



10.2478/v10103-012-0039-1

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Comparative Analysis of the Level of Knowledge-based Part of Economies in European Union Countries with KAM Methodology**Abstract**

The article presents regional classification of EU countries according to the knowledge development of economy, which in these days is treated as fundamental factor of international competitiveness. This differentiation created with Knowledge Economy Index (KEI) and Knowledge Index (KI), which are used by The World Bank in Knowledge Assessment Methodology (KAM).

In the analysis used four main pillars (i.e. The Economic Incentive and Institutional Regime, The Innovation System, Education and Human Resources, Information and Communication Technology), which showed relation between individual components.

The purpose of this article is to identify disparities in the use of knowledge in socio-economic life in the EU countries. This research was conducted with use of the cluster analysis (tools belonging to multidimensional comparative analysis).

1. Introduction

Creating an economy based on knowledge is a multidimensional process which occurs on many planes of social and economic life. The process involves not only technology of production but also the basis of society and the peoples' ability to absorb knowledge. Effective social relationships and economical

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partnership ensure social capital forming. If modern infrastructure is equally available to everyone that means that innovative activity among manufactures and consequently general competition increase.

Measuring such a complicated phenomenon like a knowledge based economy is very difficult. The World Bank suggests the use of KAM (Knowledge Assessment Methodology) which consists of two basic indexes:

1. Knowledge Index (KI) which determines the whole knowledge potential of a countries while combining the creation, applying and flow of knowledge.
2. Knowledge Economy Index (KEI) in a more complicated tool, which is used to create global statistics of certain economies according to economic aspects.

Both of them are created on the basis of the 4 GOW pillars: The Economic Incentive and Institutional Regime, The Innovation System, Education and Human Resources, Information and Communication Technology (ICT).

In different countries the meaning of the above pillars on overall concept can be diversified. Clarity of KAM methodology allows to analyse certain indexes thanks to which that we can observe which country has some arrears. However, knowledge index and knowledge based economy index ensure the overall comparison. In the article there is also used analysis of concentration is also used. Thanks to that method we can indicate similarities among some European countries and show them on the map of the knowledge based economies.

2. The essence of knowledge based economy

The phenomenon of knowledge based economy (KBE) was first observed at the beginning of the 1990s. It soon spread on other well developed economies all over the world. People noticed that knowledge is the main index of production and it determines its growth. It guarantees more effective use of manufacturing potential mainly through the use of qualified human resources. (Malara 2006, p. 126). Knowledge must be perceived more extensively, taking into consideration at least four factors:

- whole society together with its traditions, culture and social behaviour patterns,
- state, its units and its policy,

- manufacturing plants and their potential, growth strategies, ways of using knowledge, demand for knowledge and the ability of its absorption,
- system of education, system of research and system of popularization of knowledge resources (Świtalski 2005, pp. 139–140).

Together with the growth of knowledge significance for economy appeared new terms, such as: “net economy”, “digital economy” or “new economy”. For many the most suitable definition describing growing trend of the meaning of knowledge for efficiency of social–economic system is “knowledge based economy”. It is a type of economy which uses knowledge and information both in production process and in the distribution of the products (*The Knowledge...* 1996, p. 7). Subjects (i.e. people, institutions, companies) building the economy gain knowledge to spread it and consequently be able to use it in a more effective way. The above subjects grow their competence (Kukliński 2003, p. 195).

The solid basis of KBE functioning is technical factor, i.e. temporarily very fast development of ICT Sector. This crucial development delivered effective information flows technology and data transfer which have a very positive influence on the total factor productivity (TFP) and consequently on all parts of a country’s economy (Porwit 2001, p. 115). Some people ever claim that we can say about the third or even fourth technological revolution, because the conditions of KBE enable achieving faster pace of long–term growth without the threat of inflation. However, sceptics say that the Internet cannot be compared to such inventions as steam engine or electricity. They claim that the influence of the Internet and the expansion of ICT on the efficiency of an economy will be not so effective as the influence of the inventions of the XIX and XX centuries. That fact can be proved by Solow’s paradox which shows that the era of computers can be seen in all aspects of an economy except the statistics showing the efficiency of work. Moreover, we have to take into account the growth of risk which can unsettle the fluidity of decision making. Sceptics also doubt the theory of lack of inflation threat, because even if fast economic growth, faster than the pace of efficiency and employment, is noticed, that means the decrease of unemployment rate. If the index falls below stated nonaccelerating inflation rate of unemployment (NAIRU) the inflation increases automatically (Wojtyna 2001, p. 6).

