THE ANALYSIS OF POLISH ECONOMY'S TRANSFORMATION TO KNOWLEDGE BASED ECONOMY ON THE BASIS OF KNOWLEDGE ASSESSMENT METHODOLOGY

*Justyna Sokołowska-Woźniak**

Abstract
The main aim of this paper is to analyze the transformation of Poland to knowledge based economy on the basis of World Bank's Knowledge Assessment Methodology. The analysis of change will be used to compare the performance (strengths and weaknesses) of Polish economy in 1994, 2004 and 2014 with regard to the main aspects of knowledge based economy.
Keywords: *knowledge –based economy, knowledge assessment methodology, human capital, ICT system, innovation system.*

1. Introduction

The current era of capitalist development is called "knowledge based economy" (KBE). As defined by the Organisation for Economic Cooperation and Development (OECD), this term was developed to describe the trend in developed economies, that the economic progress relies more and more on the level of knowledge, information and skills, and easiness of business and the public sector access to these factors (OECD, 2008). In the most popular definition it is stressed that the knowledge-based economy is one in which production, absorption and spread of knowledge is a key factor for competitiveness and development of economies at different levels (eg. Dahlman, 2003; Arvanitidis & Petrakos, 2011)

This study uses the concept of knowledge-based economy developed by the World Bank, which assumes that knowledge economy is based on four pillars: Innovation Systems (SI) Education and Training (Human Capital) (E&HC), Dynamic Information and Communication Technologies (ICT) Economic Incentive and Institutional Regime. These pillars of knowledge-based economy do not differ from the assumptions of modern economic theories, which also indicate the importance of human capital, innovation, R&D or institutional system in creating long-term economic growth.

* Ph.D., Associate Professor in Department of Economics, Faculty of Social Sciences and Informatics, Wyższa Szkoła Biznesu – National Louis University, ul. Zielona 27, 33-300 Nowy Sącz, e-mail: sokolowj@wsb-nlu.edu.pl.

Knowledge differs from other factors of production, which has implications for the functioning of the knowledge-based economy. Knowledge is not material, but it can be fixed in various forms, e.g. patents, computer programs, or rooted in the minds of people and organizations. Knowledge as a public good is a non-rival good (the usage by a single entity does not reduce the benefits that are reached by another entity using this good) and non-excludable (no one can be excluded from the use of this good if it is publicly available, unless it is protected by patents). Using knowledge does not diminish its value, on the contrary, the more people use it, the greater its value and social benefit. The appearance of externalities to create, spread and use knowledge, are the premise to justify government intervention in this regard.

The policy objective of most countries or communities of countries has become a support to the development of the knowledge economy. