SPATIAL CONCENTRATION OF WORKFORCE IN ECONOMY SECTORS IDENTIFIED BY R&D EXPENDITURE INTENSITY IN THE EUROPEAN UNION COUNTRIES

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Abstract

The research covering spatial concentration originates from many trends in economic theory, e.g. neoclassical theory, new theory of trade or new geographic economy. The analysis of spatial concentration can be conducted by taking into account the sector structure of economy. Currently, the importance of sectors based on implementing knowledge and innovation is continuously increasing. Therefore, the empirical studies on spatial concentration can cover economic structures in the cross-section of sectors, distinguished by the intensity of research and development activities, defined as the relation of expenditure on research and development against sector added value. The purpose of this study is to identify spatial concentration of workforce number in economy sectors identified by R&D intensity, as well as its assessment and the analysis of changes over time. Location quotients and Gini index were applied in the conducted research. The research covered the space of the European Union Member States in the period 2008-2013.

Key words:spatial concentration, spatial concentration measures, sectors of R&D expenditure intensity

JEL Code:C10, J21, R11

Introduction

The concept of spatial concentration originates from many streams of the existing economic theories. The neoclassical theory assumes that spatial differentiation of productivity results from trade liberalization and higher economic integration. The new trade theory takes the standpoint that an increased concentration of economic activity results from the desire to achieve the economies of scale, the best possible access to markets and the reduction of trading costs. The new geographic economy claims that spatial concentration results from the spatial agglomeration of economic activities (Brakman and Garretsen, 2003), (Martin and Sunley, 1996). Numerous attempts were undertaken in the subject literature to explain the problem of economic phenomena cumulation in the selected geographic regions by studying

the theoretical basics of spatial development. Various explanations of regional development mechanism are also presented in the abundant theories of location, growth and development, including the contemporary theories of sectoral and regional polarization. At the same time it has been assumed that the mechanism of spatial development still remains, to a great extent, unrecognized and therefore it is worth undertaking both structural and geographical research in order to identify and measure the spatial concentration of economic phenomena. Lorenz curve remains the basic research tool applied in the course of spatial concentration studies. Spatial distribution can also be analyzed using location quotients and other concentration measures, which include e.g.: Gini, Herfindahl-Hirschman, Isard, Krugman, Theil.

The study attempts to analyze and evaluate the concentration of workforce in economy sectors of the European Union countries, identified in terms of R&D expenditure intensity, defined as the relation of R&D spending against added value or total value of the sector production. Smart growth, remaining one of the priorities in the European Union development strategy in the period 2010-2020, is focused on the development of knowledge and innovation based economy. Therefore currently the significance of economy sectors, based on the implementation of knowledge and innovation, keeps growing (Bishop, 2008), (Aslesen&Isaksen, 2007). The analysis of sectors defined as above, with particular emphasis on the importance of the so-called smart growth sectors including high and mid-tech manufacturing and knowledge-intensive services, constitutes the part of research explaining smart growth processes covering the space of the European Union Member States. The study attempts to evaluate the intensity of workforce concentration, with reference to particular sectors of the European Union Member States' economy, identified in terms of technological intensity and changes occurring in this area in the period 2008-2013. Moreover, the classification of the European Union countries was performed for the years 2008 and 2013 in relation to the concentration level of workforce number in the so-called smart growth sectors, which allowed for the identification of the EU countries, playing the role of growth poles which stimulate economic growth and attract investments, as well as the peripheries in which high and mid-tech manufacturing sectors and knowledge-intensive services do not concentrate.

1 The background of information and methodological research

In order to analyze concentration, understood as the diversification of spatial distribution, it is necessary to define the set of geographical areas and the economic phenomenon (variable) in the cross-section of sectors, the spatial distribution of which shall become the subject of the

conducted analysis. The spatial concentration study covers 28 European Union Member States and the workforce number in the cross-section of economy sectors identified by R&D expenditure intensity. The sector identification was performed based on NACE the Statistical Classification of Economic Activities in the European Community from 1997, updated and amended in 2008, which was developed by Eurostat and OECD (Science and Technology in 2007, 2009). In accordance with the above-mentioned classification the following sectors of research and development intensity were identified: high and medium high-technology manufacturing (HMH), low and medium low-technology manufacturing(LML),knowledge-intensive services (KIS), less knowledge-intensive services (LKIS), other sectors.

Due to the availability of comparable statistical data the research time span covers the period 2008-2013 (in accordance with NACE Rev. 2 classification). The indispensable statistical data were collected from Eurostat database.

Spatial concentration measurement is performed in order to specify whether the researched phenomenon values are similar in different regions, or concentrate only in just a few of them. In order to ensure comparability between regions the conducted spatial analyses, apart from the studied phenomenon, also cover the so-called weight variable, the spatial distribution of which is also taken into account. Lorenz curve, as well as many other measures, can be applied in spatial concentration studies. Such measures include e.g.: location quotients, Gini absolute and relative indices, Herfindahl-Hirschman, Isard index, divergence indices, Krugman index, the indices based on entropy measures, etc.[1] Concentration measures indicate an uneven disposal of the characteristics between the analysed geopgaphical areas.
Gini relative index is frequently applied in the assessment of spatial concentration level, which results from the empirical Lorenz curve, defined as follows:

$$G_i^* = 1 - \sum_{r=1;k=0}^{R} \left[v_{r(k+1)} - v_{r(k)} \right] \left[\lambda^i_{r(k+1)} + \lambda^i_{r(k)} \right] \qquad (1)$$

$$\lambda^i_{r(k)} = \sum_{r=1}^{k} \frac{x_{ri}}{x_{\cdot i}} \qquad v_{r(k)} = \sum_{r=1}^{k} \frac{x_{r\cdot}}{x_{\cdot\cdot}} \quad (2)$$

where: r, k= 1,…, R region number (R =28), i = 1,…, S sector number (S = 5), x_{ri}– workforce number in r-th region and i-th sector, $x_{r\cdot}$– total workforce number in r-th region, $x_{\cdot i}$– workforce number in i-th EU sector, $x_{\cdot\cdot}$– total workforce number in the EU.

[1]The studies by Overman and Combes (2004), Suchecki (2010), Mikrut, Constantin, Dimian and Dimian (2007), Plata-Perez, Sanchez-Perez, Sanchez-Sanchez (2015), Brülhart, Traeger (2005), Bosmans, Decanco, Decoster (2014), Guimaraes, Figueiredo, Woodward (2011) provide more information on the characteristics of concentration measures and the postulates referring to an ideal measure.

Location quotient represents a commonly used measure, applied in defining the regional intensity level of the studied phenomenon (Schweizog, Collins, 2015). Within the framework of the conducted study it was assumed that alocation quotient informs about the concentration of workforce number in a given sector of a particular EU country against this country weight defined as the share of workforce number in this country against the total European Union workforce. Location quotient is calculated in line with the below formula:

$$LQ_r^i = \frac{\frac{x_{ri}}{x_{\cdot i}}}{\frac{x_{r\cdot}}{x_{\cdot\cdot}}} \qquad (3)$$

Gini concentration relative index, presented as formula (1), adopts 0 value in case of the absence of the studied phenomenon spatial concentration. The index maximum value can be determined following the below formula:

$$\max G^* = 1 - \min \frac{x_{r\cdot}}{x_{\cdot\cdot}} \qquad (4)$$

If the concentration phenomenon is absent in a given region, the location quotient adopts the value of 1. LQ>1 coefficient value is defined as a relative excess of the studied phenomenon against the base, which means that a given region features a larger workforce share in a particular sector than the entire EU economy. Such phenomenon is interpreted as the occurrence of workforce concentration in a given regional economy sector. The value of LQ<1 is defined as a relative deficiency of the studied phenomenon against the base.