Nobody doubts that we can talk about spectacular changes in economy. The priorities of functioning of the whole system change. Service sector, investments into non–material assets, popularization of new technologies and creating information technology society are gaining importance (Platform, Sysko-Romańczuk, Moszoro 2004, p. 87). All these aspects influence innovation implementation. This term was first defined by Joseph Alois Schumpeter while

presenting his theory in 1920 which indicated 5 rules describing definition of innovation:

1. Innovative good is unconventional good so far unknown by the consumers because they could not purchase it earlier.
2. Innovative process of production means applying technics not used so far, which enable most of all reduction of cost, influence productivity and effectiveness in a positive way and they also ensure that interference into natural environment is smaller than with the use of traditional production methods.
3. Innovation is opening a new market, i.e. the market on which a certain branch of industry was not introduced earlier.
4. Innovation is the use of natural resources or semi-finished products which come from an unknown so far source.
5. Innovation is co-ordination of new industry, e.g. through creation or breaking monopolistic position (Schumpeter 1960, p. 60).

We have to pay attention to the fact, that today innovation is perceived wider, because it involves changes which occur in intellectual, economical, organizational and administration spheres. In a wide perspective innovation is an original idea which influences the changes in social system, economy structure, technology and environment. That is why we can say that innovation means number of actions, which meet the expectations of consumers both in material and non-material spheres. The term "innovation" is often identified with the idea, method of acting or a thing which was unknown so far. Another meaning of this issue is the ability to discover the new. Here innovation is perceived as the opposite of traditional and routine action (Janasz 2003, pp. 47–51).

3. Theoretical aspects of the use of KAM methodology

The whole process of measuring the knowledge of economies is very complex and complicated. In the area of the programme of The Knowledge for Development (K4D) the World Bank suggests the use of KAM methodology, which has been constantly upgraded since 1998. Now the methodology consists of 148 variables (both quantitative and qualitative) which are collected for 146 countries. Periodical and precise analysis is to ensure the possibility to collect more and more accurate data. KAM methodology is created by 4 important pillars:

1. The Economic Incentive and Institutional Regime which is responsible for the perfection of economic policy and the activity of different institutions. Deepening, spreading and using the knowledge in the units can ensure effective actions through sharing resources and stimulation of creativity.
2. The Innovation System which involves acting of economic subjects, research centres, universities, advisory committees and other organizations which adopt their activity to the preferences of more and more demanding customers.
3. Education and Human Resources which mean personnel who can adopt to constantly developed technological solutions thanks to developing their skills.
4. Information and Communication Technology (ICT), which ensures effective communication and faster transfer of data. All these aspects influence transfer and processing information and knowledge (Chen, Dahlman 2006, pp. 5–9).

Theory of the World Bank says that the knowledge factor can only be involve in the national production when a certain financial structure of the above pillars in kept. Such actions are to ensure the economic success of country, through raising the added value of goods, services and social and economic growth which raises competitiveness of the country on global market.

The process of collecting certain data in some countries can differentiate a little. Such situation leads to problems when we want to compare the countries being surveyed. To ensure the clear researchers use 12 sub-indexes – 3 connected with one of the pillars and additionally 2 connected with general functioning of an economy (see table 1).

