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THE EMPLOYMENT STRUCTURE IN THE SECTORS OF NATIONAL ECONOMY WITH DIFFERENT TECHNOLOGY AND KNOWLEDGE INTENSITY

СТРУКТУРА ЗАНЯТОСТИ В СЕКТОРАХ НАЦИОНАЛЬНОЙ ЭКОНОМИКИ С РАЗНЫМ УРОВНЕМ ТЕХНОЛОГИЧЕСКОЙ И НАУЧНОЙ ИНТЕНСИВНОСТИ

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Abstract. The research is focused on the employment, its structure and its changes, in the national economy, especially in the manufacturing and services activities with different knowledge and technology intensity. The research is conducted for nine sample countries, for the years 2008-2012. The results approve theory of structural changes in the national economy, as well as in the post-crisis period higher decline of employees was observed in less knowledge and technology intensive activities. Nowadays larger share of the employees is in the medium and less technology and knowledge intensive activities.

Keywords: employment, structure, structural changes, knowledge, technology, intensity.

1. Introduction

In recent decades the structure of global and national economies has changed significantly. On the one hand, the dominant share of the tertiary sector becomes increasingly high, while share of the industrial sector continues to decrease. On the other hand, a necessity of more detailed structure of national economy appears in order to analyse the processes inside the sectors. The changes of national structure are reflected not only in the structure of GDP (or gross value-added), but in the structure of employment, too. In addition, the economic crisis of the years 2008-2009 showed that no state is protected against crisis in contemporary globalized world, and one of the principal issues after the crisis remains the problem of unemployment. Nevertheless, countries are aimed on reaching a competitive position among the others. Furthermore, economists increasingly emphasize their attention to the structural changes of economy, and nowadays basic attention is concentrated on the development of the knowledge economy. According to Kondratiev's long waves, these days the world economy is in the fifth cycle - the period of microelectronics, robotics, biotechnology, genetics, etc., where knowledge and technology are most principal [1]. Therefore, the main sources of

economic growth are attributed to knowledge, innovations and technology development, and knowledge-intensive and high-technology industries become one of the major factors of country competitiveness.

In terms of transition to knowledge-based economy, a classification of industries and services based on technology and knowledge intensity was also developed. Nowadays such world organizations as European Commission, Eurostat, etc., use an aggregation of manufacturing industries based on technological intensity and on the Statistical Classification of Economic Activities in the European community (further NACE). Whereas, the service sector division is based on knowledge-intensity, i.e. on the share of enrolled employees with tertiary level of education [2].

Thus, nowadays the fears regarding the unemployment, further ability of low-skilled and unemployed people to find appropriate job in the future appear more often because of growing computerisation while developing knowledge-based economy [3, 4].

The aim of the research is to study the relationship between technology and knowledge intensity, and employment structure in the main sectors of national economy in the post-crisis period.

The research is conducted using the data of nine countries. Countries of the sample were selected according to several criteria. First of all, three Baltic countries – Estonia, Latvia and Lithuania were selected as the countries of native region. Secondly, three Balkan countries – Bulgaria, Croatia and Rumania were chosen; this choice was based on the evaluation of GDP per capita and Knowledge Index, an indicator of the knowledge-based economy development (further KI), recent values – in order to investigate statistically comparable countries. Thirdly, three Nordic countries – Denmark, Finland and Sweden were selected as a pattern of prosperity and development of knowledge-based economy according to the recent values of GDP per capita and KI. All selected countries are members of EU.

The research reflects the data for the post-crisis period, using mainly statistics from Eurostat, for the years 2008-2012. This period was selected as the recent crisis affected all countries in the world, as well as EU, and nowadays an impact of the crisis is still felt. As well, it should be noted that because of the transition to NACE Rev. 2 classification in European community of the year 2008, it was not possible to compare pre-crisis and post-crisis periods. The data before the year 2008 was available only in classification NACE Rev. 1.1. If such comparison was conducted, the results would not be entirely reliable.