The analysis of spatial concentration for workforce number, in particular economy sectors of the EU Member States, was conducted in accordance with the following stages:

1. The identification of spatial concentration intensity level regarding workforce number in particular economy sectors of the European Union countries identified in line with R&D expenditure intensity and the assessment of concentration changes, in the period 2008-2013, based on the Gini concentration index relative values.
2. The assessment of workforce concentration in the particular European Union countries within smart growth sectors: high and medium high-technology manufacturing and knowledge-intensive services, having applied location quotients and their descriptive parameters. The analysis of changes occurring in this matter in the period 2008-2013.
3. The classification of the European Union countries by the values of location coefficients for the sector of high and medium high-technology manufacturing (HMH) and the sector of knowledge-intensive services (KIS).

Based on the range the intervals of location quotient values were determined (every 20% range) in the years 2008 and 2013. In order to maintain the comparability of classification results for both timespans constant interval limits of location quotient values were adopted, based on these measures range, determined for 2013.

4. An attempt to determine growth poles and peripheries for the sectors of high and medium high-technology manufacturing and knowledge-intensive services in the years 2008 and 2013.

2 The assessment of workforce spatial concentration in economy sectors identified by R&D expenditure intensity in the European Union countries

Figure 1 presents values of the Gini relative index for 5 economy sectors in the European Union countries, identified in terms of technological advancement. The entire period under analysis was characterized by a significantly larger workforce concentration in the European Union countries in the sectors of high and medium high-technology manufacturing, which means that employment in this sector was unevenly distributed in the European Union countries. The Gini index was increasing from the value of about 0,21 in the period 2008-2009 up to about 0,24 in 2013. It was the only economy sector which featured such noticeable workforce concentration rise.

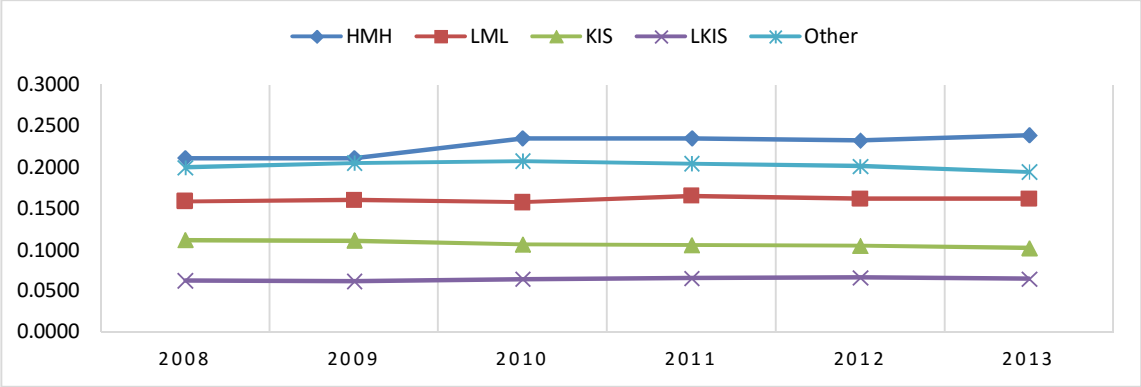
In 2008-2013 the EU Member States recorded the definitely most even distribution of workforce in the less knowledge-intensive services. Workforce spatial distribution was stable in the entire period under analysis. The Gini relative index adopted values of about 0,06. A relatively even distribution of workforce in the particular EU countries was also recorded in the second smart growth sector, i.e. knowledge-intensive services. In 2008 Gini index presented the value of about 0,11, whereas in the subsequent years it showed a slight decreasing tendency. It is characteristic that a slightly lower concentration, against HMH sector, was observed in the so-called other sectors (with the dominant role of agriculture), featuring the lowest technological intensity. Workforce concentration level in the discussed sectors, measured by the Gini relative index, amounted to about 0,20. Both workforce number concentration level in the European Union countries and the arrangement of economy sectors were characterized by stability in the entire studied period.

Fig. 2 presents the arrangement of the EU countries by the location quotient values in the sectors of high and medium high-technology manufacturing and knowledge-intensive services. The following countries present the highest workforce share in the sector of high and medium high-technology manufacturing: Czech Republic, Slovakia, Germany and Slovenia.

