

## Knowledge-intensity and employment structures in European countries

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**Abstract.** Building a knowledge-based economy is closely related to innovation growth and should be reflected in the growing importance of sectors that intensively use technology and a highly skilled workforce (i.e. human capital). The growing importance of knowledge in an economy is demonstrated, inter alia, by changes in the employment structure. This paper attempts to identify how employment structure in the service sector depends on the level of knowledge-intensity in a national economy. The analysis covered EU member countries (except Greece and Croatia) during the 2006–2011 period. The intensity of knowledge use seems to vary widely among European countries. Countries advanced in their use of knowledge, having high values of KIE ('knowledge-intensity leaders' and 'knowledge-intensity supporters') have an employment structure demonstrating their structural focus on the industries that require specialized knowledge.

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### INTRODUCTION

Modern, highly developed economies are usually defined as economies based on knowledge and services that acquire a competitive advantage as a result, on the one hand, of offering technologically advanced products and services; and on the other, of an increasingly intense internationalization of these innovative activities. The economic role of the service sector has increased significantly, which is reflected in its dominant position both in terms of its share in the creation of gross value added and in employment. In addition, the role of knowledge-based services in the service sector continues to grow.

Modern economies rely heavily on knowledge. Knowledge as such is not a growth driver—it only becomes one when used effectively in the production process or in the provision of services. Sectors of the economy associated with the creation, use and dissemination of knowledge are beginning to play a leading role in economic growth. Building a knowledge-based economy is therefore closely related to innovation growth in the economy and should be reflected in the growing importance of sectors that intensively use technology and a highly skilled workforce (i.e. human capital). The growing importance of knowledge in an economy is reflected, inter alia, by changes in the employment structure.

This paper attempts to identify how the employment structure of the service sector depends on the level of knowledge-intensity in a national economy. The analysis covered all EU member countries except Greece and Croatia during the period from 2006 to 2011. The analysis covered the following industries of the service sector: G – Wholesale and retail trade; H – Transportation and storage; J – Information and communication; K – Financial and insurance services; and M – Professional, scientific and technical services. Implementation of this objective required carrying out a three-stage analysis<sup>1</sup>. The first stage was a description of the nature of the knowledge-intensity of the economy index (KIE). The second step was to identify the countries that are similar in terms of intensity of utilising knowledge in their economies. At the final stage, an analysis was carried out to compare the employment structures in the services sectors of the identified groups of countries, with particular attention to differences in the level of employment of professionals and young people.

## 1. KNOWLEDGE-INTENSITY OF THE ECONOMY (KIE) INDEX

One of the tools to assess the structural changes in economy is an index calculated every year (from 2010 onwards) by the European Commission to assess knowledge-intensity of the Member States' economies–KIE (*Group of Research...*, 2011). The theoretical framework and the component indicators required to calculate this index were proposed by a group of European Union experts and presented in a report on structural change indicators (Malerba, Salter, Saltelli, 2011). The aim of the process was to identify the possibility of measuring various key dimensions of innovation that affect the economy and its ability to change in order to support innovation.

Compositional structural change indicators measure changes in the actual sectoral composition of the economy in terms of production and employment, business research and development (R&D), high-tech exports and technological specialization and foreign direct investments. Changes may affect the linkages among sectors and technologies and influence the changes of the international advantages of countries.

Eight compositional structural change indicators have been identified and organized into five dimensions (*Research and Innovation...*, 2013, p. 320)<sup>2</sup>.

- The R&D dimension measures the size of business R&D (as a % of GDP) and the size of the R&D services sector in the economy in terms of total value added. (Source: WIIW calculations using OECD, Eurostat, WIOD and national sources).
- The skills dimension measures changing skills and occupation in terms of the share of persons employed in knowledge-intensive activities, both in manufacturing and service sectors considered where on average at least a third of the employees have tertiary graduates. (Source: Eurostat).
- The sectoral specialization dimension captures the relative share of knowledge-intensive activities in terms of value added. (Source: WIIW calculations using OECD, Eurostat, WIOD and national sources).
- The international specialization dimension captures the share of the knowledge economy through technological (patents) and export specialization (revealed technological and competitive advantage).
- The internationalization dimension refers to the changing international competitiveness of a country in terms of attracting and diffusing foreign direct investment (inward and outward foreign direct investments).