In order to conduct this research, firstly, special economic literature, published papers and researches were studied to display the main aspects of the structure of national economy, structural changes and knowledge-based economy (*Chenery, Syrquin, Kruger, Silva, Teixeira, Drucker*, etc.). Secondly, using aggregation of industries and services by technology and knowledge intensity in terms of NACE Rev. 2 classification, the changes of employment structure in manufacturing and service sector in three regions of EU for the years 2008-2012 were examined. In

terms of this research the following methods were used: monographic method, statistical analysis of secondary data, and graphical methods.

2. Theoretical aspects

2.1. The structure of national economy and the structural changes

The national economy forms a complex system, which consists of several related to each other macroeconomic elements. The relation between these elements also forms the structure of national economy. In economics and economic history the term *structure* is mostly associated with the sectors of national economy and sectoral structure, which traditionally consists of three sectors – agriculture, industry and services or the primary, secondary and tertiary sectors. For instance, *A. Fisher* [5], *C. Clark* [6], *M. Wolfe* [7], *J. Furastie* [8], and others made a considerable contribution to the division of national economy, while *Silva and Teixeira* [9], and *J. Kruger* [10] developed a summary of the structural changes.

Furthermore, the structure of national economy accordingly to *C. Clark's* division by three sectors (agriculture, industry and services or the primary, secondary and tertiary sectors) will be used in this paper, being the most applicable and traditional in economics. *H. Chenery* and *M. Sirquin* in several works [11, 12, 13] have given a significant contribution to the study of structural changes of national economy in the long-term period.

The share of the sectors of national economy changes in the long-term period, and economic science explains structural changes of national economy by the three sector hypothesis, developed by *J. Fourastie* [8]: in the long-term period the proportion of the primary sector decreases, in the tertiary sector – increases, but changes of the share of the secondary sector in the structure of national economy is similar to an inverse U-curve, when increase is followed by decrease. These features of transformation refer to the structure of GDP (or value added) as well as the employment, i.e. the number of employees at the sectors of national economy.

Nowadays the growth of the services is common to all developed countries, while the share of the other two sectors is decreasing, regarding the structure of GDP and employment. The result of these transformations is also reflected in decrease of importance and share of labour- and natural resource-intensive industries and in increase of importance and share of intellectual capital, knowledge and technology-intensive industries [14] – the features of knowledge-based economy.

2.2. The knowledge based economy

Despite the fact that the concept of knowledge-based economy is widely used, the exact definition for the knowledge based economy is not developed. Meanwhile, it is argued that *Peter Drucker* apparently first used the phrase "the knowledge economy" in his book *The Age of Discontinuity* in 1969 [15:349].

Although, the OECD has described the knowledge based economies in very general terms, as "those which are directly based on the production, distribution

and use of knowledge and information” [16: 7]. The World Bank defines the knowledge economy as “one where organizations and people acquire, create, disseminate, and use knowledge more effectively for greater economic and social development” [17]. Anyway the term *knowledge economy* is used to point out an increasing importance of knowledge.

Another issue regarding the knowledge economy is how to measure it on a national or regional level. An attempt to solve the issue is done by *Raspe and van Oort*: “We distinguish the following latent variables: knowledge workers with indicators – ICT sensitivity, educational level, creative class, and communicative skills; R&D with indicators – the density of high and medium-tech firms and the share of R&D employees; Innovativeness with indicators – technical and non-technical innovations” [18: 105]. Additionally, *Cortright and Mayer* [19] emphasize the role of high and medium-technology firms as indicators of the knowledge economy and driving forces of economic and employment growth.

Comparing the previously mentioned data with aggregation of industries and services by technology and knowledge intensity used in European community, it is possible to observe an obvious similarity. This also determines a methodology of statistical analysis of this research: based on NACE Rev. 2 aggregation of manufacturing industries by technology intensity and services by knowledge intensity, to study changes of employment structure in the mentioned sectors, in order to identify the type of industry and services that have mostly contributed to the employment and as a result to economic growth and development of knowledge economy in different regions of EU.

