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Factor Competitiveness of the Technological Advanced Services Sector in the European Union Countries: A Typological Analysis

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Abstract:

Purpose: *The article presents a significant and current research problem concerning the competitiveness of the technologically advanced services sector. The research aimed to assess the diversity of this phenomenon in the EU Member States and make a typology of Member States based on partial competitiveness indicators.*
Design/Methodology/Approach: *The study uses a universal model of factor competitiveness - the adopted indicators can also be used to assess other sectors of the economy. Typological classification of EU Member States was made using Ward's cluster analysis.*
Findings: *Several countries shape the level of competitiveness of the high-tech services sector in the EU. The first group comprises France, Germany, Spain, the Netherlands, and Italy - it is characterized by a high level of production potential and factor competitiveness indicators. The second group comprises countries with low production potential but with the highest competitiveness indicators among the EU countries. These are Luxembourg, Cyprus, and Malta.*
Practical Implications: *The typology of EU countries in terms of the production potential and competitiveness of the high-tech services sector is a source of information that can shape regional development policies of this sector in individual EU countries. The increasing importance of knowledge-based services in economic development, which includes the studied sector, is a crucial application value of the study.*
Originality/Value: *The level of competitiveness of the technologically advanced services sector and the factors shaping it is a critical issue both in EU policy and in the development of individual countries. Research on the high-tech sector focuses mainly on manufacturing companies (high-tech industry), and to a much lesser extent, on service companies (high-tech services). The considerations contained in the article fill the research gap in this area.*

Keywords: *Competitiveness, factor competitiveness indicators, the sector of technologically advanced services, knowledge-intensive services, the European Union.*

JEL codes: *L8, O52, C38, J24, O3.*

Paper Type: *Research article.*

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1. Introduction

The changes taking place in the contemporary world reveal the growing importance of the service sector in national economies in highly developed countries (including the European Union) and in developing countries. The growing importance of the service sector manifests itself in increasing its share in the creation of GDP, employment, and international exchange. This process is not uniform in all countries, as it depends on the place it occupies in the "waves of industrialization" (Eichengreen, 2011). In developed OECD countries, the service sector has a dominant share of total employment and value-added. The average share in value-added in these countries exceeds 70%, while it varies between 30 and 50% in emerging countries. Service markets are also of crucial importance in the EU economy. In 2019, almost three-quarters of the total EU-27 value added was generated in the services sector, which employed nearly 70% of people.

Another tendency occurring in world economies is an increasing study of their development based on widely understood knowledge. The concept of the knowledge-based economy (KBE) is the primary theoretical basis of the economic growth policy of individual national economies. Along with the acceleration of the development of new technologies, the essential condition for a country to participate in global competition is the availability and use of its knowledge resources. It was one of the reasons for distinguishing among many types of services, the so-called knowledge-intensive services (KIS). According to the classification used in EU statistics, they include high-tech knowledge-intensive services (HTKIS), knowledge-intensive market services, knowledge-intensive financial services, and other knowledge-intensive services.

Skórska (2016) emphasizes that there are substantial differences between the various categories of services included in the NSS, and consequently, their importance in the development of the knowledge-based economy is different. The author also adds that the technologically advanced services sector (HTKIS) has the largest share in employment in KIS - approx. 60%. Moreover, many theoretical and empirical studies indicate that this sector - together with the high technology industry - are those sectors of national economies that determine the possibility of their development and improvement of competitiveness. Bearing in mind the presented premises, the purpose of the research in the article was to determine the level of factor competitiveness of the technologically advanced services sector in the European Union countries and make their typology on this basis.

2. Literature Review

The knowledge-intensive services sector is of interest to many scientists. Several currents of considerations can be distinguished in it. The basic one concerns determining the relationship between the knowledge-intensive services sector and its divisions and economic development. Many authors have discussed this issue

(Meshko and Shchitov, 2016; Kox and Rubalcaba, 2007; Gotsch *et al.*, 2011; Klaesson and Norman, 2015; Brenner *et al.*, 2018). They indicate a positive and robust relationship between the share of NSS in a given country's economy and the level of its development. This is due to the sector's direct and indirect contribution to economic growth and development. The direct contribution is related to employment in this sector and the added value generated in it. The contribution to indirect growth is due to the positive spill-over effects that knowledge-intensive services have for other industries.