Table 1. Sub-indexes used in individual pillars

Overall functioning of economy	GNP – Gross National Product (in %), HDI – Human Development Index,
The Economic Incentive and Institutional Regime	RB – rates barriers and non-rates barriers(based on trade policy), RQ – regulation quality (applies to frequency of unfriendly policy which hinders international trade and business development), LR – law regulations (which apply to effectiveness of crime detection and the efficiency of judiciary),
The Innovation System	EBR – employment in the sector B+R per million of citizens, P – patents granted by USPTO (Us Patent and Trademark Office) per million of citizens, SRA – scientific and research articles published per million of citizens,

Education and Human Resources	RLA – rate of literacy among adults' (people above 15 years of age in relation to the number of citizens), PPS – percentage of people who attend secondary schools in relation to the population who should attend such school, PPA – percentage of people attending colleges and universities in relation to people who can attend them,
Information and Communication Technology	PL – number of phone lines per one thousand of citizens, C – number of computers per one thousand people, I – Internet users per one thousand people.

Source: own studies based on www.worldbank.org/kam, states on 10.02.2012.

The four pillars described above two key indexes:

- Knowledge Index which determines the whole knowledge potential of a state while combining the creation, applying and flow of knowledge. The index is represented by the average of standardized findings for a certain country with the use of three most important pillars (without the economic incentive and institutional regime).
- Knowledge Economy Index in a more complicated tool, which is used to create global statistics of certain economies according to economic aspects. The most important characteristics of this group of variables assigned data is subjected to a normalization process through assigning certain. Later, partial indexes are calculated and finally they are valued again until the final index is assigned (www.worldbank.org/kam, states on 10.02.2012).

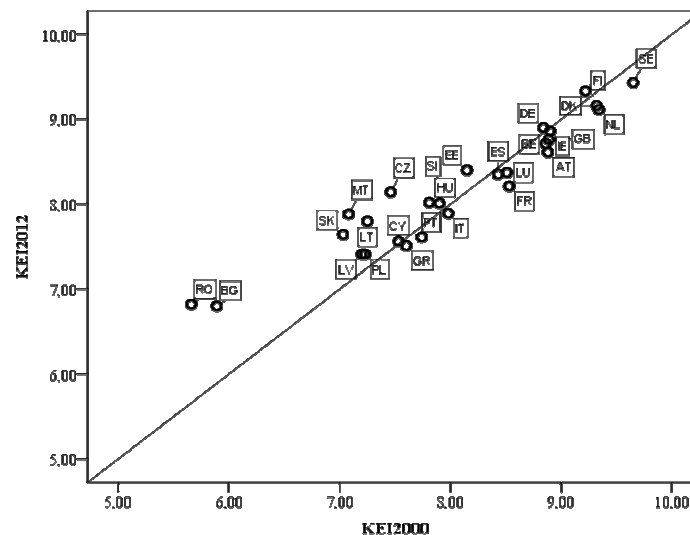
The effectiveness of this method is provided by its simplicity, clearness and versatility. Cross-sectional analysis of its certain aspects allows to create overall vision of a knowledge based economy. Another advantage is the fact that comparisons are done periodically and in international dimension, both from the synthetic and detailed perspective. Moreover, KAM methodology ensures clear graphic presentation of the analyses economic changes. There are some disadvantages of it as well. First of all, it is the aspiration to comprehensive picture of GOW. Furthermore, it is duplicating of information through taking into consideration highly correlated variables and of data in some countries which leads to difficulties in comparative analysis (Piech 2005, pp. 17–31).

4. KAM methodology in the light of empirical research

Constant analysis of a knowledge based economy conducted by the World Bank allows to determinate the growth and decreases of KEI and KI indexes in stated periods of time. The visual way of presenting the changes are scattering

graphs (see picture 1 and 2), which are layouts of points (each point means one country) according to real index values- which are presented by standardised measurements ranging 0–10. The higher the index rate, the more developed the economy is from the point of view the measured phenomenon. On the horizontal axis there are index values from the year 2000 whereas on the vertical axis current values from 2012. The graphs were prepared for 27 European Union countries. Through the centre of the graph runs a straight line expressing the equation $y=x$, which divides the area into equal parts. Points which are on the line show countries whose index level does not change in two research periods. Points which are above the line represent countries in which index growth was observed in 2012 in comparison with 2000. However, points under the line represent the countries where there was index value decrease in 2012 in comparison with the year 2000. The further from the beginning of the system of coordinates, the better because it indicates bigger potential of knowledge and its better allocation in a country¹.