3. Statistical evaluation of the employment structure in the sectors of national economy with different technology and knowledge intensity

According to the theoretical aspects of structural changes, the change of the number of employees in the sectors of national economy is a distinctive feature of the structural changes. Therefore, the research was conducted in terms of the employment change in the sectors of national economy.

Depending on the level of R&D intensity (R&D expenditures relative to value added), manufacturing is divided into four groups of industries: high-technology, medium high-technology, medium low-technology and low technology industries. The service sector is generally divided into knowledge-intensive services (further *KIS*) and less knowledge intensive services (further *LKIS*), which are based on the share of enrolled employees with tertiary level of education. Knowledge-intensive services are further sub-divided into knowledge-intensive market services (further *KIS Market*), high-tech knowledge-intensive services (further *KIS High-tech*), knowledge-intensive financial services (further *KIS Financial*) and other knowledge-intensive services (further *KIS Other*). Less knowledge-intensive services in turn are also sub-divided into less knowledge-intensive market services (further *LKIS Market*) and other less knowledge-intensive services (further *LKIS*

Other) (based on [2]). It should be noted that nowadays this aggregation is based on NACE Rev. 2 classification.

Thus, the research was developed in order to investigate the employment changes in manufacturing, which make the major part of the industrial sector and create high value-added products, and in the service sector, which contribute most to economic growth in developed countries in our time. Furthermore, four groups of industries were distinguished and applied in manufacturing, but in the service sector – six groups, according to the mentioned aggregation.

3.1. Employment structural changes in EU countries of the years 2008-2012

Table 1 displays the data of the employment share and its change in three main sectors of national economy, as well as values of GDP per capita of the year 2012 and the most recent values of KI.

Table 1. Employment structure in the main sectors of national economy

	Share of the employment in the primary sector			Share of the employment in the secondary sector			Share of the employment in the tertiary sector			GDP per capita, thousands	Knowledge Index
	2008, %	2012, %	Δ, (%)	2008, %	2012, %	Δ, (%)	2008, %	2012, %	Δ, (%)		
Denmark	2.8	2.9	0.1	1.8	1.9	-0.1	7.7	8.2	0.5	43.9	9.22
Finland	4.8	4.6	-0.2	2.1	2.3	0.2	3.1	3.1	0.0	35.5	9.22
Sweden	2.4	2.4	0.0	6.8	6.7	-0.1	0.8	0.9	0.1	42.8	9.38
Estonia	5.2	5.8	0.6	7.9	8.8	0.9	6.9	8.4	1.5	13.0	8.26
Latvia	8.6	8.7	0.1	4.3	4.8	0.5	7.1	8.4	1.3	10.9	7.15
Lithuania	8.6	9.0	0.4	6.7	7.8	1.1	4.7	6.2	1.5	11.0	7.68
Bulgaria	8.9	7.5	-1.4	3.2	8.9	5.7	8.2	3.6	-4.6	5.5	6.61
Croatia	1.3	1.0	-0.3	1.6	0.0	-1.6	5.1	7.0	1.9	10.2	7.27
Romania	2.4	2.8	0.4	1.9	9.9	8.0	3.2	5.3	2.1	6.2	6.63

Source of data for calculations: 20, 21, 22

First of all, it should be noted that the data of the sample approved theoretical aspects of structural changes in national economy – the higher GDP per capita, the higher the share of employees in the tertiary sector and the lower in the primary sector (see Tab. 1). Furthermore, it is possible to observe a positive relationship between GDP per capita and KI for all sample countries – the higher GDP per capita, the higher the index. In addition, these values differ among the regions.

Nordic countries had the highest GDP per capita and KI. Though, the Balkans had the lowest values, especially Bulgaria and Romania, but three Baltic countries had mid-level values with Estonia’s prevalence in the region (see Table. 1).