It is well visible that in 2013 the discussed share went up. The LQ in these countries exceeded the value of 1,5, which confirms very high workforce concentration. Deficiencies in this matter, against the EU economy, were observed in Luxemburg, Cyprus and Greece. The location quotient for the sector of knowledge-intensive services adopted the highest values for Luxemburg and Sweden, i.e. the countries presenting the highest workforce share in the sector of knowledge-intensive services and definitely the lowest in Romania (LQ was about 0,5).

Picture 3 presents the changes in location quotient values in 2013 against 2008, referring to HMH and KIS sectors. The highest absolute increase of the location quotient values, related to workforce in high-tech manufacturing sector, was recorded in the Czech Republic and Austria (about 0,2), whereas the highest decrease was observed in Sweden and Belgium (about -0,15). In case of knowledge-intensive services, both increasing and decreasing values of the LQ were much smaller and did not exceed the value of 0,1.

Fig. 1: The values of Gini relative index for the analyzed economy sectors of the European Union countries in the period 2008-2013

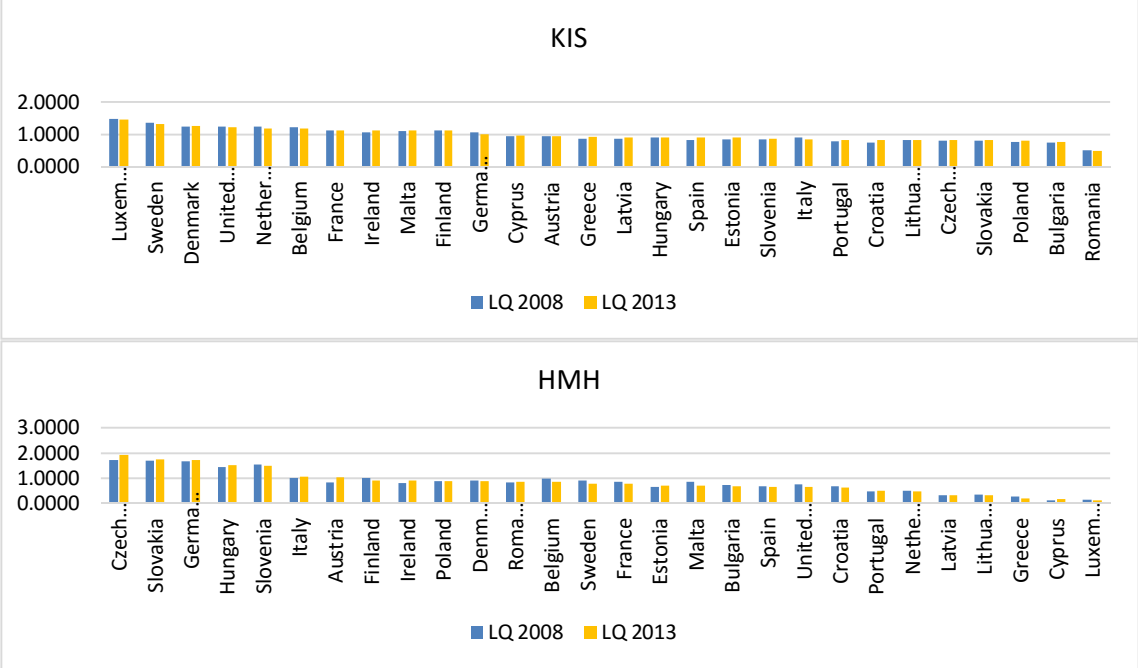


Source: authors' estimations and compilation based on Eurostat database.

Table 1 illustrates values of LQ basic descriptive parameters calculated for HMH and KIS sectors. The analysis of data included in the table shows that workforce spatial distribution, in the particular European Union countries, presented a definitely more uneven nature in case of high and medium high-technology manufacturing sector than in case of knowledge-intensive services. The variability coefficient of location quotients for HMH sector in 2008 was very high, i.e. over 52%, whereas in 2013 it grew even higher up to almost 56%. In case of KIS sector, in 2008 the variability coefficient for LQ was over 22,7% and in 2013 it still dropped by over 2 percentage points. It means that the workforce employed in

knowledge-intensive services remained much more evenly distributed in the particular European Union countries than it was observed in HMH manufacturing.