The scientific literature often mentions, for example, the substantial mutual influence of the high-tech services sector on the innovation of other sectors (Bilderbeek and den Hertog, 1998; Katsoulacos and Tsounis, 2000). These studies also show the growing interdependence between knowledge-intensive services and the manufacturing industry. They also emphasize the positive relationship between regional specialization based on knowledge-intensive services and productivity. Detailed research in this regard among EU countries was carried out by Kijek and Matras-Bolibok (2020). The analysis of the KIS location patterns in the EU countries was also performed by Merino and Rubalcaba (2012). The subject of the analysis is also the regional differentiation of companies from the KIS sector (Pauceanu, 2015; Ženka *et al.*, 2017). It is worth mentioning that all these considerations were carried out about the entire knowledge-based services sector and its selected departments (most often KIBS). The technologically advanced services sector (HTKIS) was treated marginally in them.

Another research trend that can be distinguished in KIS research is the assessment of the level of competitiveness of this sector and the factors shaping it. Grillitsch, Asheim, and Trippl (2018) emphasize that this is an important issue, as the competitive advantage depends on the resources of local knowledge and the interrelations between them that accelerate the processes of learning and introducing innovation. There are relatively few studies on this issue in the literature on the subject. They focus mainly on foreign trade results and related indicators, such as EMS - export markets share, RXA - relative export advantage, or TC - trade coverage. For example, Javalgi, Gross, Joseph, and Granot (2011), when assessing and comparing the results of the major emerging markets in KIBS exports, found that they build their competitiveness by focusing on the development of KIBS.

Yap Co (2007), examining the determinants of US exports, noted that the export of industry-related services is generally aimed at supporting other activities of companies in importing countries. In the assessment of competitiveness, it is also essentially what indicators it is analyzed with. Research by Sun and Hesmati (2010) indicates that both the volume of international trade and its structure towards high-tech exports positively impact China's regional productivity and, consequently, improve its competitive position in international markets. Chen (2011), using the TC and MI indices, indicates that China lacks international competitiveness in the trade of the KIS sector. He also claims that this is related to the immaturity of KIS industries located in that country.

A comprehensive assessment of the development and competitiveness of the knowledge-intensive services sector in the European Union was presented by Stehrer (2012). The research results included in the report indicate that KIBS export in all analyzed regions was dominated by other business services, accounting for 70% of total exports.

Moreover, the EU-15 is the largest exporter in all KIBS sectors. When analyzing the specialization patterns determined based on the RCA index, it was found that the EU-15 countries specialize in all three KIBS sectors. In the EU-12 countries, a comparative advantage emerged only in the area of research and development. Interesting considerations regarding the competitiveness of the KIS sector were made by Haataja and Okkonen (2004). In the article, they discussed three theories describing the models of enterprise competition, namely: resource-based view (RBV), knowledge-based view (KBV), and complex evolving systems (CES).

However, the considerations contained in it relate more to the micro- rather than the macroeconomic level. Wyszkowska-Kuna (2014) discussed Poland's competitiveness in the international arena in trade-in knowledge-based services (KIS). It used traditional indicators of international competitiveness, such as export performance, trade balance, and the RCA index. Again, it should be noted that the HTKIS sector is not included in these surveys. This may be because it is also included in the so-called high technology sector. It is a combination of high-tech production and service companies. Research on the competitiveness of this sector was carried out, among others, by Juchniewicz and Łada (2020) using both indicators of competitive potential (labor productivity, personnel costs, and the country's share in the number of enterprises) and competitive position (indicators of international trade). Therefore, despite the research and systematization of information on the competitiveness of the technologically advanced services sector, there is still a research gap concerning this guesswork.

3. Research Methodology

Competitiveness is a complex and multi-threaded concept. This creates many dilemmas when developing methods of measurement and indicators used to evaluate it. However, the starting point in these considerations is always the resource approach, in which the production potential is assessed regardless of the level of competitiveness analysis (macro-, meso- or microeconomic). The production potential - under the theory of the economies of scale of production and sales - is associated with an increase in the production volume within the enterprise and an increase in the production volume of the entire industry, and thus, among others, with reduction of unit costs, increase in labor productivity, the possibility of installing new machines and improvement of production technology.

