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Knowledge-Intensive Business Services Employment Structure and Economic Development in EU Regions

Małgorzata Markowska https://orcid.org/0000-0003-4879-0112
Associate Professor, Wrocław University of Economics and Business, Wroclaw, Poland
e-mail: malgorzata.markowska@ue.wroc.pl

Petr Hlaváček https://orcid.org/0000-0002-3922-5739
Associate Professor, Jan Evangelista Purkyne University, Usti nad Labem, Czechia, e-mail: petr.hlavacek@ujep.cz

Danuta Strahl https://orcid.org/0000-0001-5036-5823
Professor, WSB University in Dąbrowa Górnicza, Faculty of Management, Poland, e-mail: dstrahl@wsb.edu.pl

Abstract

The study presents the results of grouping EU NUTS 2 regions based on the share of employment in particular sectors (knowledge-intensive high-technology services, knowledge-intensive market services and other knowledge-intensive services), as well as GDP per capita, in 2008 and 2018. The grouping of regions was done by clustering methods (for structure data), including Ward's method to determine the number of groups and the k-means for the final partition. GDP groups were defined using a sample mean and one standard deviation. To assess the similarity of the classifications and, consequently, to evaluate correlations between the employment structures and the level and pace of economic development, the similarity measure for partitions proposed by Sokołowski was used.

Keywords: structures of employment, GDP per capita, regions of NUTS 2, similarity

JEL: E24, J21, R11

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Introduction

The development of civilization and successive industrial revolutions have changed the economic structures at a different pace. Various methods of production, administration, and management in business, along with evolving customer service methods, have resulted in the emergence of knowledge-intensive employment, which has replaced traditional structures (with a predominance of agriculture and the significance of industry and complementary services).

In primitive civilizations, the share of people working in agriculture was 80%. However, Fourastié (1972) predicted that at the beginning of the third millennium, the share of people working in services in developed economies would reach almost 80%, while agriculture and industry would account for the remaining 20%. Indeed, in 2018, in the European Union (EU), the share of people working in services was 74%, industry and construction 22%, and agriculture 4% (Eurostat 2021c). The transformation in employment structure is also a result of the increasing reliance of both manufacturing and services on knowledge. The share of employment is continuously growing in the sections of knowledge-intensive high-technology services and knowledge-intensive market services. The diversification of the countries and regions of the EU in the employment shares in those sections is highly significant, as are the changes in these structures over time. The countries and regions of the EU also differ in the level and pace of development.

Therefore, the purpose of the study is to investigate the correlation between employment shares in the knowledge-intensive sections and the changes in these shares related to the level and pace of economic development, and to identify groups of regions with similar levels and paths of change.

Literature overview

Clark (1940), Fisher (1952), and Fourastié (1972) are considered the pioneers of structural change assessment, proposing the concept of three sectors in the economy. Their studies represent the first attempt to grasp the regularities and reasons for the transformations in employment structures. Further research was conducted in economics by Kuznets, Fuchs, Chenery, Sauvy, Menz, and Stigler (Kwiatkowski 1982). Structural changes are analyzed from the historical perspective (Pasinetti 1981; 1993; Schmenner 2009; Timmer 2009; Gabardo, Pereima, and Einloft 2017), but also to identify structural changes in the World Economy (Memedovic and Iapadre 2010; Lewis et al. 2022), the role of manufacturing and services in economic growth (Attiah 2019; Institute 2021), employment polarization (Bárány and Siegel 2018), industrial growth, economic integration and structural change (Kallioras and Petrakos 2010;

Cutrini 2019). There have also been comparative analyses of employment structures (Sepp, Kaldaru, and Eerma 2009; Cheba and Bąk 2019; Markowska, Strahl, and Sobczak 2019; Pacana and Siwiec 2019; Bumberova and Kanovska 2020), a decomposition of changes in structure and trends in employment (Markowska 2017; Kouvavas et al. 2019; Luquini et al. 2019), and the assessment of sector share in the diversification of employment structures and trends in sector structure changes of employment (Markowska and Sokołowski 2017).

Correlations between the level of development, economic growth, and employment structures have been assessed in terms of structural change and economic growth (Laitner 2000; Bianchi, Valle, and Tapia 2021) and employment growth in knowledge-intensive business services (KIBS) (Chadwick, Glasson, and Smith 2008; Amancio et al. 2021; Zięba 2021). Research has investigated different territories, like China (Cai and Wang 2010) and US Metropolitan Areas (Bieri 2012), as well as smaller territories, including Romanian NUTS 3 regions (Jula and Jula 2013), the NUTS 3 regions of the V4 Group (Szakálné Kanó and Lengyel 2021), the Madrid city-region (de Ávila Serrano 2020), and larger economic systems, i.e., OECD countries (Dietrich 2012).

As a result of the increasing importance of knowledge in development, changes in employment in the industry sector and knowledge-based services are also research subjects. They are assessed in terms of the determinants of market extension and regional innovation systems (Bettiol et al. 2013; Lewandowska, Pater, and Cywiński 2019), testing the growth effects of structural change (Hartwig 2012), the geographical distribution and regional specialization of KIBS (Delgado-Márquez and García-Velasco 2013; Gallego and Maroto 2015; de Ávila Serrano 2019), employment growth in KIBS (Chadwick, Glasson, and Smith 2008), business services as a production factor (Drejer 2002), KIBS: prospects and policies (Miles 2005), exploring the financial consequences of the servitization of manufacturing (Neely 2007), business services location and market factors (Rubalcaba et al. 2013; Colaço and de Abreu e Silva 2021), knowledge-intensive services in a core industrial economy (Strambach 2004), innovation and productivity growth in services sector (Uppenberg and Strauss 2010; Börsch-Supan, Hunker, and Weiss 2021; Kurbonov 2021; Vujanovic 2021;), knowledge-intensive services and a restructuring economy (Wood 2004a), knowledge-intensive services: the diversity of processes and policies (Wood 2004b), the significance of KIBS (Wood 2006), and the business service revolution (Wood 2004a).

