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**HIGH-TECH INDUSTRY AND KNOWLEDGE INTENSIVE SERVICES  
AS CARRIERS OF KNOWLEDGE-BASED ECONOMY IN POLAND  
AND IN OTHER EUROPEAN UNION MEMBER STATES**

**PRZEMYSŁ HIGH-TECH ORAZ USŁUGI WIEDZOCHŁONNE JAKO NOŚNIKI  
GOSPODARKI OPARTEJ NA WIEDZY W POLSCE I INNYCH KRAJACH  
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**Streszczenie.** We współczesnych gospodarkach szczególną rolę odgrywają procesy produkcji, dystrybucji oraz wykorzystywania wiedzy i informacji, których wysoki udział charakteryzuje przemysły wysokiej techniki oraz usługi wiedzochłonne. Celem artykułu jest przedstawienie przestrzennego zróżnicowania poziomu ich rozwoju w Unii Europejskiej, ze szczególnym uwzględnieniem zmian zatrudnienia. Okres badawczy obejmuje lata 2004–2014. Realizacji tak sformułowanego celu podporządkowano rozważania w następujących obszarach: 1) istoty i uwarunkowań rozwoju sektorów wysokiej techniki; 2) analizy rozwoju przemysłu high-tech; 3) zmian zatrudnienia w usługach wiedzochłonnych, a szczególnie usług high-tech. Obserwowane w Polsce zmiany są zgodne z kierunkiem zmian zachodzących w krajach wysoko rozwiniętych, przy czym ich dynamika, ze względu na konieczność niwelowania luki występującej w tym obszarze, wydaje się niewystarczająca. W polskiej gospodarce rozwój tych sektorów powinien być traktowany w sposób priorytetowy jako istotne nośniki GOW.

**Key words:** knowledge-based economy, high-tech industry, knowledge intensive services, employment.

**Słowa kluczowe:** gospodarka oparta na wiedzy, przemysł high-tech, usługi wiedzochłonne, zatrudnienie.

## **INTRODUCTION**

Phenomena and processes observed in contemporary world, and the dynamics of changes, require new ways of defining and describing them, and the need to seek effective methods of their measurement. This also applies to knowledge-based economy, its concept and methodology of measurement. Sectoral concepts that refer to areas of economy commonly referred to as KBE (Knowledge-Based Economy) carriers, including high-tech industries and services, are immensely important for the labour market. Changes in employment level, production and the share in international exchange essentially determine not only the level of KBE development, but also a country's competitive position internationally. It should also be emphasised that both from the point of view of structural policy and the labour market, identification of the fastest developing economic areas, characterised by high dynamics of employment growth and productivity, play an important role.

Taking into consideration the aforementioned reasons, the goal of the paper is to show the spatial differentiation in the development of high-tech sectors in the European Union, with special focus on changes in employment between 2004 and 2014. The paper poses the following research questions:

What is the employment rate in high-tech industries and services, and what is the dynamics of changes in the EU countries?

Is it advisable to differentiate the classification of service sectors in the way similar to classification of industry sectors, such as the division into high, medium and low technology industries?

How are knowledge-intensive service sectors different from other industries?

How strong is the spatial diversification in development of high-tech industries and services in the European Union?

The attempt to answer the questions formulated in this way required dividing the paper into separate parts that include: 1) the essence and determinants of development of high-tech sectors; 2) analysis of development of high-tech industries; 3) changes in employment in knowledge-intensive high-tech services.

## **DETERMINANTS OF DEVELOPMENT OF HIGH-TECH INDUSTRIES AND SERVICES**

Changes occurring in contemporary world reveal increasing significance of areas based on intensive application of knowledge. These areas mainly include entities operating in high-tech industries and services. Defining and approaching them in traditional classifications is rather difficult. This category includes sectors and products that in comparison with others are characterised by larger expenditure on research and development in the final value or added value, and application of advanced technologies that are subject to relatively rapid „ageing”. Furthermore, their typical features include high rate of employees with university education, including HRST (human resources in science and technology), and also cooperation with scientific centres, other companies that provide knowledge-intensive services and manufacturers of high-tech products.

They also often develop within various industries while going beyond currently existing classification criteria. The necessity to measure high technology contributed to intensification of works on international methodological standards in this area by Eurostat, OECD or the U.S. Department of Commerce, among others. Research regarding KBE measured by its share in the structure of high-tech industries and knowledge intensive services is one of the results of the work conducted.