<sup>1</sup> Statistical Classification of Economic Activities in the European Community – NACE Rev.2

<sup>2</sup> The eight indicators in the five pillars have been normalized between 10 and 100 using the min-max method and taking into consideration three time points simultaneously. The five pillars have also been aggregated to a single composite indicator of structural change using the geometric average to provide an overall measure of country progress in this area.

Table 1 shows the 2010 values of the KIE index and their rates of growth over the 2000–2010 period. The KIE indicator is a measure of structural change in the economy towards a more intense use of knowledge. It focuses on the changes in sectoral composition and in specialization of the economies. The highest values of the index, above 60, were calculated for Ireland (65.43), Luxembourg (64.75) and Sweden (64.60). The lowest index values, below 30, were seen in Bulgaria (29.45) and Romania (28.35).

During the 2000–2010 period, the KIE index values went up by 0.93% on average. The fastest increase occurred in Romania (5.86%) and Lithuania (5.04%) and the slowest in Slovakia (0.07%). For Poland, the 2010 value of KIE was 31.78. It grew at the rate of 1.65% over the 2000–2010 period.

Table 1

## The knowledge intensity of the economy (KIE) in European Union (2010)

	The knowledge-intensity of the economy (KIE)	
	value	growth rate in % (2000-2010)
European Union (26)	48,75	0,93
Austria	42,40	2,78
Belgium	58,88	1,06
Bulgaria	29,45	3,65
Cyprus	44,11	3,27
Czech Republic	39,58	2,91
Denmark	54,95	1,64
Estonia	46,48	2,94
Finland	52,17	0,49
France	57,01	0,63
Germany	44,94	1,04
Hungary	50,23	1,87
Ireland	65,43	1,94
Italy	35,43	1,00
Latvia	34,38	3,96
Lithuania	35,28	5,04
Luxembourg	64,75	1,40
Malta	54,45	2,67
Netherlands	56,22	0,48
Poland	31,78	1,65
Portugal	41,04	3,18
Romania	28,35	5,86
Slovakia	31,64	0,07
Slovenia	45,90	4,25
Spain	36,76	2,65
Sweden	64,60	1,41
United Kingdom	59,24	1,20

Source: compiled from *Research and Innovation...*, 2013, p. 5.

## 2. CLASSIFICATION OF EU COUNTRIES BY THEIR INTENSITY OF KNOWLEDGE UTILIZATION

The EU countries were grouped for the KIE values they achieved in 2010 using Ward's hierarchical clustering method (Fig. 1). This method arrives at clusters that are relatively balanced as to their size; it has proven effective in the identification of actual clusters (Grabiński, Sokołowski, 1984, pp. 63–79). It minimizes the increases in intra-cluster variance at each step of clustering. The analysis produces a dendrogram, which is a graphical interpretation of the hierarchical relations identified in the process. This allows accurate identification of the relative position of each class and of the objects contained within a class (Walesiak 1996, pp. 316–350). At each stage of Ward's method of hierarchical clustering, the selection of pairs for clustering is based on the minimum variance criterion (Everitt et al., 2011, pp. 77–78; Stanisiz, 2007, p. 122).

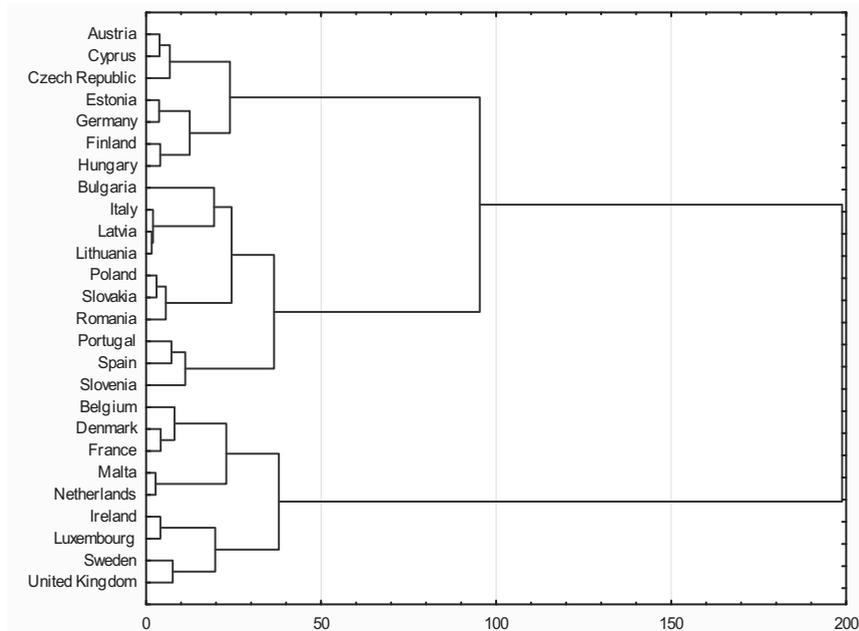


Fig. 1. Dendrogram EU countries' intensity of the use of knowledge in the economy (KIE) in 2010 created using the Ward method.