Europe, as a community of countries, is covered by the research addressing the specialization in KIBS (Marelli 2004; Gallego and Maroto 2015; Sisi and Zubiaurre 2021), the evolution of employment structures (Marelli 2004; Markowska, Sokołowski, and Strahl 2019), similarities in employment structures (Sepp, Kaldaru, and Eerma 2009; Markowska, Strahl, and Sobczak 2019; Godlewska-Dzioboń 2020), innovation and productivity growth in the EU services sector (Uppenberg and Strauss 2010; Georgescu and Herman 2019; Börsch-Supan,

Hunker, and Weiss 2021), the business service revolution (Wood 2004c), the significance of KIBS in Europe (Wood 2006), and the diversity of processes and policies in knowledge-intensive services (Wood 2004b).

Analysis lower than the country level covers NUTS 2 regions, in which the research focuses on, among other things, the geographical distribution and regional specialization of KIBS (Delgado-Márquez and García-Velasco 2013; Markowska, Kusterka-Jefmańska, and Jefmański 2016, Sisi and Zubiaurre 2020), industrial growth, economic integration, and structural change (Kallioras and Petrakos 2010), the decomposition of changes in structure and employment trends (Markowska 2017) and the correlations between KIBS and the regional importance of KIBS (Wood 2006).

Method

In order to cluster EU NUTS 2 regions concerning KIBS employment and GDP level, and to compare both classifications, the following procedure was used: 1) the set of variables that refer to employment structures and the level of development were defined, 2) the research objects and years of analysis were identified (2008 and 2018), 3) for the data on employment structures, Ward's method (Ward 1963) was used to determine the number of groups, and the k-means method (MacQueen 1967) was used for final partition, 4) for the data on the level of development, regions were divided into four groups based on the sample mean and standard deviation of GDP per capita, 5) groups and mean values of variables in the groups were identified, the composition and changes in the groups were assessed, 6) the similarity of the partitions were assessed.

Research objects and variables

The analysis required that the variables be determined and statistical data be collected. The changes in employment structures in KIBS sectors were assessed using variables selected from the Eurostat database (Eurostat 2021a):

- HT – employment share in the knowledge-intensive high-technology services section,
- M – employment share in the knowledge-intensive market services section (except for financial intermediation and high-technology services),
- O – employment share in the other knowledge-intensive services section.

Two hundred and seventy-two out of 281 EU regions (i.e., 96.8%) at the NUTS 2 level (Commission Commission Regulation (EU) No. 2016/2066) were covered by the research. Due to data unavailability, the analysis did not cover the overseas regions

of France (Guadeloupe, Martinique, Guyana, La Réunion, Mayotte), Portugal (Região Autónoma dos Açores, Região Autónoma da Madeira), or Spain (Ciudad Autónoma de Ceuta, Ciudad Autónoma de Melilla).

The assessment of the basic statistics of the employment structure variables (HT, M and O) revealed that in 2018, for each variable, the mean and median values were higher than in 2008. Additionally, an increase in characteristics was recorded for the maximum employment shares in knowledge-intensive high-technology services and other knowledge-intensive services sections. Increases were also noted for the minimum and standard deviation for employment shares in knowledge-intensive high-technology services and knowledge-intensive market services sections. However, the minimum and standard deviation for employment shares in other knowledge-intensive services were lower. The coefficient of variation was lower for all variables.

It is also interesting to find that the number of regions in which the employment shares in 2018 significantly changed compared to 2008. And so, the employment share of the HT variable increased in 180 regions, for M in 214 regions, and for O in 206 regions. A higher employment share in 2018 dynamics, which exceeded 150%, was observed for HT (42 regions), M (17 regions), and O (1 region). Additionally, HT in 9 regions and M in 2 regions exceeded 200%. There was a decline in employment shares in 2018 to, at most, 90% of 2008's level for HT in 42 regions, for M in 28 regions, and for O in six regions.

The second set of variables covers the indicators that describe the level of development – GDP per capita (GDPpc) in thousand Euro PPS (Purchasing Power Standard). Interestingly, the regions with the highest (UKI3) and the lowest (BG31) GDPpc are the same in both years. In 2018, the borderline (maximum and minimum) mean and median values were higher. Twenty regions in 2018 had lower dynamics of changes in GDPpc. For two of them, NL11 and EL41, it amounted to only 80% of the 2008 level. By contrast, for 116 regions, it exceeded 120%, for 19 regions, it reached over 150%, and for one Irish region – Southern – it was more than 200% (Eurostat 2021b).

Classification of regions in terms of the employment structure in the KIBS sections

2008 results

With Ward's agglomerative hierarchical clustering method, the number of groups of regions was identified by looking at the first big increase in agglomerative distance. Then the k-means method was used to obtain the final partitions. The characteristics of the groups of regions are presented in Table 1, and the regions included in these

groups are shown in Table 2. Full names of regions together with acronyms are given in the Appendix.

Table 1. Characteristics of the groups – 2008

Group	Number of regions	Mean values of the variable			Sum of mean values	GDPpc – values in the group		
		HT	M	O		mean	min.	max.
A	13	6.8	11.5	29.3	47.6	47.9	30.4	147.5
B	39	4.4	7.8	29.6	41.8	33.3	18.6	68.4
C	83	2.2	5.0	32.6	39.8	24.8	16.6	48.2
D	70	1.9	5.2	24.4	31.5	25.4	10.2	44.8
E	67	1.3	3.3	19.3	23.9	17.1	7.3	34.0

Source: authors' compilation.

Table 1 also summarizes the mean and borderline values of GDPpc, calculated for the regions in the groups. The decreasing average employment share in knowledge-intensive high-technology services and knowledge-intensive market services sections is accompanied by a decreasing average level of GDP per capita (excluding group D).