Highly developed countries are characterised by high development of new areas both in the industrial and service sectors, since it stems from their achievement of specific critical level of economy development and its corresponding structure. Transformation of traditional economic structure in these countries had evolutionary nature and was the result of a natural development process. In highly developed countries, appropriate potential of modern fixed assets, high quality of human capital and developed infrastructure, and also the business environment, form conditions conducive to the creation and implementation of products, processes or organisational innovations, and consequently, to the provision of high-tech and

knowledge-intensive products and services. However, there occurs a question of whether the less developed countries have the same chances for development of high technology. In their case, deliberations about the issue of embarking on the path of innovative economic growth under conditions of progressing globalisation and dispersion of production processes gain special significance. In theory, this issue is analysed through the following prisms (Grubala 2010), among others:

- the theory of developmental state and the theory of late-development;
- globalisation theories related to global production network and dispersion of industrial production;
- theories of innovative systems.

High-tech development constitutes one of the key determinants affecting economic growth and development, and also the economy's competitiveness and innovativeness. However, without state policy in this area, success seems rather unlikely, particularly in the case of less developed countries because market mechanisms are not an effective regulator in this respect (Hryniewicz 2013; Ziolo 2013). Support from the state is necessary for enterprises that start operating in technologically advanced sectors, and also for those that decide to produce goods based on advanced technologies in less developed countries in terms of economy and technology. Active role of the state should consist in long-term strategy aimed at supporting new, mostly export-oriented, sectors of economy. The state's involvement should be reflected in sectoral policies, including industry policy, oriented towards development of services, innovation, etc. Legislation in the area of protection of intellectual property rights, including scientific research results, innovations and inventions, is also of great importance. In comparison with other industries, high technologies are characterised by larger added value, therefore their development can constitute a stimulus for development of economies. State's help, aimed at boosting and supporting this sector can take various forms, from financing research and development ventures, tax and custom duty exemptions, to ensuring optimum infrastructure, also in the form of technology parks (Skórska 2015).

## HIGH-TECH INDUSTRIES DEVELOPMENT

As a consequence of the re-industrialisation process, additionally intensified by globalisation, importance of high-tech industries is growing. Under the criterion adopted by OECD they include:

- production of basic pharmaceutical substances and medications, as well as other pharmaceutical products;
- production of computers, electronics and optical products;
- production of aircrafts, spaceships and similar machines.

While in the 1970s they constituted around 5% of the world industrial production, nowadays they produce over 20% and they constantly show the growing trend. In 2014, among the countries of the European Union, the largest share in the world export of high-tech products, was reported for Germany (EUR 161.5 billion), Holland (EUR 89.8 billion), and France (EUR 90.5 billion). These industries are pivotal to the development of knowledge economies, and form the foundation on which the country's competitive advantage is built. Transnational corporations perform a special role in this process. High investments in research and

development work and innovativeness are the qualities distinguishing high-tech industries from other categories that belong to sector II. Short life-cycle of products and processes, as well as rapid diffusion of technological innovations also must be mentioned.

Development of high-tech industries in Poland started with considerable delay in comparison to other developed countries. The beginnings of new sectors such as computer industry or microelectronics took place only at the end of 1960 s. After 1989 a remarkable decline in the share of high-tech industries could be observed not only in Poland but also in other post-socialist states. The economic policy pursued, frequently ineffective privatisation and restructuring, and finally reliance on import from, in particular, Western Europe, led to decline in production and employment, and in some areas, closing down of entities that were part of high-tech industries. Therefore Poland's rate of expansion of new industries observed over the last 20–30 years is not satisfactory.

This attitude produced long-term consequences such as remarkably lower share in the export of high-tech products that in 2014 it reached only EUR 12.6 million, and in a negative balance of trade with foreign countries (EUR –6.1 million). In 2014 the share of export of high-tech products in total export was 12.6%, and of import – 11.3%. In Poland, the largest share was achieved by export of electronics and telecommunication (over 46.6% of the total export of high-tech products), and was similar to imports of the same product category – over 40.4% (GUS 2014).