Fig. 2: The values of location quotients for workforce in high and medium high-technology manufacturing sectors (HMH) and knowledge-intensive services (KIS) in the years 2008 and 2013, arranged by decreasing values in 2013



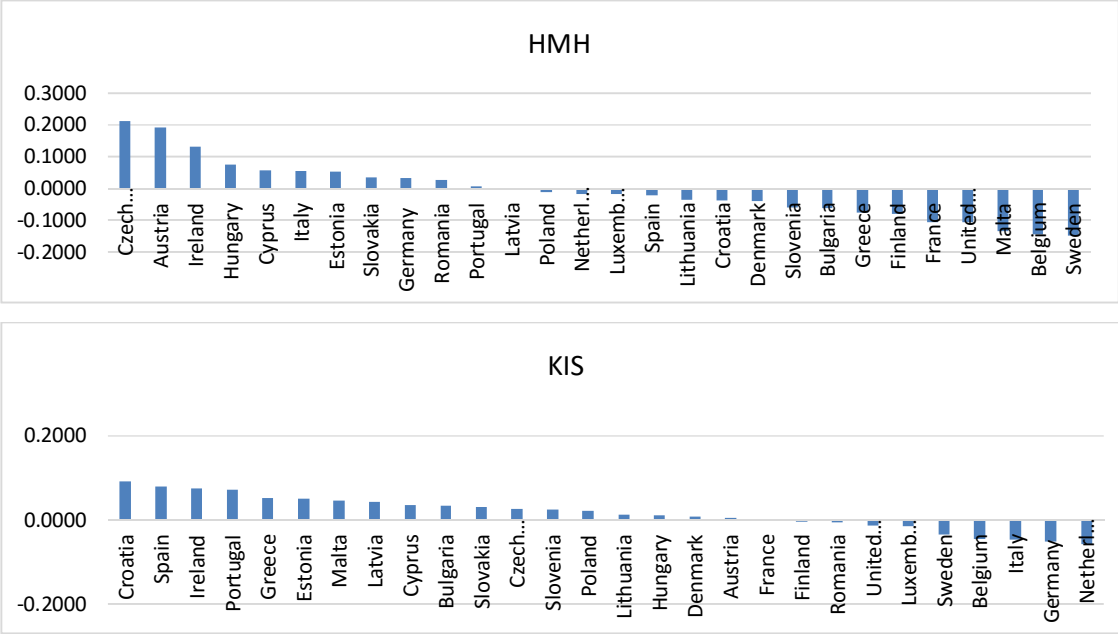
Source: authors' estimations and compilation based on Eurostat database.

Five classes of countries, characterized by different workforce levels, were identified in this sector. Class V includes the European Union countries which can be referred to as growth poles. In the years 2008 and 2013 it covered the countries presenting the highest employment rate in HMH sector: Slovenia, Hungary, Germany, Slovakia and the Czech Republic. The countries listed in the first group should be treated as peripheries in line with the theory of polarization. In 2008 this class covered: Luxemburg, Cyprus, Lithuania, Latvia and Portugal, whereas in 2013 the place of Portugal was taken by The Netherlands.

Table 2 presents classification results of the EU countries in terms of location quotient values for HMH sector workforce. Table 3 presents the classification of the EU countries in terms of location quotient values for the workforce employed in knowledge-intensive services

sector. In the fifth class Sweden and Luxemburg were listed among the growth poles in 2008 and 2013, while the first – peripheral class included Romania.

Fig. 3: Absolute increases of the location quotient values for high and medium high-technology manufacturing sectors (HMH) and knowledge-intensive services (KIS) in 2013 against 2008.



Source: authors' estimations and compilation based on Eurostat database.

Tab. 1: Descriptive parameters of the LG for high and medium high-technology manufacturing sectors and knowledge-intensive services in the years 2008 and 2013

Descriptive parameters	HMH		KIS	
	LQ 2008	LQ 2013	LQ 2008	LQ 2013
Min	0,17	0,15	0,52	0,51
Max	1,72	1,94	1,48	1,47
Range	1,56	1,79	0,97	0,96
Median	0,84	0,78	0,91	0,93
Variation coefficient in (%)	52,06	55,98	22,72	20,52

Source: authors' estimations based on Eurostat database.