Table 2. Number of regions from a given country and regions in the groups in 2008 – breakdown by employment structure

Group	Regions – acronym and number of regions from a given country
D (70)	DE (19), EE (1), IE (1), EL (3), ES (7), FR (2), HR (1), IT (17), CY (1), LV (1), HU (3), AT (6), PL (2), PT (1), FI (1), UK (4)
	DE11, DE13, DE14, DE23, DE24, DE25, DE26, DE27, DE91, DE93, DE94, DEA1, DEA3, DEA4, DEA5, DEB3, DED4, DEE0, DEG0; EE00; IE05; EL52, EL54, EL63; ES12, ES21, ES41, ES43, ES51, ES61, ES70; FRD2, FRF1; HR03; ITC1, ITC3, ITC4, ITH1, ITH2, ITH3, ITH4, ITH5, ITI1, ITI2, ITF1, ITF2, ITF3, ITF4, ITF5, ITF6, ITG2; CY00; LV00; HU12, HU23, HU32; AT11, AT12, AT21, AT22, AT32, AT33; PL42, PL63; PT18; FI1C; UKD1, UKF2, UKF3, UKM5
B (39)	BE (3), BG (1), DK (1), DE (7), EL (1), IT (1), LT (1), LU (1), MT (1), NL (5), AT (1), PT (1), RO (1), SI (1), SE (3), UK (9)
	BE10, BE24, BE31; BG41; DK01; DE12, DE21, DE30, DE60, DE71, DEA2, DED5; EL30; ITI4; LT01; LU00; MT00; NL23, NL31, NL32, NL33, NL41; AT13; PT17; RO32; SI04; SK01; SE12, SE22, SE23; UKD6, UKH2, UKH3, UKI5, UKI6, UKJ2, UKJ3, UKK1, UKM8
E (67)	BG (5), CZ (7), DE (1), EL (8), ES (9), HR (1), IT (1), LT (1), HU (4), AT (2), PL (14), PT (3), RO (7), SI (1), SK (3)
	BG31, BG32, BG33, BG34, BG42; CZ02, CZ03, CZ04, CZ05, CZ06, CZ07, CZ08; DE22; EL51, EL53, EL61, EL62, EL64, EL65, EL42, EL43; ES11, ES13, ES22, ES23, ES24, ES42, ES52, ES53, ES62; HR04; ITI3; LT02; HU21, HU22, HU31, HU33; AT31, AT34; PL21, PL22, PL41, PL43, PL51, PL52, PL61, PL62, PL71, PL72, PL81, PL82, PL84, PL92; PT11, PT15, PT16; RO11, RO12, RO21, RO22, RO31, RO41, RO42; SI03; SK02, SK03, SK04

Group	Regions – acronym and number of regions from a given country
C (83)	BE (8), DK (4), DE (11), IE (1), EL (1), FR (19), IT (2), NL (7), FI (2), SE (4), UK (24)
	BE21, BE22, BE23, BE25, BE32, BE33, BE34, BE35; DK02, DK03, DK04, DK05; DE40, DE50, DE72, DE73, DE80, DE92, DEB1, DEB2, DEC0, DED2, DEF0; IE04; EL41; FRB0, FRC1, FRC2, FRD1, FRE1, FRE2, FRF2, FRF3, FRG0, FRH0, FRI1, FRI2, FRI3, FRJ1, FRJ2, FRK1, FRK2, FRL0, FRM0; ITC2, ITG1; NL11, NL12, NL13, NL21, NL22, NL34, NL42; FI19, FI1D; SE21, SE31, SE32, SE33; UKC1, UKC2, UKD3, UKD4, UKD7; UKE1, UKE2, UKE3, UKE4, UKF1, UKG1, UKG2, UKG3, UKH1, UKJ4, UKK2, UKK3, UKK4, UKL1, UKL2, UKM6, UKM7, UKM9, UKN0
A (13)	CZ (1), IE (1), ES (1), FR (1), HU (1), PL (1), FI (2), SE (1), UK (4)
	CZ01; IE06; ES30; FR10; HU11; PL91; FI1B, FI20; SE11; UKI3, UKI4, UKI7; UKJ1

Source: authors' compilation.

The names of groups A-E correspond to the decreasing intensity related to the sum of mean values in the groups of regions. Group A, which covers 13 regions, has the highest average employment share in the knowledge-intensive high-technology services and knowledge-intensive market services sections. The subsequent groups, due to employment shares in these sections, mostly have regressively lower values. The most numerous group – group C – which covers 83 regions, shows the highest average employment share in the knowledge-intensive services section.

2018 results

In this section, the k-means method was again used to cluster the EU regions into the number of groups identified in Ward's dendrogram. The initial characteristic of the groups of regions identified based on employment shares in the analyzed sections is provided in Table 3, and the regions assigned to these groups are shown in Table 4.

Table 3. Characteristics of the groups – 2018

Group	Number of regions	Mean values of the variable			Sum of mean values	GDPpc – values in the group		
		HT	M	O		mean	min.	max.
A	17	7.6	11.3	28.3	47.2	55.6	25.4	190.5
B	43	4.2	9.1	31.1	44.4	37.2	14.4	80.9
C	66	2.4	5.9	34.6	42.9	27.8	14.9	46.3
D	81	1.9	4.8	27.8	34.5	28.8	14.1	69.2
E	65	1.9	4.6	20.5	27.0	22.6	10.3	43.9

Source: authors' compilation.

Table 4. Number of regions from a given country and regions in the groups in 2018 – breakdown by employment structure