Unfavourable balance of trade, relatively small share of production of high-tech products speak of an inadequate structure of Polish economy, but also limit the scope of changes in other economic sectors. This is because technological progress, the carriers of which are high-tech industries including automation, robotisation, and new solutions in electronics or telecommunication drives productivity forward, and results in replacement of physical work with work based on knowledge and workers' competences (Skórska 2013).

The structure of production and employment in Poland, in comparison with other EU states, particularly with EU-15 is unfavourable. In 1989 in Poland 257 thousand people in total were employed in high-tech industries which constituted 5.4% of the total employment in industry. In 2000 their number declined to 84 thousand. In the following years, increase in the number to 120 thousand was reported, however it constituted only 0.8% of the total number of working people and respectively 4.6% of the employment in industry. For comparison, in Hungary, the share of employment in high-tech industries was 2.3%, in the Czech Republic it was 1.8, in Germany and Denmark 1.7%, and in Ireland 3%, see Table 1. A smaller rate was observed in Greece, Spain, Croatia, Portugal, and Romania or in Sweden, among others. It should also be emphasised that due to the economic crisis, among others, the dynamics of changes in most EU states was negative, which additionally widened the gap between Poland and highly-developed countries in this respect.

Considering the fact that production of technologically advanced goods demands involvement of high quality labour resources, the share of people having university education among people working in high-tech industries, and also the direction and dynamics of changes occurring in this sphere is higher than in other industry sectors. Among people working in high-tech industries, nearly 37% are university graduates, whereas in the whole industry sector the rate is not higher than 15.5%. Furthermore, almost 49% of workers in high-tech industries in Poland belong to HRST category, but their rate remains lower by 18 percentage points than the rate of workers employed in this category in Lithuania or Croatia.

Table 1 Employment in high-tech industry in European Union in 2004–2014

Country	2004		2006		2008		2012		2014		Changes	
	thous.	%	thous. 2004– –2014	% 2004 = = 100								
EU-28	2275	1.1	2306	1.1	2516	1.1	2334	1.1	2333	1.1	68	102.9
Belgium	32	0.8	28	0.7	62	1.4	54	1.2	51	1.1	19	159.3
Bulgaria	13	0.4	16	0.5	29	0.9	24	0.8	24	0.8	11	184.6
Czech Republic	61	1.3	81	1.7	74	1.5	90	1.8	89	1.8	28	145.9
Denmark	27	1	22	0.8	44	1.5	47	1.8	46	1.7	19	170.3
Germany	651	1.8	635	1.7	606	1.6	617	1.6	659	1.7	8	101.2
Estonia	11	1.8	7	1.1	7	1.1	7	1.2	6	1.0	–5	54.5
Ireland	50	2.7	55	2.7	61	2.9	56	3.0	56	3.0	6	112.0
Greece	7	0.2	11	0.2	21	0.5	16	0.4	15	0.4	8	214.3
Spain	91	0.5	88	0.4	123	0.6	115	0.7	103	0.6	12	113.2
France	289	1.2	281	1.1	307	1.2	258	1.0	253	1.0	–36	87.5
Croatia	5	0.3	8	0.5	14	0.8	9	0.5	10	0.7	5	200.0
Italy	232	1	294	1.3	241	1.0	218	1.0	216	1.0	–16	93.1
Cyprus	:	:	1	0.1	2	0.4	2	0.4	2	0.5	:	:
Latvia	:	:	:	:	4	0.4	3	0.3	4	0.4	:	:
Lithuania	12	0.9	9	0.6	:	:	:	:	:	:	:	:
Luxembourg	1	0.4	:	:	1	0.3	:	:	1	0.3	0	100.0
Hungary	101	2.6	98	2.5	108	2.8	102	2.7	94	2.3	–7	93.1
Malta	6	4	5	3.1	4	2.7	4	2.1	5	2.9	–1	83.3
Netherlands	62	0.8	51	0.6	68	0.8	51	0.6	40	0.5	–22	64.5
Austria	48	1.3	53	1.4	43	1.1	44	1.1	49	1.2	1	102.0
Poland	69	0.5	84	0.6	125	0.8	131	0.8	120	0.8	51	173.9
Portugal	23	0.5	22	0.4	33	0.6	19	0.4	19	0.4	–4	82.6
Romania	38	0.4	29	0.3	51	0.5	57	0.7	67	0.8	29	176.3
Slovenia	10	1.1	10	1.1	17	1.7	15	1.7	16	1.8	6	160.0
Slovakia	34	1.6	41	1.8	43	1.8	33	1.4	30	1.3	–4	88.2
Finland	46	2	51	2.1	44	1.8	34	1.4	29	1.2	–17	63.0
Sweden	46	1.1	40	0.9	34	0.7	29	0.6	30	0.6	–16	65.2
UK	312	1.1	292	1	361	1.2	304	1.0	302	1.0	–10	96.8

Source: Eurostat. Database (<http://ec.europa.eu/eurostat/data/database>).