Source: own elaboration, performed with Statistica 10 PL software package.

Cutting the dendrogram at the level of cluster distances equal to 30 has led to identification of five clusters (groups) of countries that are similar in terms of knowledge-intensity of their economies<sup>3</sup>.

- KIE 1 – 'knowledge-intensity leaders': countries where the KIE value exceeds the EU average by at least 30% (Sweden, Luxembourg, Ireland and the United Kingdom).
- KIE 2 – 'knowledge-intensity supporters': countries where the KIE value exceeds the EU-26 average by 0% to 30% (the Netherlands, France, Malta, Denmark and Belgium).

<sup>3</sup> The analysis covered 26 of the EU member countries – except Greece and Croatia, for whom no data were available.

- KIE 3 – ‘countries of moderate knowledge-intensity’: countries where the KIE value ranges between 0% and 15% below the EU-26 average (Finland, Hungary, Estonia, Cyprus, Germany, Austria, Czech Republic).
- KIE 4 – ‘countries of poor knowledge-intensity’: countries where the KIE value ranges between 15% and 30% below the EU-26 average (Slovenia, Portugal, Spain).
- KIE 5 – ‘least knowledge-intensive countries’: countries where the KIE value is below the EU-26 average by more than 30% (Bulgaria, Italy, Latvia, Lithuania, Poland, Slovakia, Romania).

### 3. EMPLOYMENT STRUCTURE BY CLUSTER

Once the identification of individual clusters of countries was carried out on the basis of the intensity with which they utilise knowledge, the clusters were analysed in terms of the employment structure in the service sector in each country. The analysis covered the 2010 data for five innovative service industries<sup>4</sup>.

- Section G – Wholesale and retail trade,
- Section H – Transportation and storage,
- Section J – Information and communication,
- Section K – Financial and insurance services, and
- Section M – Professional, scientific and technical services.

For each section, variables describing the structure of employment were analysed. These included:

- the section’s share in the national employment figure [% of employees],
- the share of professionals in the total employment within the section [% of professionals],
- the share of employees aged 15–24 in the total employment (aged 15–64) within the section [% of young employees].

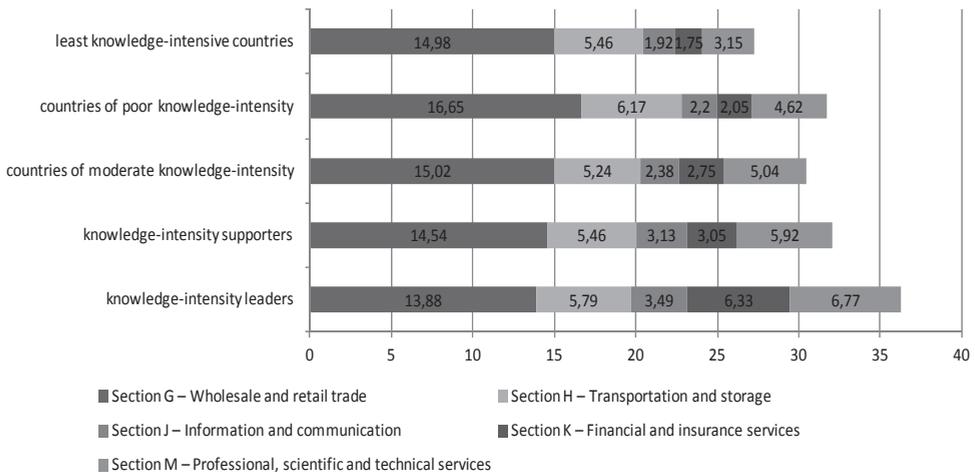


Fig. 2. Share of the service sector employees by countries’ cluster (2010, % of employees)

Source: own compilation.

<sup>4</sup> Sections classified as innovative in the Community Innovation Survey (CIS).