Group	Regions – acronym and number of regions from a given country
A (17)	BE (1), BG (1), CZ (1), IE (1), ES (1), FR (1), HU (1), PL (1), RO (1), SK (1), FI (1), SE (1), UK (5)
	BE10; BG41; CZ01; IE06; ES30; FR10; HU11l; PL91; RO32; SK01; FI1B; SE11; UKI3, UKI4, UKI6, UKI7; UKJ1
B (43)	BE (3), DK (1), DE (5), EL (2), FR (1), IT (2), CY (1), LT (1), MT (1), NL (7), AT (1), PT (1), SI (1), FI (1), SE (3), UK (11)
	BE21, BE24, BE31; DK01; DE21, DE30, DE60, DE71, DEA2; EL30, EL41; FRJ2; ITC3, ITI4; CY00; LT01; LU00; MT00; NL11, NL22, NL23, NL31, NL32, NL33, NL41; AT13; PT17; SI04; FI20; SE12, SE22, SE23; UKD3, UKD6, UKG1, UKH1, UKH2, UKH3, UKI5, UKJ2, UKJ3, UKK1, UKL2
C (66)	BE (7), DK (4), DE (6), EL (1), FR (14), IT (1), NL (3), FI (3), SE (4), UK (23)
	BE22, BE23, BE25, BE32, BE33, BE34, BE35; DK02, DK03, DK04, DK05; DE40, DE50, DE72, DED2, DED5, DEF0; EL54; FRB0, FRC1, FRC2, FRD2, FRE1, FRE2, FRH0, FRI1, FRI2, FRJ1, FRK1, FRK2, FRL0, FRM0; ITC2; NL12, NL13, NL21; FI19, FI1C, FI1D; SE21, SE31, SE32, SE33; UKC1, UKC2, UKD1, UKD4, UKD7, UKE2, UKE3, UKE4, UKF1, UKF2, UKF3, UKG2, UKG3, UKJ4, UKK2, UKK3, UKK4, UKL1, UKM6, UKM7, UKM8, UKM9, UKN0
D (81)	DE (27), EE (1), IE (2), EL (4), ES (9), FR (6), HR (1), IT (8), LV (1), LT (1), HU (4), NL (2), AT (6), PL (2), PT (3), SK (2), UK (2)
	DE11, DE12, DE13, DE14, DE22, DE23, DE24, DE25, DE26, DE27, DE73, DE80, DE91, DE92, DE93, DE94, DEA1, DEA3, DEA4, DEA5, DEB1 Koblenz, DEB2 Trier, DEB3, DEC0, DED4, DEE0, DEG0; EE00; IE04, IE05; EL51, EL52, EL53, EL61; ES11, ES12, ES13, ES21, ES24, ES41, ES42, ES43, ES61; FRD1, FRF1, FRF2, FRF3, FRG0, FRI3; HR03; ITH1, ITH2, ITF2, ITF3, ITF5, ITF6, ITG1, ITG2; LV00; LT02; HU23, HU31, HU32, HU33; NL34, NL42; AT11, AT12, AT21, AT22, AT32, AT33; PL42, PL62; PT15, PT16, PT18; SK03, SK04; UKE1, UKM5
E (65)	BG (5), CZ (7), EL (6), ES (7), HR (1), IT (10), HU (3), AT (2), PL (14), PT (1), RO (7), SI (1), SK (1)
	BG31, BG32, BG33, BG34, BG42; CZ02, CZ03, CZ04, CZ05 CZ06, CZ07, CZ08; EL62, EL63, EL64, EL65, EL42, EL43; ES22, ES23, ES51, ES52, ES53, ES62, ES70; HR04; ITC1, ITC4, ITH3, ITH4, ITH5, ITI1, ITI2, ITI3, ITF1, ITF4; HU12, HU21, HU22; AT31, AT34; PL21, PL22, PL41, PL43, PL51, PL52, PL61, PL63, PL71, PL72, PL81, PL82, PL84, PL92; PT11; RO11, RO12, RO21, RO22, RO31, RO41, RO42; SI03; SK02

Source: authors' compilation.

Group A comprises 17 regions and is characterized by the highest mean values of the HT and M variables. In the subsequent groups, the mean values of these variables get smaller. Group C, with 66 regions, has the highest share in the Other knowledge-intensive services section. The table also shows the mean and borderline values of GDPpc for the regions in these groups.

Like the classification for 2008, the decreasing average employment share in the knowledge-intensive high-technology services and knowledge-intensive market services sections accompanies the decreasing average level of GDPpc (except for group D). Table 4 provides the list of regions included in the groups.

Regional clustering by GDP per capita

2008 results

In order to define the groups of EU regions at the NUTS 2 level based on GDPpc, we are using the mean value and standard deviation. The first group covers the regions where the GDPpc is higher than the average plus standard deviation. The second group comprises the regions for which the variable value is lower than this limit but higher than the mean value. The third group includes regions characterized by a GDPpc that is below the average but higher than the mean value minus standard deviation. The fourth group consists of the regions where the GDPpc is lower than the mean value minus standard deviation. Table 5 presents the characteristics of the groups of regions.

The groups of NUTS 2 regions identified in terms of GDPpc values are characterized by the fact that the increasingly lower ranges of GDPpc level go along with the decreasing mean values of employment shares in the sections of knowledge-intensive high-technology services, knowledge-intensive market services and other knowledge-intensive services. The sums of average shares in the groups I-IV were, respectively, 43.1, 36.2, 33.7, and 23.9.

Table 5. Characteristics of the groups – 2008

Group	Number of regions	Group limits	GDPpc value in the group			Values of variables in the groups identified according to the level of GDPpc								
						HT			M			O		
			mean	max	min	mean	max	min	mean	max	min	mean	max	min
I	24	>37.1	48.5	147.5	37.5	4.8	7.8	1.3	9.1	19.7	4.4	29.2	36.3	22.9
II	97	25.4–37.1	30.0	36.5	25.4	2.8	7.8	0.9	6.0	13.0	3.4	27.4	27.4	16.5
III	121	13.6–25.4	21.0	25.1	14.0	1.9	6.7	0.4	4.7	9.1	1.6	27.1	27.1	12.7
IV	30	<13.6	12.6	13.4	7.3	1.1	1.9	0.6	2.8	5.3	1.0	20.0	20.0	11.7

Source: authors' compilation.

The technique used to determine the "ranges" for including regions in particular groups imposed their progressively lower mean values, as well as the decreasing values of these ranges.

2018 results

The previously described technique for determining ranges used in grouping the regions according to GDPpc was also used for the data from 2018 (cf. Table 6).

Table 6. Characteristics of the groups – 2018

Group	Number of regions	Group limits	GDPpc value in the group			Values of variables in the groups identified according to the level of GDPpc								
						HT			M			O		
			mean	max	min	mean	max	min	mean	max	min	mean	max	min
I	24	>44.5	59.5	190.5	44.6	5.6	9.6	1.9	9.6	17.0	4.3	28.5	37.0	22.3
II	89	30.0–44.5	35.6	44.5	30.1	3.1	9.1	1.0	6.9	15.5	3.2	29.5	42.9	18.4
III	143	15.5–30.0	23.4	29.7	15.5	2.2	6.9	0.7	5.3	13.6	2.6	28.0	41.7	13.2
IV	16	<15.5	13.7	15.4	10.3	1.6	4.8	0.7	3.5	6.4	1.4	23.1	30.3	10.7

Source: author's compilation.