Figure 1. Scattering graph of KEI index in European Union countries

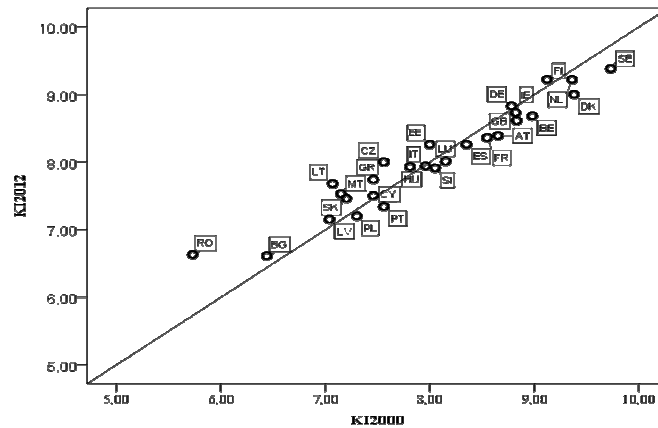


Source: own studies based on www.worldbank.org/kam, states on 10.02.2012 with SPSS Statistics.

¹ To make the graphs more clear a set of values ranging from 5 to 10 was set and the abbreviations of the names of countries were used according to the ISO 3166 system: AT – Austria, BE – Belgium, BG – Bulgaria, CY – Cyprus, CZ – The Czech Republic, DE – Germany, DK – Denmark, EE – Estonia, ES – Spain, FI – Finland, FR – France, GB – Great Britain, GR – Greece, HU – Hungary, IE – Ireland, IT – Italy, LT – Latvia, LU – Luxemburg, LV – Lithuania, MT – Malta, NL – Holland, PL – Poland, PT – Portugal, RO – Romania, SE – Sweden, SI – Slovenia, SK – Slovakia.

Looking at picture 1 we can assume that in the majority of top countries there was an index value decrease in the knowledge based economies in 2012 in comparison with the year 2000. The decrease also affected the leading country – Sweden. The only top countries, which reported index growth are Finland and Germany. Bottom and middle countries registered index, growth, which may indicate slow but constant process of catching up the arrears to the countries which can make a better use of knowledge in the economy. It is also worth mentioning that Bulgaria and Romania despite the biggest KEI changes, diverge from the rest of the countries.

Figure 2. Scattering graph of the KI index in European Union countries



Source: own studies based on www.worldbank.org/kam, states on 10.02.2012 with SPSS Statistics.

KI is very similar to KEI in most top countries (except Germany and Finland which noticed a slight growth of knowledge potential) are characterized by the index value decrease. Some middle and bottom countries (Romania, Bulgaria, Latvia, Lithuania, Slovakia, Malta, Cyprus, the Czech Republic, Hungary, Slovenia, Estonia and Greece) noticed the growth of the index. Situation is similar to the first graph where Bulgaria and Romania diverge from other countries, whereas Poland and Latvia are on the third position from the end in the year 2012 (after a decrease of a few positions comparing with the year 2000).

The graphs show two main indexes used in KAM methodology. But to be able to define the elements describing the indexes we must analyse the four main pillars (see table 2). Clarity of this method rely on possibility to construct four separate rankings which are assigned to all key pillars. Thanks to this it is easily to notice in which field certain state have development

backlog. Only high values in all pillars guarantee this high values in main pillars (KI and KEI) and high place in general ranking.