The production potential of the technologically advanced services sector in individual EU countries was calculated based on the following indicators: a country's share in

the total number of enterprises (% EN), country's share in the total number of employees (% EM), a country's share in the total sales value (% PV), a country's share in total gross value added (% VA). All indicators were calculated by dividing the appropriate variable occurring in a given country by the sum of its values among all analyzed EU countries.

Rationally used production potential is a source of factor competitiveness. It can be assessed using a variety of indicators. Many economists equate it with productivity because it determines the ability to use the resources at hand. The importance of productivity in the context of research on competitiveness is emphasized, among others, by Porter (2008), who equates competitiveness and productivity. A positive relationship between competition and productivity is also demonstrated in the studies of other authors, both theoretical and empirical (Nickell, 1996, Blundell, Griffith, and Van Reenen, 1999). It is one of the primary indicators in the assessment of factor competitiveness.

The article uses the most popular factor productivity index, the labor productivity index (Petranov, 2018). It was obtained using the following formula:

$$LP = \frac{V}{L} \tag{1}$$

where: LP - labor productivity, V - value of sold production, L - employment in the sector. Additionally, the ratio of the reciprocal of unit labor costs was calculated based on the formula:

$$LCP = \frac{V}{LC} \tag{2}$$

where: LCP - labor cost productivity, LC - labor costs.
This indicator reflects the degree of coverage (financing) of the labor factor remuneration by its productivity.

All measures of productivity or efficiency of economic processes are based on the value of production, considered as its result. However, the goal or effect of these processes is not the production itself, measured by its value, but the achievement of an increase in value that can be spent on consumption or economic development. The added value is such an effect on the meso scale (sectors of the economy). The comparison of this category of effects with labor inputs or labor costs determines the effectiveness of their use. For this purpose, the following indicators were used:

$$LIE = \frac{VA}{L}, \qquad LCE = \frac{VA}{LC} \tag{3}$$

where: LIE - labor input efficiency, LCE - labor cost efficiency, VA - value-added**.**

The above-mentioned partial components of the competitiveness indicators can be expressed in monetary terms. These data are usually available at current prices. The examination of the relationship between these components of the account does not require converting them into constant (comparable) prices, which means that the results of the calculations are not burdened with errors that may be made when selecting deflators. The adoption of the indicators mentioned above resulted from substantive and statistical premises and limitations resulting from the availability of data for analysis. Typological groups of EU countries regarding the production potential and competitiveness of the technologically advanced services sector were distinguished due to intra-group variability. For this purpose, one of the hierarchical agglomeration groups of cluster analysis methods, the Ward method, was used.

This method allows combining objects into consecutive clusters based on the value of the similarity function. The more similar the objects are, the earlier they are combined (minimizing the sum of the squared deviations of any two clusters formed at each stage). This made it possible to create homogeneous "groups" and "subgroups" of countries similar to each other in terms of the analyzed features (adopted indicators of production potential and competitiveness). In class formation, the features were standardized, and the Euclidean distance was used (Randriamihamison, Vialaneix, and Neuvial, 2020). The clusters are arranged hierarchically so that the lower-order clusters are included in the higher-order clusters based on the similarity hierarchy.

The sector of technologically advanced services, which is the subject of the considerations presented in the article, was defined based on the Statistical Classification of Activities of the European Union NACE Rev. 2. It includes the following sections: 59 - Motion picture, video and television program production, sound recording and music publishing activities, 60 - Programming and broadcasting activities, 61 - Telecommunications, 62 - Computer programming, consultancy, and related activities, 63 - Information service activities (63) and 72 - Scientific research and development. The analysis covered three years (the latest available data in the Eurostat database - as of April 26, 2021). The average of the analyzed time intervals was adopted for the calculations. The research covered the countries currently included in the European Union (Ireland was omitted due to the lack of data).

4. Results and Discussion

The conducted research shows that there were significant differences in the level of indicators describing the competitiveness of the technologically advanced services sector in the analyzed period. It should also be emphasized that a much higher differentiation was found among the indicators of production potential than in the case of competitiveness indicators (Tables 1 and 2). This is because the variables describing the production potential were related to the size of a given country. On the other hand, competitiveness indicators describe the degree of utilization of resources held in a given country.

Using Ward's method, five internally homogeneous clusters of countries were created in terms of the analyzed characteristics of the production potential (Table 1). Germany was included in the first typological class. This country was characterized by the highest levels of all the potential production indicators adopted for the calculations. About 27% of enterprises in the EU's technologically-advanced services sector were concentrated in Germany. They employed almost 14% of people working in this sector in the EU. Business entities in the technologically advanced services sector located in Germany generated almost 25% of the production value in the EU and as much as 30% of the added value. France formed the second typological class. It was a country with a similar level, in comparison to Germany, of the share in employment and the value of sold production.On the other hand, the share in the number of enterprises and value-added was much lower. The technologically advanced services sector's production potential in these two countries was by far the highest. In total, 42% of enterprises were concentrated in them, which produced approx. 45% of the value of sold production and 48% of the value-added of the entire sector in the EU

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Table 1. *Typology of the European Union countries based on the production potential of the technologically advanced services sector*

Description	Production potential indicators			
	% EN	% EM	% PV	% VA
I group				
Germany	27.2	13.8	24.6	29.0
II group				
France	15.0	12.7	20.7	19.0
III group				
I subgroup: Italy	9.8	10.7	11.6	10.7
II subgroup: Netherlands, Poland, Spain				
Mean	6.5	9.1	5.6	5.6
Minimum	5.3 (Netherlands)	7.9 (Spain)	3.0 (Poland)	2.9 (Poland)
Maximum	7.9 (Spain)	10.4 (Poland)	7.2 (Netherlands)	7.4 (Spain)
Variation coef. (%)	20.6	13.7	40.3	43.3
IV group				
I subgroup: Belgium, Sweden				
Mean	3.1	4.3	4.9	4.0
Minimum	2.3 (Belgium)	3.4 (Belgium)	4.0 (Belgium)	3.6 (Belgium)
Maximum	3.8 (Sweden)	5.2 (Sweden)	5.7 (Sweden)	4.4 (Sweden)
Variation coef. (%)	33.7	29.8	25.5	14.7
II subgroup: Czechia, Hungary				
Mean	2.4	4.2	1.3	1.3
Minimum	2.4 (Hungary)	4.1 (Hungary)	1.0 (Hungary)	1.1 (Hungary)
Maximum	2.5 (Czechia)	4.3 (Czechia)	1.7 (Czechia)	1.6 (Czechia)

Variation coef. (%)	3.1	2.5	40.1	24.8
V group				
I subgroup: Bulgaria, Portugal, Greece, Slovakia, Romania, Denmark, Austria, Finland				
Mean	1,8	1,8	1,4	1,5
Minimum	1.1 (Slovakia))	1.0 (Finland)	0.5 (Bulgaria)	0.6 (Bulgaria, Slovakia))
Maximum	3.2 (Romania)	2.4 (Romania)	2.8 (Denmark)	2.8 (Denmark)
Variation coef. (%)	34.5	26.1	56.1	58.7
II subgroup: Estonia, Croatia, Cyprus, Latvia, Lithuania, Luxembourg, Malta, Slovenia				
Mean	0.4	0.5	0.3	0.3
Minimum	0.1 (Malta)	0.1 (Malta)	0.2 (Malta)	0.1 (Malta)
Maximum	0.7 (Croatia)	1.0 (Slovenia)	0.8 (Luxemburg)	0.6 (Luxemburg)
Variation coef. (%)	51.8	61.3	58.0	50.0

Source: *Own calculations based on Eurostat (2021).*

The third typological group consisted of two subgroups. Italy was included in the first group. A slightly lower share in employees characterized enterprises of technologically advanced services in this country than Germany and France. However, the remaining indicators were much less favorable - about a 2-fold lower share in the value sold and a 2-3 times lower share in the added value. Another subgroup was made up of the Netherlands, Poland, and Spain. The similarity of these countries resulted mainly from the similar share in employment (from 7.9% to 10.4%) and in the number of entities in the advanced technology sector (from 5.3 to 7.9).

Much more significant differences were recorded in the share of sold production and value-added (variation index 40-43%). It is essential in this context to indicate the reasons for this situation. It resulted from a relatively low share in the value of sold products and the value-added of economic entities in Poland's technologically advanced services sector. Compared to other countries, it was more than two times smaller. The production potential of the countries forming the third typological group was significant. 29% of enterprises were located there, employing 38% of all people working in the technologically advanced services sector in the EU. They accounted for approx-28% of the value of sold production and value-added of the analyzed sector in the EU countries.