The analysis of available data allows for stating that the fact that Poland lags behind other EU countries in terms of high-tech constitutes a barrier for formation of modern, competitive and innovation-based structure of economy. Consistently pursued industrial policy of the state is one of determinants for the creation and implementation of high technologies (Bianchi and Labory 2011; European Commission 2012, 2014). In this respect, it is important to identify priority sectors of strategic importance. Educational policy promoting investments in qualifications as the basis for creation of high quality human capital should contribute to this. Further development of high technologies is not possible without adequately qualified workers. Enterprises should definitely engage more actively in cooperation with the academic and research sector, which ought to spur innovations that can find applications in industry.

## THE ESSENCE OF KNOWLEDGE-INTENSIVE HIGH-TECHNOLOGY SERVICES AND THEIR IMPORTANCE IN ECONOMY

The attempts to distinguish and identify the category of knowledge-intensive services (KIS) imply the following questions: How do these services differ from other services? What criteria should be adopted? According to Bettencourt, KIS are ventures in which added value occurs

as a result of the process of formation, accumulation and distribution of knowledge for the purpose of improvement of existing service or application of a solution that satisfies customer's demands within its new type (Bettencourt et al. 2002). Therefore, if it is assumed that KIS services are based on professional, specialist knowledge and the intensity of its use, the classification suggested by Eurostat according to which KIS includes knowledge-intensive market, financial, high-tech and other services seems to be too broad. Particular controversies are raised by the fact that this category includes security services, services related to water transport, leisure or some forms of activity associated with employment in. e.g., private employment agencies. This is because in their case the criterion of knowledge-intensity seems not to be met.

Such deep differences occurring between particular categories of services constituting KIS, and their significance for the creation and development of knowledge-based economy show that in this case identifying, and then limiting one's considerations only to high-tech services seems to be justified, see Fig. 1.