Table 2. Ranking of the European Union countries by KAM (2012)

EU rank	Global rank		Country	KEI	KI	The Economic Incentive and Institutional Regime	The Innovation System	Education and Human Resources	Information and Communication Technology
1	1	0	Sweden	9.43	9.38	9.58	9.74	8.92	9.49
2	2	6	Finland	9.33	9.22	9.65	9.66	8.77	9.22
3	3	0	Denmark	9.16	9.00	9.63	9.49	8.63	8.88
4	4	-2	Holland	9.11	9.22	8.79	9.46	8.75	9.45
5	8	7	Germany	8.90	8.83	9.10	9.11	8.20	9.17
6	11	0	Ireland	8.86	8.73	9.26	9.11	8.87	8.21
7	14	-2	Great Britain	8.76	8.61	9.20	9.12	7.27	9.45
8	15	-1	Belgium	8.71	8.68	8.79	9.06	8.57	8.42
9	17	-4	Austria	8.61	8.39	9.26	8.87	7.33	8.97
10	19	7	Estonia	8.40	8.26	8.81	7.75	8.60	8.44
11	20	2	Luxemburg	8.37	8.01	9.45	8.94	5.61	9.47
12	21	2	Spain	8.35	8.26	8.63	8.23	8.82	7.73
13	24	-3	France	8.21	8.36	7.76	8.66	8.26	8.16
14	26	7	The Czech Republic	8.14	8.00	8.53	7.90	8.15	7.96
15	27	2	Hungary	8.02	7.93	8.28	8.15	8.42	7.23
16	28	0	Slovenia	8.01	7.91	8.31	8.50	7.42	7.80
17	30	-3	Italy	7.89	7.94	7.76	8.01	7.58	8.21
18	31	8	Malta	7.88	7.53	8.94	7.94	6.86	7.80
19	32	2	Lithuania	7.80	7.68	8.15	6.82	8.64	7.59
20	33	7	Slovakia	7.64	7.46	8.17	7.30	7.42	7.68
21	34	-4	Portugal	7.61	7.34	8.42	7.62	6.99	7.41
22	35	-3	Cyprus	7.56	7.50	7.71	7.71	7.23	7.57
23	36	-5	Greece	7.51	7.74	6.80	7.83	8.96	6.43
24	37	0	Latvia	7.41	7.15	8.21	6.56	7.73	7.16
25	38	-3	Poland	7.41	7.20	8.01	7.16	7.76	6.70
26	44	9	Romania	6.82	6.63	7.38	6.14	7.55	6.19
27	45	6	Bulgaria	6.80	6.61	7.35	6.94	6.25	6.66

Source: own studies based on www.worldbank.org/kam, states on 10.02.2012.

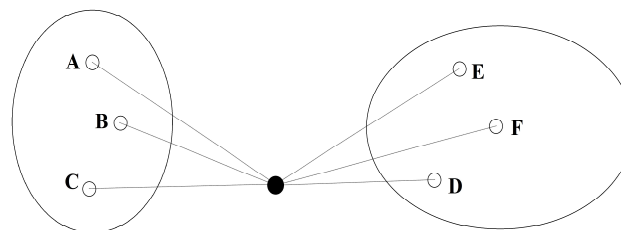
The first column in table 2 shows European ranking, the second world ranking while the third one represents growth/decrease in the world ranking in comparison with the year 2010. Both in the world and Europe Scandinavian countries dominate. Finland with its spectacular growth (6 points up within the last 2 years) in the ranking is also worth paying attention to. We must also mention that leading Sweden is constantly on the same position. Poland has a bottom position in the European Union. Unfortunately, Poland has registered a decrease of 3 positions in the world ranking since 2010.

Analysing the key pillars we can notice that the most work must be done in the education and human resource pillars (the level of these indexes in the majority of the countries is relatively lower than the level of indexes in other pillars). Spain, Hungary and Romania are the only exceptions. Their indexes connected with education are higher than in other pillars. In Luxemburg (placed 11 in Europe) education index only 5,61. But high index in other pillars allow the country a rather high position in the general ranking.

5. Territorial classification of the EU based on KAM methodology

Similarities of education potential and its implementing in the economy between the European Union countries can be seen with the use of cluster analysis. The analysis comes from the multidimensional statistics which combines methods of data classification. The technique of cluster analysis guaranties the division of a researched area into consistent class objects. Object in one area are similar according to a stated measure of similarity and can be identified with some distance between them and differ from the objects in other areas. In the article hierarchic agglomeration method of Ward was used. To estimate the distance between the clusters the method uses variation analysis.