Fig. 2 illustrates the 2010 share of service sector employees by countries' cluster. Within the KIE 1 cluster (the 'knowledge-intensity leaders'), the largest shares in total employment were enjoyed by the following sections: J – Information and communication, K – Financial and insurance services, and M – Professional, scientific and technical services. These are sections of crucial importance for any knowledge-based economy, and their operation relies on the intensive use of knowledge. In addition, the countries included in this cluster demonstrate the lowest average share of employment in Section G – Wholesale and retail trade. For the five service industries analysed in this cluster, the share in employment was the highest, averaging 36.26% of total employment in the national economy. These countries are characterized by a modern structure of employment, manifesting in a high proportion of workers in knowledge-based service sections. Within the KIE 2 cluster (the 'knowledge-intensity supporters'), the five sections' shares in total employment were high and averaged 32.10% of the total.

A well-developed sector of knowledge-intensive services favours the transition to knowledge-based economies, hence the high values of the KIE index. The common feature of the KIE 3 cluster ('countries of moderate knowledge-intensity') was the lowest rates of employment in Section H – Transportation and storage. The average share of employment in the five sections of the service sector amounted to 30.43% of the total working population. The KIE 4 cluster ('countries of poor knowledge-intensity') demonstrated the highest percentage of employment in two traditional industries, i.e. G – Wholesale and retail trade, and Section H – Transportation and storage. Generally, the employment structure in this cluster may be considered obsolete and hardly capable of successfully meeting the economic challenges of the 21<sup>st</sup> century. The last cluster, KIE 5 ('least knowledge-intensive countries') proved to have the lowest employment in the modern service industries. The countries grouped into this cluster have the lowest share of employment in Sections J, K and M in the total employment. In addition, when compared to the other clusters, KIE 5 shows the lowest percentage share of employment in the service sections analysed. This share was 27.26%. It proves a low level of development of the knowledge-intensive services which hinders the progress towards a knowledge-based economy.

Fig. 3 illustrates the share of professionals working in the various sections of the service sector as a percentage of total employment in a given section for each identified cluster of countries. The data on professionals' employment refer to graduates of a specific, high level of education. Professionals, defined in line with the International Standard Classification of Education (ISCED 97) are people at the fourth level of qualifications (or ISCED Levels 5 and 6 of education)<sup>5</sup>. Countries classified as 'knowledge-intensity leaders' proved to have a relatively low share of well-educated workers in total employment. The share of professionals employed in the knowledge-intensive sections was the lowest of all the clusters identified. On average, working professionals made up 36.93% of total employment in Section J – Information and communication and 35.77% in Section M – Professional, scientific and technical services.

In the KIE 2 cluster ('knowledge-intensity supporters'), the lowest rate of professionals' employment was observed in Section K – Financial and insurance services (13.52%). The distinctive feature of the KIE 3 cluster ('countries of moderate knowledge-intensity') was the lowest rate of professionals working in Section H – Transportation and storage, where they made up only 2.92% of the total employment. The KIE 4 cluster – 'countries of poor knowledge-intensity' – proved to employ the largest share of professionals in the traditional sections, namely Section G – Wholesale and retail trade (5.43%) and Section H – Transportation and storage (3.84%). As far as the percentage share of professionals employed goes, the largest figures were found in as many as three sections of the service sector of KIE 5 ('least knowledge-intensive') countries. On average, working professionals made 45.33% of total employment in Section J, 45.02% in Section M and 39.1% in Section K.

<sup>5</sup> ISCED's Level 5 of education is achieved through graduation from the first stage of tertiary education (programmes leading to the award of a BA or BSc degree or the award of a MA or MSc degree, as well as post-graduate courses), while ISCED's Level 6 means second stage of tertiary education leading to an advanced research qualification.