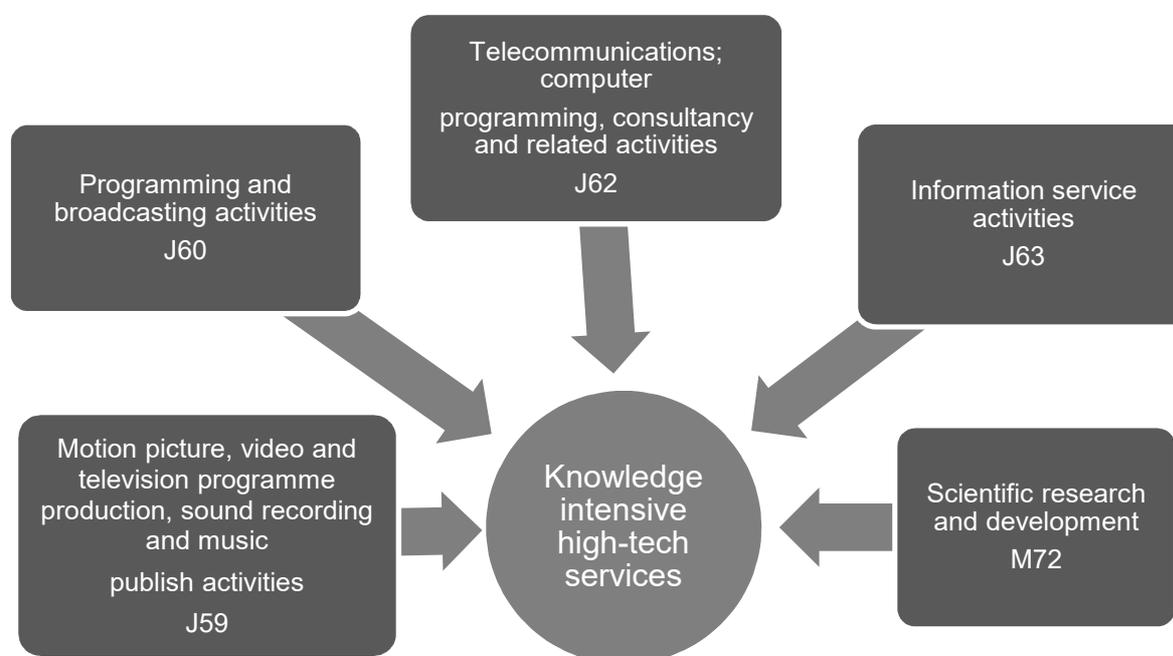


Fig. 1. Knowledge intensive high-technology services

Regardless of differences in the proposed concepts as well as in theoretical and methodological approaches, in contemporary economies, progressing expansion of the service sector, particularly of knowledge-intensive services that engage high quality labour forces, also observed in Poland, remains unquestionable (Skórska 2012, 2014). However, as compared to other EU countries, the share of employment in this sphere is relatively low in Poland. Although dynamic growth in the number of people working in high-tech services was observed in Poland in the analysed period (by over 57 thousand), that constituted almost 20% growth, it still remains one of the lowest among all EU states. The smallest share of employment in high-tech services in 2014 was reported in Greece (2.1%) and Lithuania (1.8%) – see Table 2.

Table 2. Employment in knowledge intensive high-tech services in European Union in 2004–2014

Country	2004		2006		2008		2012		2014		Changes	
	thous.	%	thous. 2004– 2014	% 2004 = = 100								
EU-28	6662	3.2	7111	3.3	5837	2.6	6050	2.8	6192	2.8	–470	92.9
Belgium	163	3.9	167	3.9	132	3.0	159	3.5	147	3.2	–16	90.1
Bulgaria	81	2.8	80	2.6	74	2.2	70	2.4	73	2.4	–8	90.1
Czech Republic	144	3.1	142	2.9	117	2.4	125	2.6	149	3.0	5	103.4
Denmark	112	4.1	123	4.4	100	3.5	99	3.7	104	3.8	–8	92.8
Germany	1187	3.4	1294	3.5	986	2.6	1071	2.7	989	2.5	–198	83.3
Estonia	14	2.4	16	2.5	14	2.2	15	2.5	22	3.5	8	157.1
Ireland	66	3.6	78	3.8	70	3.3	82	4.5	82	4.3	16	124.2
Greece	81	1.9	88	2	78	1.7	66	1.8	75	2.1	–6	92.5
Spain	453	2.5	589	3	552	2.7	538	3.1	526	3.0	73	116.1
France	946	3.8	974	3.9	692	2.7	791	3.1	767	2.9	–179	81.1
Croatia	31	2	33	2.1	36	2.1	31	2.0	38	2.5	7	122.6
Italy	688	3.1	702	3.1	522	2.3	541	2.4	545	2.5	–143	79.2
Cyprus	7	2.2	7	2	9	2.5	10	2.5	9	2.5	2	128.5
Latvia	29	2.9	27	2.5	21	2.0	20	2.2	26	2.9	–3	89.6
Lithuania	28	1.9	31	2.1	22	1.6	27	2.1	23	1.8	–5	82.1
Luxembourg	7	3.5	6	3.3	7	3.3	10	4.1	10	3.9	3	142.8
Hungary	116	3	134	3.4	87	2.3	96	2.5	99	2.4	–17	85.3
Malta	4	2.6	5	3.1	6	3.7	7	4.0	6	3.3	2	150.0
Netherlands	324	4	312	3.8	291	3.4	265	3.2	252	3.1	–72	77.7
Austria	95	2.6	108	2.8	96	2.4	99	2.4	118	2.9	23	124.2
Poland	292	2.1	346	2.4	286	1.8	316	2.0	349	2.2	57	119.5
Portugal	70	1.4	94	1.9	81	1.6	80	1.8	104	2.3	34	148.5
Romania	139	1.5	150	1.6	112	1.2	132	1.5	140	1.6	1	100.7
Slovenia	24	2.5	26	2.7	28	2.8	28	3.0	31	3.4	7	129.1
Slovakia	49	2.3	59	2.6	45	1.8	60	2.6	58	2.5	9	118.3
Finland	109	4.6	113	4.6	103	4.1	111	4.5	115	4.7	6	105.5
Sweden	205	4.8	224	5.1	189	4.1	200	4.3	200	4.2	–5	97.5
UK	1229	4.4	1 214	4.2	1081	3.7	1005	3.4	1136	3.7	–93	92.4

Source: see Table 1.