In 2018, the regions grouped by GDPpc regarding the HT and M variables were characterized by increasingly lower ranges of GDPpc and decreasing mean values of employment shares in the two sections. The sums of average shares in groups I-IV were, respectively, 43.7, 39.5, 35.3 and 28.2.

Changes and similarities in regional clustering

Based on the employment structure in 2008 and 2018

Compiling the results of grouping the EU regions by employment structure allows us to assess changes in the classifications. Table 7 presents the number of regions that were included in groups with similar employment structures (i.e., average shares) in both classifications in both years.

Table 7. Number of regions in the groups according to employment structure – 2008 and 2018 classifications

Specification	A 2018	B 2018	C 2018	D 2018	E 2018	Total
A 2008	12 (92.31)	1 (7.69)				13
B 2008	5 (12.82)	31 (79.49)	2 (5.13)	1 (2.56)		39
C 2008		9 (10.84)	58 (69.88)	16 (19.28)		83
D 2008		2 (2.86)	6 (8.57)	48 (68.57)	14 (20.0)	70
E 2008				16 (23.88)	51 (76.12)	67
Total	17	43	66	81	65	272

Note: row % are given in parenthesis.
Source: author's compilation.

After adding the number of regions that were included in the groups characterized by similar "parameters" of employment structures in both years, the total number reached 200, i.e., 73.5% of all the assessed regions. Table 8 lists the regions that changed position. Of the 272 regions, 72 i.e. 26.5% changed position.

Table 8. Regions that changed classification positions in terms of employment structures in the respective sections in 2018

Group in year		Number of regions	Regions (acronym)
2008	2018		
A	B	1	FI20
B	A	5	BE10, BG41, SK01, UKI6
	C	2	DED5, UKM8
	D	1	DE12
C	B	9	BE21, EL41, FRJ2, NL11, NL22, UKD3, UKG1, UKH1, UKL2
	D	16	DE73, DE80, DE92, DEB1, DEB2, DEC0, IE04, FRD1, FRF2, FRF3, FRG0, FRI3, ITG1, NL34, NL42, UKE1
D	B	2	ITC3, CY00
	C	6	EL54, FRD2, FI1C, UKD1, UKF2, UKF3
	E	14	EL63, ES51, ES70, ITC1, ITC4, ITH3, ITH4, ITH5, ITI1, ITI2, ITF1, ITF4, HU12, PL63
E	D	16	DE22, EL51, EL53, EL61, ES11, ES13, ES24, ES42, LT02, HU31, HU33, PL62, PT15, PT16, SK03, SK04

Source: author's compilation.

Based on the GDPpc in 2008 and 2018

Initially, the similarity of the regional classifications was assessed by comparing the number of regions that had the same GDP values per capita regarding similar parameters in both years. Group III was the most numerous and most stable in terms of the number of regions covered in both years, followed by group II (Table 9).

Table 9. Regions in the groups according to GDP per capita – 2008 and 2018 classifications

Specification	I 2018	II 2018	III 2018	IV 2018	Total
I 2008	20 (83.3)	4 (16.7)			24
II 2008	4 (4.1)	80 (82.5)	13 (13.4)		97
III 2008		5 (4.1)	113 (93.4)	3 (2.5)	121

IV 2008			17 (56.7)	13 (43.3)	30
Total	24	89	143	16	272

Note: % from the row is given in parenthesis.
Source: authors' compilation.

Twenty regions were moved to a "lower" group and 26 to a "higher" one, which means that 226 regions, i.e., over 83%, were included in the same groups of regions in terms of GDPpc parameters. Twenty regions in both years were always listed in group I, 80 in group II, 113 in group III, and 13 in group IV (Table 10).

Table 10. Regions in the groups identified in terms of GDPpc in 2008 and 2018

Group in year		Number of regions	Regions (acronym)
2008	2018		
I		20	BE10, CZ01, IE06, FR10, SK01, SE11, UKI3, UKI4, DK01, DE21, DE60, DE50, DE11, DE71, LU00, NL31, NL32, AT13, ITH1, AT32
II	I	4	HU11, PL91, RO32, IE05
I	II	4	FI1B, UKJ1, NL11, UKM5
II		80	BE21, BE24, BE31, BE23, BE25, PT17, SI04, FI20, SE12, SE22, SE23, SE21, SE31, SE32, SE33, UKD6 UKH2, UKJ2, UKJ3, UKI7, UKK1, DK03, DK04, DK05, DE72, DEF0, FRK2, FI19, FI1C, UKM7, DE12, DE13, DE14, DE22, DE23, DE24, DE25, DE26, DE27, DE73, DE91, DE92, DE94, DEA1, DEA3, DEA4, DEA5, DEB1, DEB3, DEC0, DE30, DEA2, NL34, NL42, NL22, NL33, NL41, NL21, AT12, AT21, AT22 S, AT33, AT31, AT34, ES22, ES51, ES53, ES21, ES24, ES30, ITC1, ITC4, ITH3, ITH4, ITH5, ITI1, ITC3, ITI4, ITH2, ITC2
III	II	5	LT01, MT00, NL23, UKG1, DED5
II	III	13	UKI6, EL30, CY00, UKH1, NL12, NL13, FI1D, UKE2, UKM6, EL42, ES23, ITI2, ITI3
III		113	BG41, FRJ2, UKD3, UKH3, UKI5, UKL2, BE22, BE32, BE33, BE34, BE35, DK02, DE40, DED2, FRB0, FRC1, FRC2, FRD2, FRE1, FRE2, FRH0, FRI1, FRI2, FRJ1, FRK1, FRL0, FRM0, UKC1, UKC2 UKD1, UKD4, UKD7, UKE3, UKE4, UKF1, UKF2, UKF3, UKG2, UKG3, UKJ4 Kent, UKK2, UKK3, UKK4, UKL1, UKM8, UKM9, UKN0, DE80DE93, DEB2 Trier, DED4, DEE0, DEG0, EE00, IE04, EL52, EL53, EL61, ES11, ES12, ES13, ES41, ES42, ES43, ES61, FRD1, FRF1, FRF2, FRF3, FRG0, FRI3, HR03, ITF2, ITF3, ITF5, ITF6, ITG1, ITG2, LV00, AT11, PT15, PT16, PT18, SK03, UKE1, CZ02, CZ03, CZ04, CZ05, CZ06, CZ07, CZ08, EL62, EL63, EL64, EL65, EL43, ES52, ES62, ES70, HR04, ITF1, ITF4, HU12, HU21, HU22, PL22, PL41, PL51, PT11, RO42, SI03, SK02
IV	III	17	LT02, HU33, PL42, SK04, PL21, PL43, PL52, PL61, PL63, PL71, PL72, PL84, PL92, RO11, RO12, RO22, RO31
III	IV	3	EL41, EL54 , EL51

Group in year		Number of regions	Regions (acronym)
2008	2018		
IV		13	HU23, HU31, HU32, PL62, BG31, BG32, BG33, BG34, BG42, PL81, PL82, RO21, RO41

Source: author's compilation.