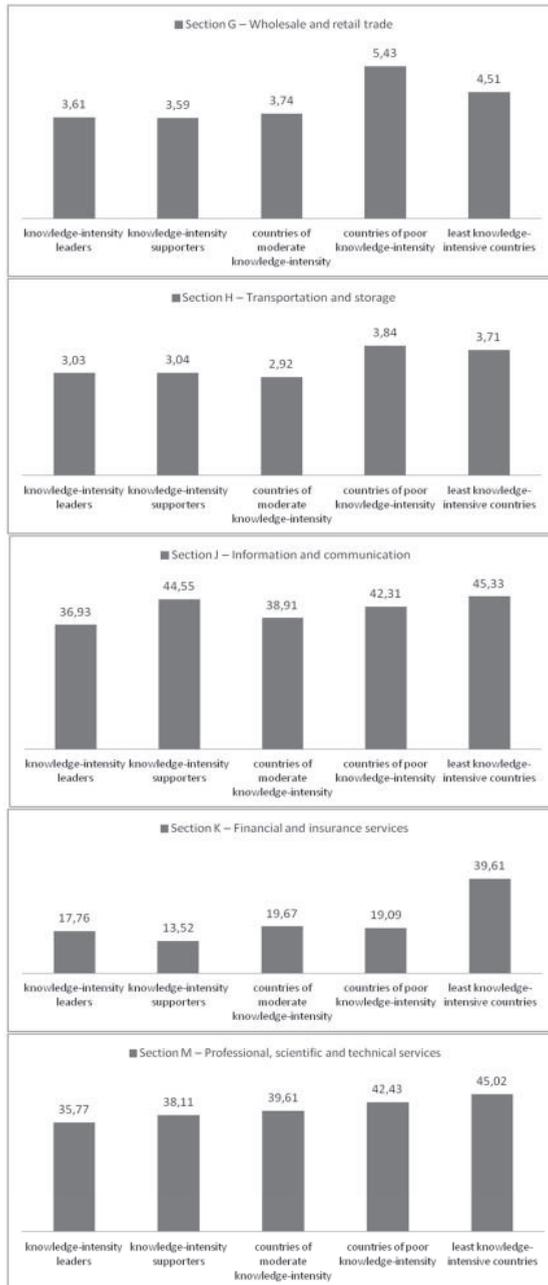


Fig. 3. Share of professionals working in the various sections of the service sector as a percentage of total employment in a given section for each identified cluster of countries.

Source: compiled from the website of Eurostat. <http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home>.

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The highest percentage of professionals working in Section M was found in the countries assigned to the ‘least knowledge-intensive’ and ‘poor knowledge-intensity’ clusters, where they made respectively 45.02% and 42.43% of the total Section M employment. With Section J, the highest percentage of professionals employed occurred in the ‘least knowledge-intensive’ cluster (45.33%) and in the ‘knowledge-intensity supporters’ cluster (44.55%).

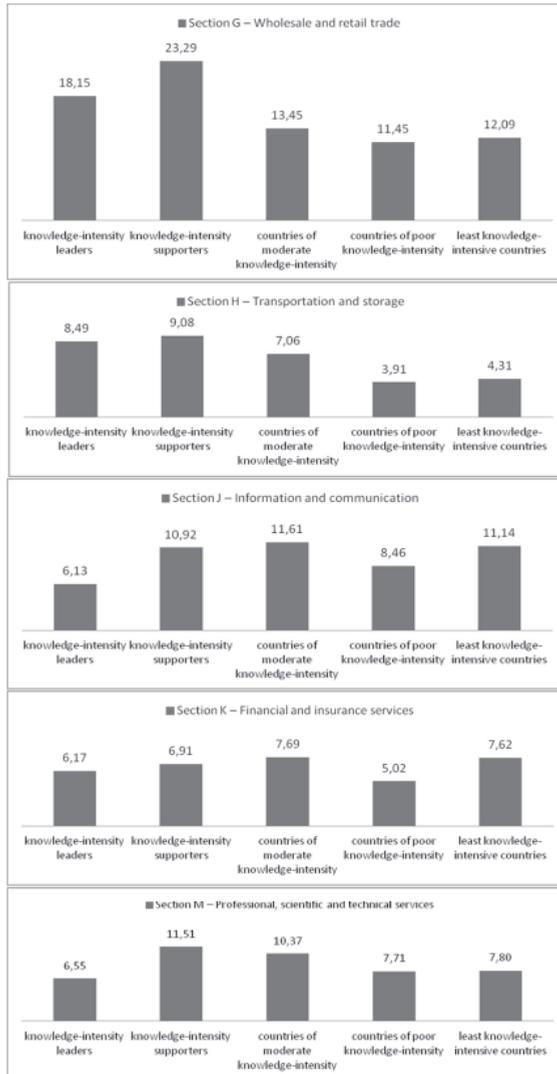


Fig. 4. Share of young employees as a percentage of total employment in a given section for each identified cluster of countries.

Source: compiled from the website of Eurostat. <http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home>.

Referred on 2014-03-03.

