Author's estimations.

Net structural effects were defined by means of decreasing gross effects by workforce growth rate in the EU. Employment changes in knowledge-intensive services sector in 2009 resulted in higher workforce number in all EU countries, on average by 3,32% and in 2010 by 1,1%. Employment growth rate in less knowledge-intensive services sector in 2010 also influenced the slight growth of workforce size in the EU countries (0,07%). The employment in remaining sectors distinguished in line with R&D activities intensity was related to the drop of employment in the analysed countries. However, in 2009 the largest employment rate decline in the EU countries was caused by transformations occurring in low-tech industry sector (-6,22%). In 2010 employment rate decline in the EU countries (by 2,31%) was, to the largest extent, influenced by the changes taking place in high-tech industry sector.

In order to identify sectors responsible for the EU countries development table 2 presents Pearson linear correlation coefficients values for structural effects (distinguished in accordance with the classical shift-share analysis) and the share of workforce in particular economy sectors. The relations referring to both studied years turned out similar. Definitely, the strongest positive relation occurred between structural effects and the share of workforce in knowledge-intensive services sector (0,964 and 0,965). Positive relation, but of much lower intensity (statistically irrelevant for the accepted significance level $\alpha = 0,05$) was characteristic for structural effects and the share of workforce in less knowledge-intensive services sector and in high-tech industry sector. The remaining sectors featured negative influence on structural effects in the particular EU countries. Definitely the strongest negative correlation was registered in case of structural effects and the share of workforce in low-tech sector (-0,870 and 0,851).

Table 2. Correlation coefficient of structural effects and workforce share in the analyzed sectors

Workforce share in sectors	Structural effect	
	2009/2008	2010/2009
1. high-tech manufacturing (HTM)	0,008	0,070
2. mid-high-tech manufacturing	-0,393	-0,310
3. mid-low-tech manufacturing	-0,590	-0,534
4. low-tech manufacturing	-0,870	-0,851
5. knowledge-intensive services (KIS)	0,964	0,965
6. less knowledge-intensive services	0,289	0,229
7. other sectors	-0,736	-0,821

Source: Author's estimations.

Table 3 and picture 1 present the decomposition of overall workforce growth rate, ranked by R&D activities intensity in the period of 2010/2008,

preformed in line with the shift-share dynamic analysis rules. Therefore further analysis covered aggregated structural and competitive effects calculated based on the effects for the years 2009/2008 and 2010/2009. Countries were ranked by the declining values of aggregated structural effects. The interdependence between aggregated net effect and aggregated structural effects and also the competitive ones measured by correlation coefficient was 0,385 and 0,995 respectively (both values are statistically significant). Therefore it may be concluded that the relevance of structural factor was much lower than in case of competitive factor.

In thirteen of the analysed EU countries a positive aggregated structural effect was observed, which means that workforce structure in these countries had a positive impact on workforce size changes. Only two countries form the, so called, new accession were included in this group, i.e. Malta and Cyprus. In the countries characterized by positive structural effects the share of workforce in knowledge-intensive services ranged from over 35% in Cyprus to almost 55% in Luxemburg.

Table 4 illustrates the classification of the EU countries with regard to positive and negative values of aggregated structural and competitive effects. The first group includes countries featuring positive influence of both structural and competitive factors on employment structure fluctuations, which indicates that workforce number changes in these countries may be more favourable for two reasons: because sectoral workforce structure has a positive impact on employment rate growth and also because economic sectors are characterized by higher dynamics of workforce size fluctuations than in other regions. This group covered six countries from EU 15 and 2 countries from EU 12.

Table 3. Dynamic shift-share analysis results of workforce number growth rate in economic sectors by R&D activities intensity in the period of 2010/2008

No	Country	Net total effect	Structural effect	Competitive effect	Workforce share in KIS
Positive structural effect					
1	Luxembourg	12,40	1,67	10,73	54,98
2	Sweden	1,31	0,99	0,32	50,70
3	United Kingdom	0,78	0,91	-0,14	48,01
4	Denmark	-2,35	0,75	-3,10	49,72
5	Netherlands	0,50	0,74	-0,24	45,64
6	Belgium	3,24	0,63	2,61	46,12
7	France	1,63	0,56	1,07	43,69
8	Ireland	-10,57	0,38	-10,96	44,71
9	Finland	-0,99	0,35	-1,34	42,22