Similarity of classifications

The assessment of the classification similarity was performed using the similarity measure proposed by Sokołowski (1976; see also Rand 1971), as shown in Table 11. The similarity coefficients demonstrate what portion of pairs of objects were identically classified (pair of objects together or separately) in both classifications. The study focused on assessing the similarity of the groups of EU NUTS 2 regions based on the employment structure in KIBS sections, and the level of development assessed using GDPpc.

Table 11. The similarity of classifications

Specification	Sections 2008	Sections 2018	GDPpc 2008	GDPpc 2018
Sections 2008	1	0.799	0.625	0.605
Sections 2018	0.799	1	0.615	0.595
GDPpc 2008	0.625	0.615	1	0.807
GDPpc 2018	0.605	0.595	0.807	1

Source: author's compilation.

The assessment was performed from different perspectives, i.e., sections, level of development and years. The largest similarity of divisions (0.807) is characteristic for the regions grouped according to the level of development in 2008 and 2018, followed by employment in the service sections regarding the intensity of using knowledge in 2008 and 2018, and next groups of regions from the EU countries in 2008 in terms of the employment structure in the analyzed sections and the level of development (0.625). Generally, the level of similarity of analyzed partitions can be evaluated as moderate.

Conclusions

The multivariate data analysis methods made it possible to identify groups of regions that are similar due to their employment structures in KIBS sections and the level of development, and changes and similarities in the classifications for 2008 and 2018. It also made it possible to assess these regions' allocation in relation to the shifts and similarities, covering the countries that have joined the EU since 2004.

The shifts of regions to "better" mean an increase in employment share in KIBS sections (38 regions), and to the groups with the smallest numbers, there is an increase in the GDPpc (26 regions). At the same time, no changes in classification were observed for 200 regions regarding the employment structure in KIBS sections in both analyzed years, or for 226 regions regarding GDPpc. In total, 172 EU regions were simultaneously in the same groups in terms of employment structure and GDPpc, i.e., over 63%. This situation means that in the analyzed period, the majority of EU regions recorded stagnation in the structure and level of development.

There are many regions (34) – covering whole countries, including Austria, Denmark, Czechia, Croatia, Sweden and Slovenia, and three country-regions, i.e., Estonia, Luxembourg and Latvia – which were allocated to the same groups in terms of employment structure and development level in both years. The regions from Belgium, Bulgaria, France, and Portugal (25 in total) are included in the same groups based on development level in both years. Malta is a country-region that, based on the employment structure, was placed in the same group in both years.

More than half of the regions (32 out of 61) from the countries that joined the EU in 2004 were placed in the same group in both years in terms of employment structure and development level:

- CZ01 was in group A and group I.
- SI02 was in group B and group II.
- SI04, HR03, EE00, and LV00 were in group D and group III.
- The remaining 7 Czech regions (CZ02–CZ08), three Polish regions (PL22, PL41, and PL51), as well as two Hungarian (HU21 and HU22), one Slovak (SK02), one Romanian (RO04), one Croatian (HR04) and one Slovenian (SI03) region were in group III and group E.
- Two Hungarian regions (HU23 and HU32) were in group D and group IV.
- Five Bulgarian (BG31, BG32, BG33, BG34, and BG42), two Polish (PL81 and PL82) and two Romanian (RO21 and RO41) regions were in group IV and group E.

The movement to "better" groups was recorded for 38 regions in terms of:

1. **both classification systems** for five EU regions, including four that joined the EU in 2004.
   - RO32 moved from group B to A and from group II to I;
   - UKG1 moved from group C to B and from group III to II;
   - LT02, HU33, and SK04 moved from group E to D and from group IV to III;
2. **the level of development for 26 regions:**
   - four regions moved from group II to I, including three that joined the EU in 2004: HU11, PL91 (the capital region), RO32 and IE05 from group A;
   - five regions moved from group III to II, including one that joined the EU in 2004: LT01, MT00, NL23 (group B in terms of the employment structure), DED5 (it went from B to C), and UKG1 (from group C to B);
   - 17 regions moved from group IV to III, including twelve that joined the EU in 2004 and which were classified E in terms of employment structure: eight Polish regions (PL21, PL43, PL52, PL61, PL71, PL72, PL84, PL92) and four Romanian regions (RO11, RO12, RO22, RO31);
3. **the employment structure for 38 regions:**
   - five regions moved from group B to A, including three that joined the EU in 2004: BE10, SK01 (group I), RO32 (from II to I), UKI6 (although it moved from group II to III), BG41 (stable level of development);
   - nine regions moved from group C to B: NL11 (group I to II), BE21 and NL22 (stable in group II), UKH1 (although it moved from group II to III), UKG1 (group III to II), FRJ2, UKD3, UKL2 (stable in group III), and EL41 (although it moved from group III to IV);
   - two regions moved from group D to B, including one new EU member – this is the only "leap" by two groups: ITC3 (stable in group II), CY00 (group II to III);
   - six regions moved from group D to C: FRD2, UKD1, UKF2, UKF3, and FI1C (stable in group III), and EL53 (although it moved from group III to IV);
   - 16 regions moved from group E to D, including six new EU members: DE22 and ES24 (stable in group II), EL53, EL61, ES11, ES13, ES42, PT15, PT16, and SK03 (stable in group III), HU31 and PL62 (stable in group IV), EL51 (although it moved from group III to IV), and LT02, HU33, and SK04 (group IV to III).