During the analysed period, the share of the number of employees in the secondary sector shrank in all sample countries, while it increased in the tertiary sector. Besides, the highest percent of the services was especially typical of Nordic countries, high GDP per capita and KI level, but the lowest – for the Balkans. In 2012 the largest share of the tertiary sector was in Sweden – 82.9 % of total employment that increased by 2.1 percentage point in comparison with 2008. However, in 2012 this share was smaller in the Baltics and Balkans, especially in Romania - only 35.3% of total number of the employees was employed in the service sector. In the Baltic countries the employment structure was similar to the Nordic countries, but the Baltics still had a greater share of employees in the primary and secondary sector in the years 2008-2012 (see Table. 1).

3.2. The employment structure in manufacturing industries with different technology intensity

Nowadays high attention is devoted to high- and medium high-technology industries. These industries are supposed to create products with high value-added, and, accordingly, contribute most to economic growth. According to the Fig.1, around 36-41% of manufacturing employees in the Nordics were employed in these industries. In the Balkans and Baltics this share was noticeably smaller.

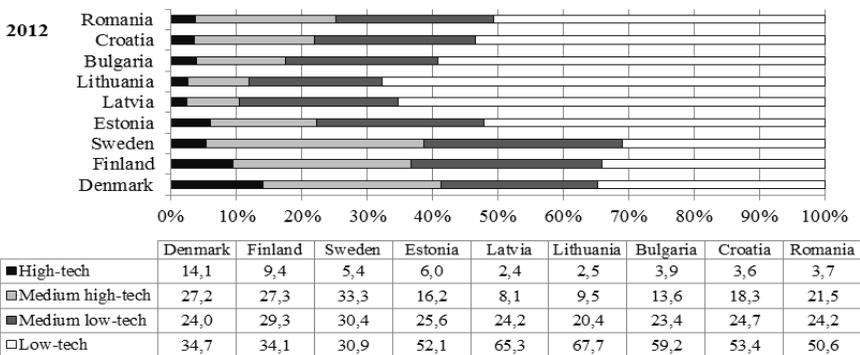


Fig. 1. Employment structure in manufacturing by type of industry, in 2012, in %
 [Source of data for calculations: 20]

In addition, these industries engaged only 10.5% and 12% of the manufacturing employees in Latvia and Lithuania, but in Estonia – 22.2%.

According to the Fig.1, in the sample countries with relatively high income level (the Nordics) low-technology industries engaged around 30-34% of the total

number of employees in manufacturing. While in the Baltics and Balkans this share was remarkably higher – in Latvia and Lithuania it was more than two times larger (65.3% and 67.7%, accordingly). In the sample countries with relatively low and middle income level the larger share of employees in manufacturing was engaged in low- and medium low-technology industries. While in the countries that are considered to be highly developed, high- and medium high-technology industries had a larger share.

The recent crisis definitely affected the employment and its structure in the sectors of economy. Fig. 2 displays the changes in the number of employees in manufacturing that accompanied the crisis.

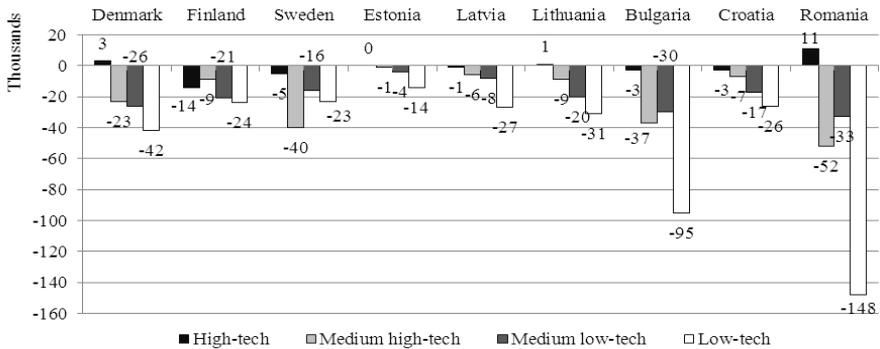


Fig. 2. Change of the number of employees in manufacturing, by type of industry, from 2008 to 2012, in thousands [Source of data for calculations: 20]

During the research period the number of employees changed mostly in low-technology industries, especially in Romania – decreased by 148 thousands (see Fig.2). As well, a noticeable decrease was observed in medium high and medium low-technology industries. Despite the fact that a higher decline in absolute values was noticed in Bulgaria and Rumania, in the Baltics the number of employees in manufacturing shrank not as significantly as in the Nordics, nevertheless, the percentage change displays a different vision (see Fig. 3).