It should be indicated here that in many EU countries, between 2004 and 2014, a decline in employment in high-tech services was reported, for example in Holland (–22.3%), Italy (–20.8%), or France (–18.9%). However, it must be emphasised that despite small dynamics of growth, and in some countries a decline in employment in high-tech services, both the added value and the value of production are increasing, the reasons for which can be attributed to growing labour productivity. The countries with the largest employment in this sector include Finland (4.7%), Sweden (4.2%) and Ireland (4.3%), whereas the highest dynamics of changes was characteristic for Estonia (growth by 57%), Portugal (growth by 48.5%), Malta and Luxembourg.

The analysis of available data confirms the existence of a gap between Poland and highly-developed countries, and the necessity to intensify activities aiming at modernisation of the structure of Polish economy. This is all the more significant because high-tech services constitute one of the carriers of knowledge economy recognised as the driver of high productivity and job creation for highly-qualified people who are available in large numbers in Poland.

Analysis of high-tech services shows considerable diversification of their internal structure that results, i.a., from differences between markets in which they are provided, average size of enterprises, and traditions and methods of work – see Fig. 2.

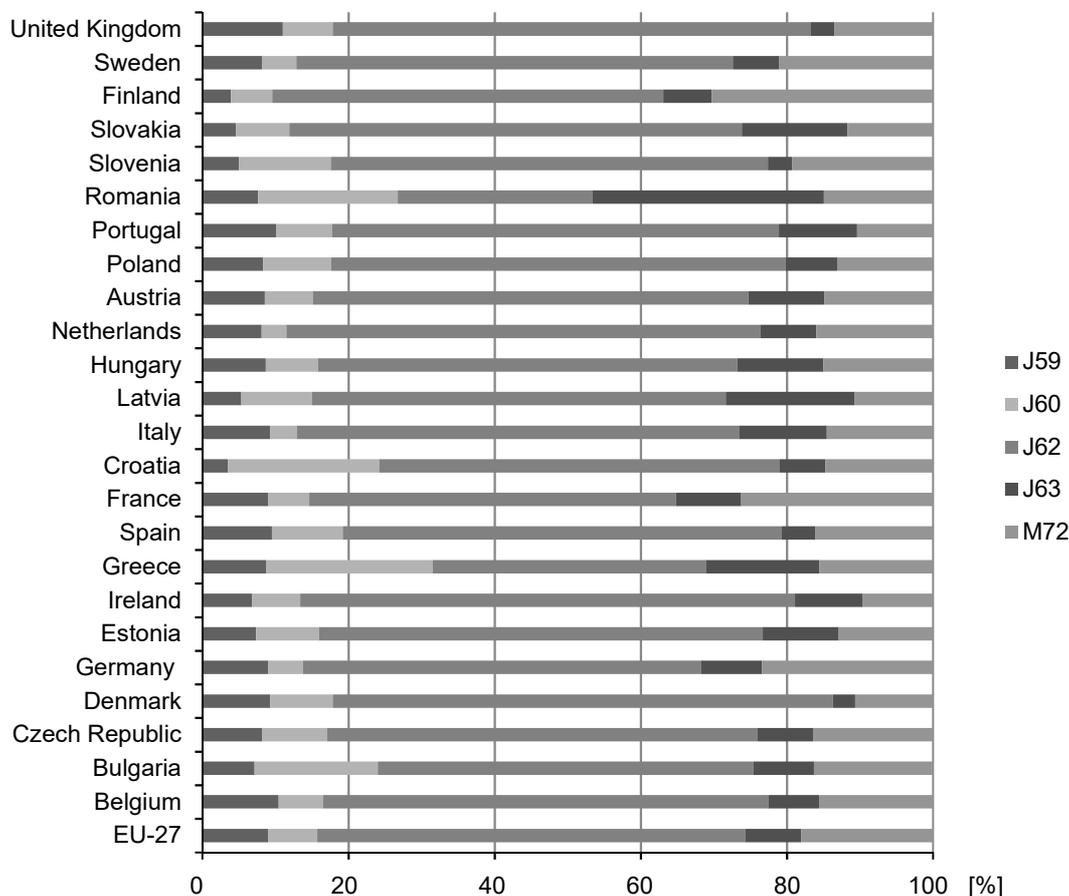


Fig. 2 Employment structure of knowledge intensive high-tech services in European Union in 2014  
Source: see Table 1.