Tab. 2: The classification of the European Union countries in terms of location quotient values for high and medium high-technology manufacturing sector (HMH)

Classes	LQ value ranges	Countries	
		2008	2013
I	[0,15; 0,51)	Luxembourg, Cyprus, Greece, Lithuania, Latvia, Portugal,	Luxembourg, Cyprus, Greece, Lithuania, Latvia, Netherlands
II	[0,51; 0,86)	Netherlands, Croatia, United Kingdom, Spain, Bulgaria, Malta, Estonia, Romania, Ireland, Austria	Portugal, Croatia, United Kingdom, Spain, Bulgaria, Malta, Estonia, France, Sweden, Belgium, Romania
III	[0,86; 1,22)	France, Sweden, Belgium, Denmark, Poland, Finland, Italy	Denmark, Poland, Ireland, Finland, Austria, Italy

IV	[1,22; 1,43)	-	-
V	[1,43; 1,94)	Slovenia, Hungary, Germany, Slovakia, Czech Republic	Slovenia, Hungary, Germany, Slovakia, Czech Republic

Source: authors' estimations based on Eurostat database.

Tab. 3: The classification of the European Union countries in terms of location quotient values for knowledge-intensive services sector (KIS)

Classes	LQ value ranges	Countries	
		2008	2013
I	[0,51; 0,70)	Romania	Romania
II	[0,70; 0,89)	Bulgaria, Poland, Slovakia, Czech Republic, Lithuania, Croatia, Portugal, Slovenia, Estonia, Spain, Latvia, Greece	Bulgaria, Poland, Slovakia, Czech Republic, Lithuania, Croatia, Portugal, Italy, Slovenia
III	[0,89; 1,09)	Italy, Hungary, Austria, Cyprus, Germany	Estonia, Spain, Hungary, Latvia, Greece, Austria, Cyprus, Germany
IV	[1,09; 1,28)	Finland, Malta, Ireland, France, Belgium, Netherlands, United Kingdom, Denmark	Finland, Malta, Ireland, France, Belgium, Netherlands, United Kingdom, Denmark
V	[1,28; 1,47)	Sweden, Luxembourg	Sweden, Luxembourg

Source: authors' estimations based on Eurostat database.

In case of both HMH and KIS sector, the classification results for 2008 and 2013 are only slightly different. It results from the fact that the structural transformations occurring in economy are of evolutionary nature, which is also true for changes in workforce structure and therefore, it was highly predictable that the adopted research period 2008-2013 did not result in any radical changes of workforce spatial distribution in the European Union countries.

Conclusions

The conducted analysis of workforce spatial concentration in economy sectors identified in terms of research and development expenditure intensity, covering the European Union countries in the period 2008-2013, allows to put forward the following conclusions:

1. The highest spatial concentration of the EU workforce, in the entire period under analysis, was recorded in high and medium high-technology manufacturing sector, whereas the lowest in less knowledge-intensive services sector, followed by the sector of knowledge-intensive services.
2. The intensity of workforce spatial concentration in the EU countries, measured applying the Gini concentration relative index, within the studied period, did not present any significant changes. Workforce concentration growth was observed only in case of HMH sector.
3. The highest workforce level in high and medium high-technology manufacturing sector was characteristic for Slovenia, Hungary, Germany, Slovakia and the Czech Republic. The location quotient in these countries exceeded the value of 1,40, and in case of the Czech Republic it amounted to 1,94, therefore these countries were

qualified for the class of growth poles. The class including peripheries covered five EU Member States.

4. The highest workforce level in the sector of knowledge-intensive services was recorded in Sweden and Luxemburg (growth poles) and the lowest in Romania (peripheral class).

The research on workforce spatial concentration in economy sectors identified by technological intensity can become an initial step for further analyses of spatial distribution, conducted at the level of the European Union NUTS 2 regions, and also for the identification purposes of regional growth factors.

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