Countries belonging to the three typological groups discussed were characterized by the highest production potential of the technologically advanced services sector among all EU countries. In total, 71% of enterprises from the EU sector, employing 65% of employees, were concentrated in them. Entities located in these six countries accounted for approx-75% of the value of sold production and value-added. The following typological groups - IV and V - were of much less importance. Among the countries included in the fourth typological cluster, it is worth paying attention to two

countries included in the first subgroup, Belgium and Sweden. With a lower share in the number of enterprises and employees than recorded among the countries of the third typological group, their share in the value of sold production and value-added was relatively high. For example, about the indicators obtained in Poland, the share of economic entities from the technologically advanced services sector in Sweden in creating the value of sold production was almost twice as high, and in the creation of the value-added, it was 1.5 times greater.

The analysis of the indicators of the production potential of the technologically advanced services sector of the European Union countries and their typology obtained on this basis indicates two phenomena. First, a country's productive potential is related to its size and the number of people living there. It is a natural situation resulting from the economies of scale of production of a given national economy. Many studies indicate that irrespective of the sector of the economy in question, it is the main factor of competitiveness not only on a European but also on a global scale. Secondly, small countries may take advantage of the competitive advantages resulting from the effective use of their relatively small resources. Therefore, it is essential to assess the competitiveness of the technologically advanced services sector in EU countries based on the productivity and efficiency indicators.

Table 2. *Typology of European Union countries based on the competitiveness of the technologically advanced services sector*

Description	Competitiveness indicators			
	LP (thousand euro / person)	LCP (euro/euro)	LIE (euro/person)	LCE (euro/euro)
I group				
I subgroup: Luxembourg	384	5.1	151	2.0
II subgroup: Cyprus, Malta				
Minimum	204 (Malta)	7,0 (Malta) (Luxemburg)	80 (Malta)	2.7
Maximum	264 (Cyprus)	7.9 (Cyprus)	90 (Cyprus)	2.7
Mean	234	7.5	85	2.7
Variation coef. (%)	17,9	8,5	8,3	0,5
II group				
I subgroup: Belgium, Denmark, Netherlands, Italy, Finland				
Minimum	187 (Finland)	3.2 (Denmark)	75 (Italy)	1.6 (Denmark, Finland)
Maximum	234 (Belgium)	4.1 (Belgium)	105 (Belgium)	1.9 (Belgium)
Mean	193	3.7	90	1.7
Variation coef. (%)	13.3	9.8	12.7	7.1
II subgroup: Sweden, France, Austria, Germany, Spain				
Minimum	114 (Spain)	2.4 (Austria)	64 (Spain)	1.2 (Sweden)
Maximum	207 (Sweden)	3.2 (Sweden)	87 (Austria)	1.6 (Spain)

Mean	154	2.8	78	1.5
Variation coef. (%)	26.7	11.3	12.3	10.1
III group				
I subgroup: Portugal, Slovenia, Czechia, Greece, Estonia, Slovakia, Poland, Croatia				
Minimum	67 (Croatia)	3.2 (Estonia)	32 (Poland)	1.5 (Estonia)
Maximum	108 (Portugal)	4.2 (Poland)	52 (Portugal)	2.0 (Poland, Croatia)
Mean	85	3.8	40	1.8
Variation coef. (%)	17.0	7.5	16.8	9.1
II subgroup: Hungary, Lithuania, Romania, Latvia, Bulgaria				
Minimum	43 (Bulgaria)	2.9 (Bulgaria)	24 (Bulgaria)	1.6 (Lithuania, Romania, Latvia, Bulgaria)
Maximum	55 (Hungary)	3.2 (Romania)	32 (Hungary)	1.7 (Hungary)
Mean	51	3.0	28	1.6
Variation coef. (%)	9.5	3.8	10.4	3.2
Basic statistical measures of the EU countries covered by the analysis				
Minimum	43 (Bulgaria)	2.9 (Bulgaria)	24 (Bulgaria)	1.6 (Lithuania, Romania, Latvia, Bulgaria)
Maximum	384 (Luksemburg)	7.9 (Cyprus)	151 (Luksemburg)	2.7 (Malta, Cyprus)
Mean	136	3.8	62	1.7
Variation coef. (%)	60.6	32.9	51.1	19.0