Development of new technologies and their increasing application scope is one of the major reasons for growth in demand for services related to software and consultancy in the sphere of information technology, that constitute the key category included in KIS. The number of people working in this sector both in Poland and in other EU countries is constantly growing and their share in the structure of high-tech services is the largest. In majority of the countries it is over 60%. Application of IT tools, software and computer consulting services, data processing and website management is in high demand in contemporary world. Thanks to information technology that allows to create knowledge networks and monitor supply chains, customers can maximise profits, and collaborate with companies located in even the most remote places. IT services, along with engineering services, contribute to the simplification of production processes, as well as expansion and application of new technologies. Research and development services perform an increasingly more important role in business restructuring processes. They are also applied in the development of international business strategies. Enterprises that effectively use such services achieve comparative advantage. This

raises some concerns because in Poland employment in R + D sphere is not higher than 1.2%, whereas in Luxembourg it amounts to 9.4%, and in Sweden to 5%, and the mean for the EU is 2.2%. In the structure of high-tech services, R + D activity accounts for 13.3% in Poland, whereas in Finland for over 30%. Although in the study period there was increase in employment in R + D, the changes are certainly insufficient. Inflow of foreign investment to Poland, and workplaces created by research and development centres offer some optimistic signs. In 2013, 21.6 thousand people worked in 113 R&D centres and 21.1 thousand people worked in 73 ITO centres (ABSL 2014).

Summing up, the worldwide range of economic cooperation and the complex nature of global economy encourage increased demand for knowledge provided within KIS and high-tech products. Therefore, when adopting, employment in high-tech industries and services as a knowledge carrier, that is representative for the assessment of KBE development, it should be stated that its level in Poland is still very low, and the dynamics of changes is insufficient if the country aspires to eliminate the gap that sets it apart from highly developed countries.

## **CONCLUSIONS**

In knowledge-based economies a significant role is performed by processes of production, distribution and application of knowledge and information, the high share of which is characteristic for high-tech industries and services. Knowledge incorporated in new technologies, highly processed products, highly qualified labour resources that create and use these technologies, as well as products and services, determines the innovativeness of an economy and its international competitiveness. Therefore, to create a modern, competitive economy it is essential to take into account the trends and dynamics of structural changes, and the resultant relocation of labour resources, with special focus on inter-sectoral changes.

The research, conducted with the use of various methodologies, confirm that Poland's knowledge-based economy is lagging behind not only the „old” EU-15 states, but also many Central and Eastern European countries. The small share of high-tech industries and services both in the total employment and international exchange, points to a gap between Poland and other EU countries in this area.

In view of the above, it should be stated that in Polish economy, development of high-tech sectors ought to be treated as priority. Undoubtedly, application of appropriate instruments of economic policy, particularly the fiscal policy, and also expansion of specialised institutions such as parks and technological platforms might contribute to their development, and consequently to the modernisation of Polish economy. Another important element is organized, planned support for the development of these sectors and other KBE carriers, since they are able to absorb high quality labour resources. And if one analyzes closely the strategic documents and policy pursued by the Polish government, no programmes address specifically the issue of reindustrialisation and the growing role of high-tech industries in contemporary economies, though their importance for the social and economic development, and innovativeness of Polish economy, is pivotal. In the structural policy pursued it would be advisable to focus more on the sectors that show significant dynamics of growth and high labour productivity. Ultimately, a failure to rise to this challenge may result not only in growing disparities in the level of social and economic development, but also waste in regrettable waste of human resources.

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**Summary.** The processes of knowledge production and diffusion play a special role in contemporary economies. Their high share is typical of high-tech industries and knowledge-intensive services. The goal of the article is to present their spatial diversity in the European Union, with special attention paid to employment changes. The research period covers the years 2004–2014. The research goal was attained through examination of the following areas: 1) high-tech industries and knowledge-intensive services determinants of development, 2) analysis of high-tech industries development, 3) employment changes in KIS, especially high-tech KIS. Changes in Poland are in line with the direction of the changes taking place in developed countries, however their dynamics seems to be insufficient. That's why the development of high-tech sectors – as important carriers of KBE – should be treated as a priority in Polish economy.