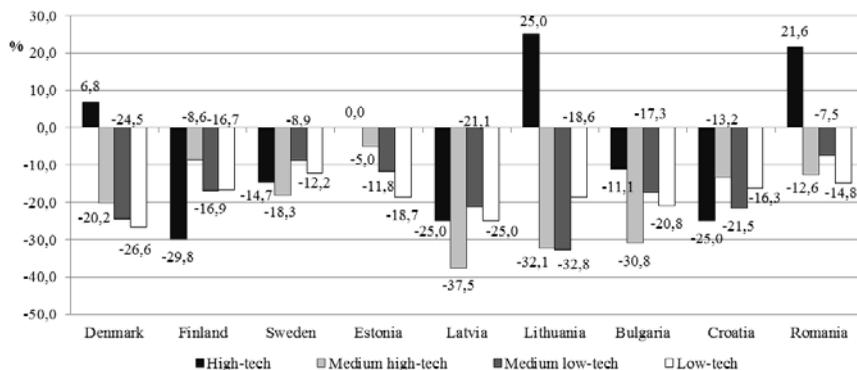


Fig. 3. Percentage change of the number of employees in manufacturing, by type of industry, from 2008 to 2012, in % [Source of data for calculations: 20]

Fig. 3 shows that Bulgaria's and Rumania's percentage change of the number of employees in aggregated industries of manufacturing was not as high as the absolute changes. Moreover, the Baltics, where decline in the number of manufacturing employees was relatively modest, showed rather high percentage changes of the year 2008 (Latvia, Lithuania), as well as the Nordic countries. This is explained with the sectorial structure of employment in the national economy. The Balkans had the highest share of employees in the secondary sector, therefore, even high absolute changes resulted in a lower percentage changes. In other countries the situation was the opposite.

3.3. The employment structure in the service sector activities with different knowledge intensity

The employment structure in the service sector was similar among the sample countries – the main part of the employees was engaged in *KIS Other* and *LKIS Market* services, but at the same time this share is smaller in the Nordics than in the Balkans and Baltics (around 81-83%, see Fig. 4). In addition, in the Nordics the share of employees in *KIS Other* was higher than in *LKIS Market* services unlike the Baltics and Balkans. The Nordics also had a higher share of employees in *KIS high-tech* services, which these days are considered as the major driving forces of innovations and higher value-added.

Regarding the absolute changes of the employment in the aggregated groups of the service sector in the post-crisis period (Fig. 5), the number of employees in all countries especially declined in *LKIS Market* services, except Rumania - there was an obvious increase in all groups of services, except *KIS Other*.

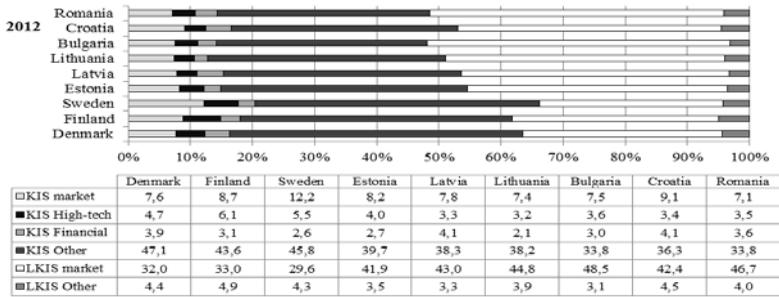


Fig. 4. Employment structure in the service sector by type of the services, in 2012, in %
 [Source of data for calculations: 20]

A sharp decline in *KIS Other* services was also observed in Latvia, Bulgaria and Lithuania, while in the post crisis period the Nordics (and Estonia) indicated the growth of employees in *KIS* groups (see Fig. 5 and Fig. 6), particularly Sweden and Finland. Nevertheless, the absolute and relative decrease of the employees was more noticeable in the countries with lower income level (Latvia, Lithuania, Croatia and Bulgaria) (Fig. 5, Fig. 6). It should be stated that despite the low income level in Rumania and larger share of employees in the secondary sector than in the services (see Tab. 1), a relatively low decline in the manufacturing (Fig. 3, Fig. 4) and remarkably high increase of employment in the service sector (Fig. 5, Fig. 6) are shown in the post crisis period.