| 10	Malta	4,90	0,31	4,59	40,49
11	Cyprus	2,82	0,24	2,58	35,24
12	Germany	2,16	0,04	2,12	40,00
13	Austria	2,48	0,02	2,47	37,11
Negative structural effect					
14	Greece	-1,48	-0,13	-1,35	33,29
15	Spain	-6,73	-0,13	-6,60	34,48
16	Italy	0,01	-0,29	0,30	33,69
17	Latvia	-14,55	-0,34	-14,22	34,34
18	Hungary	-0,22	-0,47	0,25	35,03
19	Lithuania	-9,66	-0,56	-9,10	33,93
20	Estonia	-11,12	-0,61	-10,50	35,25
21	Portugal	-2,02	-0,70	-1,32	30,05
22	Slovenia	-0,81	-0,87	0,06	33,51
23	Czech Republic	-0,09	-0,93	0,83	31,84
24	Slovakia	-2,53	-0,94	-1,58	32,35
25	Poland	3,34	-0,95	4,29	30,36
26	Bulgaria	-6,89	-1,13	-5,77	28,86
27	Romania	0,93	-1,86	2,79	19,95

Source: Author's estimations.

Table 4. Classification of EU countries by positive and negative effect values: structural and competitive (dynamic SSA 2010/2008)

Group	Criterion of division	Countries	Number of countries
I	effects: structural (+) competitive (+)	Luxembourg, Sweden, Belgium, France, Germany, Austria, Malta, Cyprus	8 EU15 6 EU12 2
II	effects: structural (+) competitive (-)	United Kingdom, Denmark, Netherlands, Ireland, Finland	5 EU15 5 EU12 0
III	effects: structural (-) competitive (+)	Italy, Hungary, Slovenia, The Czech Republic, Poland, Romania	6 EU15 1 EU12 5
IV	effects: structural (-) competitive (-)	Greece, Spain, Portugal, Latvia, Lithuania, Estonia, Slovakia, Bulgaria	8 EU15 3 EU12 5

Source: Author's compilation.

Figure. 1. Dynamic shift-share
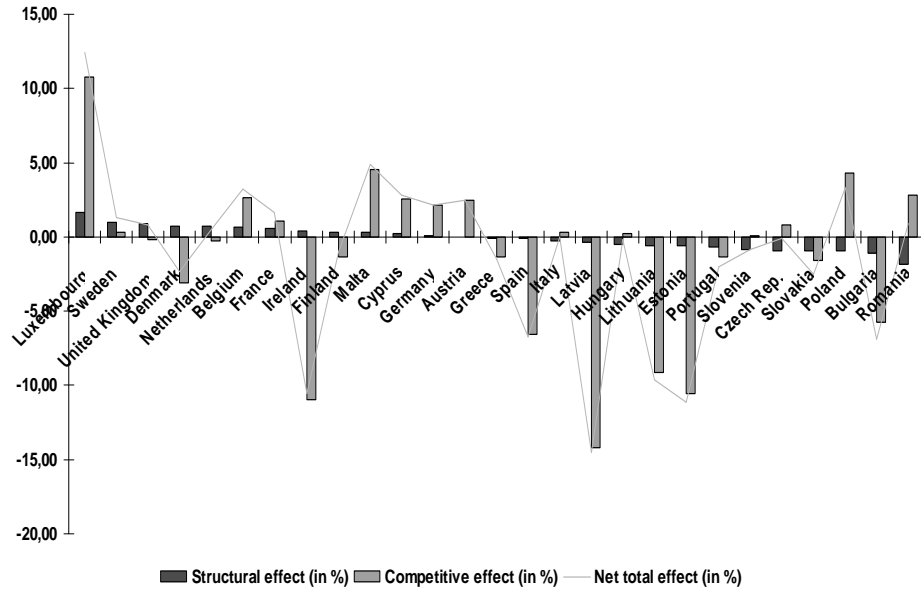
Source: Author's compilation.

The second group, characterized by positive influence of only the structural factor does not include any country from the, so called, new EU accession. The third group, featuring positive influence on employment changes of only the competitive factor, covered 5 new EU accession countries, including Poland. The forth group lists countries in which both the employment structure and internal regional development determinants exerted negative influence on workforce number changes in the period of 2008-2010. It covers 8 countries including Greece, Spain and Portugal of EU 15.

Tables 5 and 6 present the classification of EU countries with regard to allocation component effects: smart specialization or its absence as well as the advantage or disadvantage of competitiveness in high-tech industry and knowledge-intensive services sectors, respectively.