It is evident that the highest proportion of skilled workers can be found among the countries belonging to the 'least knowledge-intensive' group. These countries have a specific employment structure as reflected in the relatively low share of employment in modern service sectors but a high percentage of professionals employed there. In turn, the countries classified as those with 'poor knowledge-intensity', while having a typical traditional employment structure with a majority share of employment in Sections G and H, have the highest share of professionals employed in precisely the same sections. This indicates that these countries so far have not seen a clear shift of employment structure towards the modern, knowledge-based service industries which determine the transition to a knowledge-based economy.

Fig. 4 illustrates the arithmetic mean shares of young employees as a percentage of total employment in a given section for each identified cluster of countries. Within the KIE 1 cluster ('knowledge-intensity leaders'), the lowest shares of young people in total employment were observed in the following sections: J – Information and communication (6.13% of total employment in this section) and M – Professional, scientific and technical services (6.55%).

In the remaining sections surveyed, the lowest percentage of young workers occurred in the KIE 4 cluster – 'countries of poor knowledge-intensity'. This cluster showed the lowest values of this indicator for Section G (11.45%), Section H (3.91%) and Section K (5.02%). In contrast, the largest proportions of young workers are in the countries of the KIE 2 cluster, i.e. the knowledge-intensity supporters. These countries had the highest average proportion of employees aged 15–24 in such sections as: G – Wholesale and retail trade (23.29%), H – Transportation and storage (9.08%) and M – Professional, scientific and technical services (11.51%). Countries of the KIE 3 cluster ('of moderate knowledge-intensity') also clearly put their stakes on young workers, especially in the modern sections of the service sector. The average share of employees aged 15–24 in the total employment was 11.61% in Section J – Information and communication and 7.69% in Section K – Financial and insurance services. The last cluster, KIE 5 ('least knowledge-intensive countries') proved to have the highest share of young workers in Section G – Wholesale and retail trade (12.09%) and in Section J – Information and communication (11.14%).

It seems clear that young people have a good chance of employment in the countries belonging to the 'knowledge-intensity supporters' group, but the jobs are likely to be in the traditional industries, i.e. Wholesale and retail trade (Section G) and Transportation and storage (Section H).

#### 4. CONCLUSIONS

The results of this study indicate that employment structure varies significantly among European countries. Countries advanced in the utilization of knowledge and which have high values of KIE index (the 'knowledge-intensity leaders' and the 'knowledge-intensity supporters') have an employment structure resulting from their focus on sections that require specialized knowledge. The proportion of employment in sections requiring professional knowledge, namely J, K and M, ranges from 12.0% to 16.5% of total employment in the national economy. Meanwhile, for the less knowledge-intensive countries the same figure never exceeds 7.0%. Another significant conclusion is that countries with high KIE values make better use of young people's potential. Knowledge-intensive countries have a much higher share of young workers (aged 15–24) in modern sections than those with poor knowledge-intensity. A relatively high proportion of young workers was found to occur in countries of the 'knowledge-intensity supporters' group, where in Section G – Wholesale and retail trade young people accounted for more than 23% of this section's total employment. For comparison, in the countries of poor knowledge-intensity this share was lower by half and amounted to 11.4%.

The structure of employment in countries with low levels of knowledge-intensity ('poor knowledge-intensity' and 'least knowledge-intensive') is clearly predominated by the traditional service industries, i.e. transport and trade. Such an 'outdated' employment structure does not correspond to the evolving needs of knowledge-intensive economy. It hinders the shift towards a knowledge-based economy. The relatively poor performance of the economies belonging to the 'least knowledge-intensive' cluster (including Poland) indicates a significant, untapped potential for building a knowledge-based economy. This refers in particular to the young people whose situation in the local labour markets is difficult indeed.

What also requires some attention and explanation is the high proportion of professionals working in the service sector of the countries with low levels of knowledge-intensity. It turns out that larger general employment in the knowledge-intensive sections is more important for good utilization of advanced knowledge than a large share of professionals employed in those sections. The analysis shows that across all sections analysed, the share of professionals employed was the highest just in the countries classified as 'least knowledge-intensive'. It should be noted that the data referring to professionals are quantitative only. There is no data available that would allow measurement and comparison of education quality. Undoubtedly, closing the developmental gap must make the individual structures of employment in the service sectors, in both their traditional and modern sections, increasingly similar to their counterparts in the more knowledge-intensive countries.

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