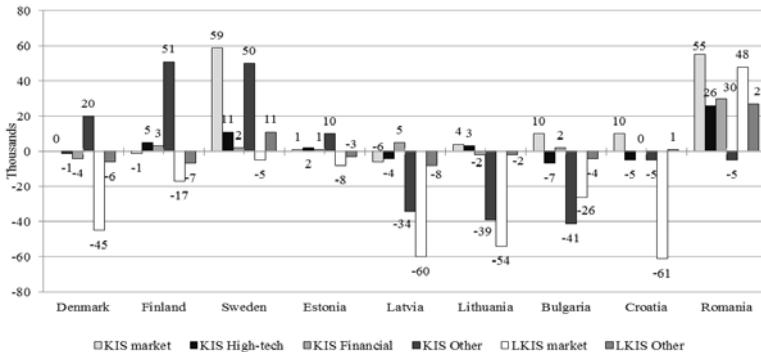


Fig. 5. Change of the number of employees in the service sector, by type of the services, from 2008 to 2012, in thousands [Source of data for calculations: 20]

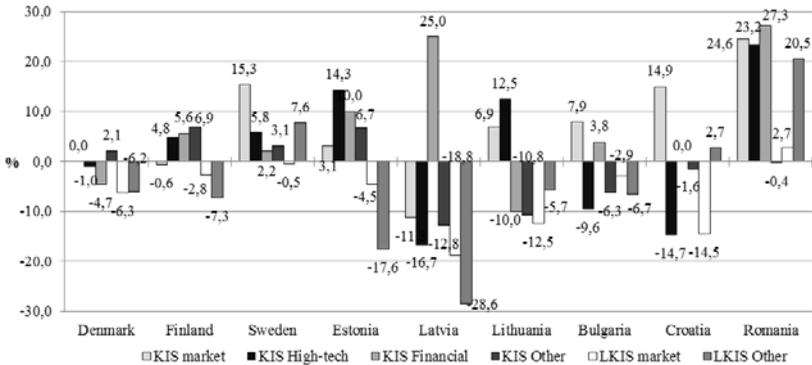


Fig. 6. Percentage change of the number of employees in the service sector, by type of the services, from 2008 to 2012, in % [Source of data for calculations: 20]

Investigating the structure of employment and its changes in the service sector activities, it is possible to observe that despite the high absolute changes in the number of employees in *LKIS Market* activities, the percentage changes were not so remarkable (Fig. 5, Fig. 6). That is explained with a rather high share of *LKIS Market* activities in the service sector.

4. Conclusions

The sample countries approved a positive relationship between higher income level and knowledge-based economy development, on the one hand, and high share of the service sector and comparatively low share of the primary and secondary sector in the structure of national economy, on the other hand. As well, these days structural transformation in terms of employment is continuing in all countries.

In all sample countries in the post crisis period the decline of the number of employees was more observed in manufacturing, especially in low-technology industries. In the service activities the decline of employees was also typical of less knowledge-intensive services. Nevertheless, during the research period more developed countries also presented the increase of number of employees in more knowledge-intensive activities.

Despite the fact that nowadays in terms of knowledge-based economy developing high attention is devoted to the evolution of the industries and services with high technology and knowledge intensity, the conducted research shows that in the countries with the high income level (the Nordics) the employment share in the high-technology industries and high-tech knowledge-intensive services was larger than in the less developed countries with the lower income level. However, even in the Nordics these high-tech activities did not engage as many employees as less technology- and knowledge-intensive activities did. Accordingly, it is not necessary to engage all work forces in the technology and knowledge intensive activities to have a higher prosperity level.

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