Table 5. Classification of EU countries by allocation effect components of workforce in HTM in 2010

Definition	Countries	Components of allocation effect	
		specialization (workforce share in HTM in %)	competitiveness (growth rate of employment in HTM in country less in EU in %)
Reference area	EU	1,08	-8,48
Smart specialization Competitive advantage	1. Ireland	3,10	2,13
	2. Hungary	2,77	5,15
	3. Malta	2,58	6,54
	4. Finland	1,89	6,53
	5. Slovenia	1,76	10,02
	6. Denmark	1,67	10,68
	7. Germany	1,51	1,36
	8. Czech Rep.	1,49	6,76
	9. Estonia	1,24	8,86
	10. France	1,09	1,07
Smart specialization Competitive disadvantage	1. Slovakia	1,46	-13,61
	2. Belgium	1,27	-0,73
Absence of smart specialization Competitive advantage	1. Italy	1,05	5,77
	2. Poland	0,78	7,14
	3. Sweden	0,71	2,65
	4. Romania	0,53	3,57
	5. Greece	0,46	4,81
	6. Lithuania	0,32	1,27
	7. Luxemburg	0,31	40,98
Absence of smart specialization Competitive disadvantage	1. United Kingdom	1,06	-2,47
	2. Austria	0,98	-0,16
	3. Spain	0,64	-12,97
	4. Netherlands	0,62	-11,07
	5. Bulgaria	0,59	-24,76
	6. Latvia	0,38	-7,39
	7. Portugal	0,37	-36,85
	8. Cyprus	0,20	-40,5

Source: Author's estimations.

Table 6. Classification of EU countries by allocation effect components of workforce in KIS in 2010

Definition	Countries	Components of allocation effect	
		Specialization (workforce share in KIS in %)	Competitiveness (growth rate of employment in KIS in country less in EU in %)
Reference area	EU	38,54	2,12
Smart specialization Competitive advantage	1. Luxembourg	54,98	9,73
	2. Denmark	49,72	0,97
	3. United Kingdom	48,01	1,48
	4. Belgium	46,12	0,63
	5. Malta	40,49	2,59
	6. Germany	40,00	0,69
Smart specialization Competitive disadvantage	1. Sweden	50,70	-0,92
	2. Netherlands	45,64	-4,27
	3. Ireland	44,71	-1,90
	4. France	43,69	-0,85
	5. Finland	42,22	-4,45
Absence of smart specialization Competitive advantage	1. Austria	37,11	4,53
	2. Cyprus	35,24	0,67
	3. Hungary	35,03	0,61
	4. Spain	34,48	0,49
	5. Slovenia	33,51	2,00
	6. Slovakia	32,35	2,04
	7. Czech Rep.	31,84	2,51
	8. Poland	30,36	6,12
	9. Romania	19,95	1,56
Absence of smart specialization Competitive disadvantage	1. Estonia	35,25	-3,90
	2. Latvia	34,34	-12,68
	3. Lithuania	33,93	-3,62
	4. Italy	33,69	-3,63
	5. Greece	33,29	-3,18
	6. Portugal	30,05	-0,78
	7. Bulgaria	28,86	-5,16

Source: Author's estimations.

A country is characterized by workforce structure featuring smart specialization in high-tech industry sector (knowledge-intensive services) if workforce share in this sector is higher than EU average. On the other hand, competitive advantage in high-tech industry sector (knowledge-intensive services) is present in the country in which employment changes rate in this particular sector is more favourable than sectoral changes rate in EU.

Based on the information presented in tables 5 and 6 the typology of workforce structure in EU countries was prepared with regard to smart specialization and the presence of competitive advantage, which was illustrated in table 7. As this analysis indicates, both smart specialization and competitive advantage, in both high-tech sectors in 2010, were characteristic for workforce structures in Denmark, Germany and Malta. Two-sectoral absence of smart specialization and competitive advantage occurred in Bulgaria, Latvia and Portugal.

Single-sectoral smart specialization in high-tech industry sector, as well as competitive advantage in this sector were registered in Estonia, The Czech Republic, Hungary and in Slovenia. Single-sectoral smart specialization in knowledge-intensive services sector and competitive advantage were present in this sector in 2010 in Luxemburg and Great Britain.