Negative changes occurred for 34 regions:

1. **the Italian region ITI2 moved for both classification systems, from group D to E and from II to III;**
2. **in terms of the level of development:**
   - four regions moved from I to II: FI1B and UKJ1 (both in group A), NL11 (although it moved from group C to B), and UKM5 (stable in group D);
   - 13 regions moved from II to III, including one new EU region: NL12, NL13, FI1D, UKE2, and UKM6 (stable in group C), EL42, ES23, ITI3 (stable in group E), EL30 (stable in group B), UKI6 (although it moved from B to A), UKH1 (although it moved from C to B), CY00 (although it moved from D to B), and ITI2 (from D to E);
   - three regions moved from III to IV, although they all improved in terms of employment structure: EL41 (from C to B), EL54 (from D to C), and EL51 (from E to D);
3. **in terms of employment structure:**
   - region FI20 from A to B (stable in group II);
   - two regions moved from B to C: UKM8 (stable in group III) and DED5 (although it moved from group III to II);
   - one moved from B to D: DE12 (stable in group II);
   - 16 regions moved from C to D: DE73, DE92, DEB1, DEC0, NL34, NL42 (stable in group II), and DE80, DEB2, IE04, FRD1, FRF2, FRF3, FRG0, FRI3, ITG1, and UKE1 (stable in group III);
   - 14 regions moved from D to E: ES51, ITC1, ITC4, ITH3, ITH4, ITH5, and ITI1 (stable in group II), EL63, ES70, ITF1, ITF4, and HU12 (stable in group III), ITI2 (from group II to III), and PL63 (from III to IV).

The main finding observed in the 2008 and 2018 classifications of Central and Eastern Europe regions (i.e., Poland, Czechia, Bulgaria, Hungary, Romania, Slovakia, Slovenia, Latvia, Lithuania, and Estonia) based on the KIBS employment structure is the high level of cluster stability. Eighty-eight percent of the 59 regions were in the same clusters, and most were in groups with lower employment rates in all economic sections. Seven regions improved, moving from group B to A (regions with capital cities, i.e., BG41 Yugozapaden, RO32 Bucuresti – Ilfov, and SK01 Bratislavský kraj) or from E to D (HU31 Észak-Magyarország, SK03 Stredné Slovensko, SK04 Východné Slovensko, and LT01 Lithuania). Generally, the employment structures in Central and Eastern Europe were fixed between 2008 and 2018.

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Struktura zatrudnienia w usługach biznesowych opartych na wiedzy a rozwój gospodarczy regionów Unii Europejskiej

Praca przedstawia wyniki grupowania regionów Unii Europejskiej szczebla NUTS 2 dokonanego na podstawie struktury zatrudnienia w usługach biznesowych opartych na wiedzy, rozpatrywanej w trzech sekcjach: usługi wysokich technologii, usługi marketingowe oraz pozostałe usługi biznesowe oparte na wiedzy, w powiązaniu z poziomem PKB na mieszkańca. Analizę przeprowadzono dla lat 2008 i 2018. Do grupowania regionów z punktu widzenia struktury zatrudnienia wykorzystano aglomeracyjną metodę Warda (do identyfikacji liczby grup) oraz metodę k-średnich (dla uzyskania ostatecznego podziału). Dla oceny podobieństwa podziałów oraz związków pomiędzy strukturą zatrudnienia w analizowanych usługach biznesowych a poziomem i dynamiką rozwoju gospodarczego zastosowano miarę podobieństwa podziałów zbioru skończonego.

Słowa kluczowe: struktura zatrudnienia, PKB per capita, region NUTS 2, podobieństwo

Appendix – list of regions and acronyms

AT11 Burgenland
AT12 Niederösterreich
AT13 Wien
AT21 Kärnten
AT22 Steiermark
AT31 Oberösterreich
AT32 Salzburg
AT33 Tirol
AT34 Vorarlberg
BE10 Région de Bruxelles-Capitale
BE21 Prov. Antwerpen
BE22 Prov. Limburg
BE23 Prov. Oost-Vlaanderen
BE24 Prov. Vlaams-Brabant
BE25 Prov. West-Vlaanderen
BE31 Prov. Brabant Wallon
BE32 Prov. Hainaut
BE33 Prov. Liege
BE34 Prov. Luxembourg
BE35 Prov. Namur
BG31 Severozapaden
BG32 Severen tsentralen
BG33 Severoiztochen
BG34 Yugoiztochen
BG41 Yugozapaden
BG42 Yuzhen tsentralen
CY00 Kypros
CZ01 Praha
CZ02 Střední Cechy
CZ03 Jihozápad
CZ04 Severozápad
CZ05 Severovýchod
CZ06 Jihovýchod
CZ07 Střední Morava
CZ08 Moravskoslezsko
DE11 Stuttgart
DE12 Karlsruhe
DE13 Freiburg
DE14 Tübingen
DE21 Oberbayern
DE22 Niederbayern
DE23 Oberpfalz
DE24 Oberfranken
DE25 Mittelfranken
DE26 Unterfranken
DE27 Schwaben
DE30 Berlin
DE40 Brandenburg
DE50 Bremen
DE60 Hamburg
DE71 Darmstadt
DE72 Gießen
DE73 Kassel
DE80 Mecklenburg-Vorpommern
DE91 Braunschweig
DE92 Hannover
DE93 Lüneburg
DE94 Weser-Ems
DEA1 Düsseldorf
DEA2 Köln
DEA3 Münster
DEA4 Detmold
DEA5 Arnsberg,
DEB1 Koblenz
DEB2 Trier
DEB3 Rheinhessen-Pfalz
DEC0 Saarland
DED2 Dresden
DED4 Chemnitz
DED5 Leipzig
DEE0 Sachsen-Anhalt
DEF0 Schleswig-Holstein
DEG0 Thüringen
DK01 Hovedstaden
DK02 Sjalland
DK03 Syddanmark
DK04 Midtjylland
DK05 Nordjylland
EE00 Esti
EL30 Attiki
EL41 Voreio Aigaio
EL42 Notio Aigaio
EL43 Kriti
EL51 Anatoliki Makedonia, Thraki
EL52 Kentriki Makedonia
EL53 Dytiki Makedonia
EL54 Ipeiros
EL61 Thessalia
EL62 Ionia Nisia
EL63 Dytiki Ellada
EL64 Sterea Ellada
EL65 Peloponnisos