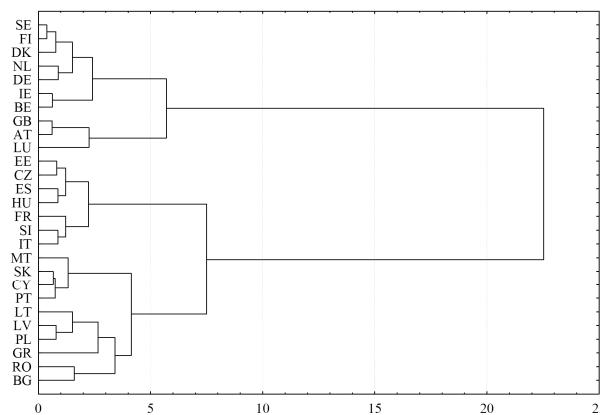
Figure 3. Semi-group distances in Ward's minimal variations method



Source: own studies based on Suchecki 2010, p. 62.

The distance between clusters is defined as a module of the difference between sums of squares of distances of points from the small created subsets join into numerous groups until the biggest subset contains all the objects. In the end the whole research process can be expressed as a hierarchic tree, thanks to which we can observe the consecutive analysis stages. This method is most frequently used in the economic analysis. By many researchers it is said to be the best, because it ensures the highest effectiveness of structure recognition in data matrix which describes analysed areas (Suchecky 2010, p. 62).

Figure 4. The diagram of Ward's agglomeration method

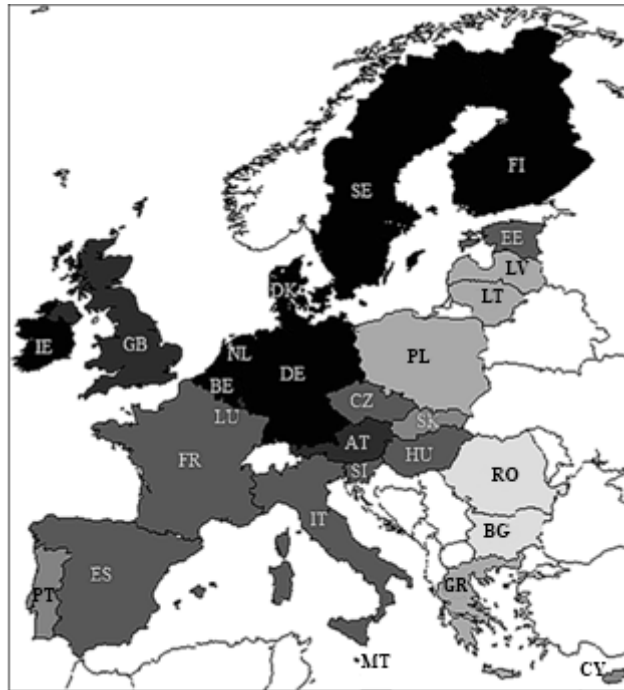


Source: own studies based on www.worldbank.org/kam, states on 10.02.2012 with Statistica 8.

Analysing picture 4 we can notice that two most similar countries are Sweden and Finland, which join into clusters on the level of consistent bond at 0,5. The most different is Greece which joins the group containing Poland, Latvia and Lithuania on the level slightly lower than 3.

On the basis of the diagram a map was constructed showing special relation of researched countries in different parts of the continent. The number of groups was decided on the level of consistent bond 3, which allowed to determine 6 groups. Two groups were distinguished. There are 7 countries which belong to each of them. In the first group there is Sweden, Finland, Denmark, Holland, Germany, Ireland and Belgium. The second Estonia, the Czech Republic, Spain, Hungary, France, Slovenia and Italy. Other groups contain 4 countries. In the first one there are: Poland, Lithuania, Latvia and Greece. The second 4-part group consists of Malta, Slovakia, Cyprus and Portugal. The least numerous is 3-part group, formed of Great Britain, Austria and Luxemburg. Bulgaria and Romania form the smallest, 2-element group.