Table 7. Typology of employment structure by smart specialization and competitiveness in 2010

Smart specialization	Competitiveness			
	two-sector	single sector in HTM	single sector in KIS	absence
two-sector	Denmark, Malta Germany	Ireland, France, Finland	Belgium	-
single sector in HTM	Czech Rep., Hungary, Slovenia	Estonia	Slovakia	-
single sector in KIS	Luxembourg	Sweden	United Kingdom	Netherlands
absence	Poland, Romania	Greece, Italy, Lithuania	Spain, Cyprus, Austria	Bulgaria, Latvia, Portugal

Source: Author's compilation.

Poland and Romania were included in the group for which two-sectoral absence of smart specialization, as well as the occurrence of two-sectoral competitive advantage were identified which, while maintaining high employment rate growth in both high-tech sectors, may be the prognosis for

workforce structure evolution in these countries towards smart specialization development.

4. Conclusions

The global crisis resulted in the fact that the average employment rate changes in EU were negative and equal -1,82% in the period of 2009/2008, -0,5% in the period of 2010/2009 and -2,31% in the period of 2010/2008. In the period of 2010/2008 the employment rate changes were better than average in UE in 13 countries (including four UE12 countries i.e.: Malta, Cyprus, Poland and Romania). These changes resulted mainly from internal changes occurring in the analyzed countries (competitive effect). The relationship between net effect and structural and competitive effects was respectively 0,385 and 0,995. Low-tech industry workforce number had the largest influence on employment rate decline in the period of 2009/2008. It resulted in employment rate drop in EU countries on average by 6,22%. In the period of 2010/2009 this influence was significantly lower, however, persisted negative (-2,12%). Number of workforce employed in knowledge-intensive services resulted in higher employment rate in EU countries in 2009 by 3,32% on average and in 2010 by 1,1%. Slight positive influence had, in 2010, the number of workforce in less knowledge-intensive services. The influence in remaining sectors was negative. 14 analyzed countries (including 10 from EU12, excluding Malta and Cyprus) were characterized by a negative structural effect, which confirms that in these regions workforce structure had negative impact on employment rate changes. In the countries featuring positive structural effect the workforce share in knowledge-intensive service ranged from 35% in Cyprus to almost 55% in Luxemburg. In the group of countries characterized by negative structural effect the lowest workforce share in knowledge-intensive services was registered in Romania at the level of 19,95%. Negative competitive effect occurred in 13 countries, which means that their sectors were characterized by lower than average dynamics of changes as compared to other EU countries. This group covered 5 EU12 countries – Latvia, Lithuania, Estonia, Slovakia and Bulgaria.

Two-sector smart specialization was identified in Denmark, Germany and Malta. These countries were characterized by both higher share and better employment rate changes in high-tech industry sectors and knowledge-intensive services than in EU. Bulgaria, Latvia and Portugal were included in the group of countries which featured the absence of both specialization and competitiveness in high-tech sectors. Poland and Romania constituted the target group characterized by the absence of smart specialization and competitiveness in both

high-tech sectors which may open an opportunity for smart specialization development in the future.

The ongoing employment changes were related to economic crisis and their interregional diversification resulted mainly from internal conditions. It has to be emphasized that the competitive effect of employment rate changes was of dominating importance, which allows to assess favorably the positive competitive effects of less wealthy EU12 countries, including Poland.

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Streszczenie

INTELIGENTNA SPECJALIZACJA STRUKTURY PRACUJĄCYCH W KRAJACH UNII EUROPEJSKIEJ – ANALIZA DYNAMICZNA Z WYKORZYSTANIEM SHIFT-SHARE ANALYSIS

Celem referatu jest dynamiczna analiza i ocena struktury pracujących w krajach Unii Europejskiej w oparciu o strukturalno-geograficzną metodę przesunięć udziałów (Shift-Share Analysis). Ocenie zróżnicowania i przemian poddano strukturę pracujących w sektorach ekonomicznych wyodrębnionych wg intensywności działalności badawczo-

rozwojowej w krajach Unii Europejskiej w latach 2008-2010. Analiza przesunięć udziałów umożliwiła dekompozycję zachodzących zmian na efekty regionalne, strukturalne i globalne, jak również identyfikację tzw. efektu alokacji prowadzącego do klasyfikacji badanych krajów ze względu na występujące kombinacje specjalizacji lokalnej i korzyści konkurencyjności.

Przeprowadzone badania pozwoliły na identyfikację różnych rodzajów struktur pracujących cechujących się inteligentną specjalizacją (znaczący udział pracujących w sektorze przemysłu wysokiej techniki lub usług opartych na wiedzy) oraz ocenić generowane przez nie efekty strukturalne i konkurencyjne.