ES11 Galicia
ES12 Principado de Asturias
ES13 Cantabria
ES21 País Vasco
ES22 Comunidad Foral de Navarra
ES23 La Rioja
ES24 Aragón
ES30 Comunidad de Madrid
ES41 Castilla y León
ES42 Castilla-la Mancha
ES43 Extremadura
ES51 Cataluna
ES52 Comunidad Valenciana
ES53 Illes Balears
ES61 Andalucía
ES62 Región de Murcia
ES70 Canarias
FI19 Länsi-Suomi
FI1B Helsinki-Uusimaa
FI1C Etelä-Suomi
FI1D Pohjois-ja Itä-Suomi
FI20 Aland
FR10 Île de France
FRB0 Centre-Val de Loire
FRC1 Bourgogne
FRC2 Franche-Comté
FRD1 Basse-Normandie
FRD2 Haute-Normandie
FRE1 Nord-Pas de Calais
FRE2 Picardie
FRF1 Alsace
FRF2 Champagne-Ardenne
FRF3 Lorraine
FRG0 Pays de la Loire
FRH0 Bretagne
FRI1 Aquitaine
FRI2 Limousin
FRI3 Poitou-Charentes
FRJ1 Languedoc-Roussillon
FRJ2 Midi-Pyrénées
FRK1 Auvergne
FRK2 Rhône-Alpes
FRL0 Provence-Alpes-Côte d'Azur
FRM0 Corse
HR03 Jadranska Hrvatska
HR04 Kontinentalna Hrvatska
HU11 Budapest
HU12 Pest
HU21 Közép-Dunántúl
HU22 Nyugat-Dunántúl
HU23 Dél-Dunántúl
HU31 Észak-Magyarország
HU32 Észak-Alföld
HU33 Dél-Alföld
IE04 Northern and Western
IE05 Southern
IE06 Eastern and Midland
ITC1 Piemonte
ITC2 Valle d'Aosta
ITC3 Liguria
ITC4 Lombardia
ITF1 Abruzzo
ITF2 Molise
ITF3 Campania
ITF4 Puglia
ITF5 Basilicata
ITF6 Calabria
ITG1 Sicilia
ITG2 Sardegna
ITH1 Provincia Autonoma di Bolzano
ITH2 Provincia Autonoma di Trento
ITH3 Veneto
ITH4 Friuli-Venezia Giulia
ITH5 Emilia-Romagna
ITI1 Toscana
ITI2 Umbria
ITI3 Marche
ITI4 Lazio
LT01 Sostines regionas
LT02 Vidurio ir vakaru Lietuvos regionas
LU00 Luxembourg
LV00 Latvija
MT00 Malta
NL11 Groningen
NL12 Friesland
NL13 Drenthe
NL21 Overijssel
NL22 Gelderland
NL23 Flevoland
NL31 Utrecht
NL32 Noord-Holland
NL33 Zuid-Holland
NL34 Zeeland
NL41 Noord-Brabant
NL42 Limburg
PL21 Małopolskie
PL22 Śląskie
PL41 Wielkopolskie

PL42 Zachodniopomorskie
PL43 Lubuskie
PL51 Dolnośląskie
PL52 Opolskie
PL61 Kujawsko-Pomorskie
PL62 Warmińsko-Mazurskie
PL63 Pomorskie
PL71 Łódzkie
PL72 Świętokrzyskie
PL81 Lubelskie
PL82 Podkarpackie
PL84 Podlaskie
PL91 Warszawski stołeczny
PL92 Mazowiecki regionalny
PT11 Norte
PT15 Algarve
PT16 Centro
PT17 Área Metropolitana de Lisboa
PT18 Alentejo
RO11 Nord-Vest
RO12 Centru
RO21 Nord-Est
RO22 Sud-Est
RO31 Sud-Muntenia
RO32 Bucuresti–Ilfov
RO41 Sud-Vest Oltenia
RO42 Vest
SE11 Stockholm
SE12 Östra Mellansverige
SE21 Smaland med öarna
SE22 Sydsverige
SE23 Västsverige
SE31 Norra Mellansverige
SE32 Mellersta Norrland
SE33 Övre Norrland
SI03 Vzhodna Slovenija
SI04 Zahodna Slovenija
SK01 Bratislavský kraj
SK02 Západné Slovensko
SK03 Stredné Slovensko
SK04 Východné Slovensko
UKC1 Tees Valley and Durham
UKC2 Northumberland and Tyne and Wear
UKD1 Cumbria
UKD3 Greater Manchester
UKD4 Lancashire
UKD6 Cheshire
UKD7 Merseyside
UKE1 East Yorkshire and Northern Lincolnshire
UKE2 North Yorkshire
UKE3 South Yorkshire
UKE4 West Yorkshire
UKF1 Derbyshire and Nottinghamshire
UKF2 Leicestershire Rutland and Northamptonshire
UKF3 Lincolnshire
UKG1 Herefordshire Worcestershire and Warwickshire
UKG2 Shropshire and Staffordshire
UKG3 West Midlands,UKH1 East Anglia
UKH2 Bedfordshire and Hertfordshire
UKH3 Essex
UKI3 Inner London-West
UKI4 Inner London-East
UKI5 Outer London-East and North East
UKI6 Outer London-South
UKI7 Outer London-West and North West
UKJ1 Berkshire Buckinghamshire and Oxfordshire
UKJ2 Surrey East and West Sussex
UKJ3 Hampshire and Isle of Wight
UKJ4 Kent
UKK1 Gloucestershire Wiltshire and Bristol/Bath area
UKK2 Dorset and Somerset
UKK3 Cornwall and Isles of Scilly
UKK4 Devon
UKL1 West Wales and The Valleys
UKL2 East Wales
UKM5 North Eastern Scotland
UKM6 Highlands and Islands
UKM7 Eastern Scotland
UKM8 West Central Scotland
UKM9 Southern Scotland
UKN0 Northern Ireland