Source: *Own calculations based on Eurostat (2021).*

The typology of EU countries in terms of the competitiveness of the technologically advanced services sector includes three groups (Table 2). The first includes Luxembourg, Cyprus, and Malta. These countries recorded the highest level of average competitiveness indicators. The strengths of Luxembourg were labor productivity and the related efficiency of labor inputs, Cyprus - high labor productivity, but above all, the above-average coverage of labor costs with the value of sold production and the effectiveness of labor costs. On the other hand, Malta stood out with a high ratio of products sold per labor costs. It is symptomatic that all the countries included in this group were characterized by a low production potential of the technologically advanced services sector.

Another second typological group consisted of ten countries. The first subgroup included Belgium, Denmark, Netherlands, Italy, and Finland. Apart from Italy, all countries included in this subgroup were characterized by a low production potential of the high-tech services sector. A clear difference between them and the countries included in the first typological subgroup concerned the ratio of covering labor costs with the value of sold production (LCP) and the related labor cost efficiency index (LCI) - it was about two times lower. However, it is worth noting that in Belgium, labor productivity was comparable to the average of the countries included in the first

typological group. The LCP index was also relatively high in this country. This proves the high level of competitiveness of the high-tech services sector in this country. It is worth emphasizing the high level of competitiveness indicators recorded in Italy. Combined with the above-average production potential, this is the reason for including this country among the most competitive. The second subgroup consisted of countries such as Sweden, France, Austria, Germany, and Spain.

The feature linking these countries is primarily above average or close to the EU average competitiveness indicators. Germany and France were among the countries with a dominant competitive potential, and Spain had above-average production potential. The technologically advanced services sector entities located in these countries use the high production potential and the above-average efficiency of its management. As a result, they were classified among the countries with a high level of competitiveness in the analyzed sector.

The third cluster covered as many as thirteen countries. The first subgroup includes the following countries: Portugal, Slovenia, Czechia, Greece, Estonia, Slovakia, Poland, and Croatia. The labor productivity index (LP) and the labor input efficiency index (LIE) in these countries were over 1.5 times lower than the EU average, and approx. 3-2 times lower than the countries included in the first and second typological groups. More minor differences occurred in the ratio of covering labor costs with the value of production (LCP) and the labor cost-effectiveness index (LCE).

Compared to the EU average, they were at a similar level, and about the most competitive countries (included in typological groups I and II), they were about 1.5 times more minor. In the discussed subgroup, only Poland belonged to the countries with a relatively high level of production potential. The competitiveness indicators analyzed in the study indicate that in this country, it is not used rationally. Low payment of labor, which is an element of the application of the strategy of competing based on cost-price advantages, does not translate into the degree of financing the remuneration of the labor factor by its efficiency.

This is an essential factor limiting entities located in this country to compete on the EU market. The second subgroup of the third cluster included the following countries: Hungary, Lithuania, Romania, Latvia, Bulgaria. They belonged to the countries with a low level of production potential and the lowest competitiveness indicators among the analyzed countries. There was a noticeable difference in the case of the labor productivity index. It was three times smaller than the EU average and six times smaller than the countries in the first typological group. Much more minor differences occurred when comparing the indicators of covering labor costs with the production value (LCP) and the labor cost-effectiveness index (LCE). This again indicates that low-wage labor cannot be the only competitive factor. It should be correlated with the corresponding increase in the productivity of this production factor.

5. Conclusions

The configuration of the technologically advanced services sector varies across the European Union. Countries with low production potential and high use of production factors are Luxembourg, Cyprus, Malta, and Belgium. The countries with above-average factor competitiveness and high production potential include France, Germany, Spain, the Netherlands, and Italy. This indicates the rational management of resources in the technologically advanced services sector in these countries.

Against this background, Poland fares negatively, where the sector in question was characterized by a much lower level of factor competitiveness indicators than the previously mentioned countries. In other countries, the factor competitiveness of the technologically advanced services sector was low. These results are consistent with the general level of competitiveness of the national economies of these countries. The direction of future research is related to the extension of the analysis with the results of foreign trade in the technologically advanced services sector and the resulting competitiveness level calculated on this basis. An exciting guess is also the determination of the inter-industry differentiation of the competitiveness of this sector.

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