Figure 5. Map of GOW potential in the European Union Countries (in 2012)



Source: own studies.

Looking at the map (drawing 5) we can see, that knowledge is the most effectively used in the economies of Scandinavian countries and in central Europe. The measures are slightly worse in South-West European countries. The worst situation is in East Europe. It is also worth paying attention on the fact, that countries with the highest grades are in immediate proximity (except Ireland). The situation is similar as far at the countries with the lowest grades are concerned (two weakest groups), which are on the east border (from Latvia to Bulgaria).

6. Conclusions

The use of knowledge potential in the European Union countries is very diversified. Between the top countries in the ranking and those which are at the bottom there is a very big developmental difference. But in the last few years the index growth of lowest classified countries and the slight decrease in the leading countries have been observed. It can indicate a slow make

up in the arrear worse developed areas. But it will take a lot of time and effort to balance the levels of KI and KEI. There is also a threat that this can be impossible.

Poland, in terms of the use of knowledge in the economy presents average. It has the third position from the end in Europe and very distant position in the world ranking. Moreover, in the last few years the position of Poland has been weakening (which may indicate too slow pace of knowledge allocation in social and economic areas). What makes the situation worse, countries which joined European Union together with Poland (1 May, 2004), i.e. Cyprus, Lithuania, Latvia, Malta, Slovakia and Slovenia have got higher indexes. We cannot forget Estonia, the Czech Republic and Hungary where the indexes are much higher. It must be also mentioned that the KI and KEI are constantly increasing in Bulgaria and Romania (the only two countries which are lower in the ranking comparing with Poland).

Therefore, we can ask a question if Poland fully used the development chances after joining EU? There is no clear answer to this question. But to make Polish manufactures more competitive it is necessary to unite education and business. The government has a very important role to play in this area. Its policy should be for innovation and should support the use of knowledge in economic life through raising expenditure on research and developmental sectors. Changes should also be introduced in education which should not deal with perfecting people's abilities but first of all it should be able to respond to the needs of human resources on the job market. More frequent use of computers and the Internet by entrepreneurs is crucial. According to the results in KAM, ITC pillar has the lower index in comparison with the other three.

There are no doubts that in Poland there are a lot of areas which demand bigger involvement of knowledge to increase its effectiveness. But we must look into future with hope that it will happen and that the indexes of knowledge and economy based on knowledge will be higher and that it will influence not only the higher position in the ranking but also social-economic reality and real effects taking place visible in the economy.

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Websites:

Organisation for Economic Co-operation and Development: www.oecd.org

The World Bank: www.worldbank.org

Streszczenie

ANALIZA PORÓWNAWCZA POZIOMU GOSPODAREK OPARTYCH NA WIEDZY W PAŃSTWACH UNII EUROPEJSKIEJ Z WYKORZYSTANIEM METODOLOGII KAM

W artykule przedstawiono klasyfikację terytorialną państw Unii Europejskiej według rozwoju wiedzy gospodarek, która w dzisiejszym świecie traktowana jest jako determinanta międzynarodowej konkurencyjności. Zróżnicowanie to zostało skonstruowane na podstawie indeksów KEI (Knowledge Economy Index) oraz KI (Knowledge Index) wykorzystywanych przez Bank Światowy w metodologii KAM (Knowledge Assessment Methodology).

Uwzględnienie czterech głównych filarów (tj. system bodźców ekonomicznych, system innowacyjny, edukacja i jakość zasobów ludzkich oraz nowoczesna infrastruktura informacyjna) umożliwiło wskazanie relacji pomiędzy poszczególnymi składowymi.

Celem artykułu jest wskazanie dysproporcji wykorzystania wiedzy w życiu społeczno-gospodarczym w państwach UE. Badanie zostało przeprowadzone przy użyciu analizy skupień (narzędzia zaliczanego do wielowymiarowej analizy porównawczej).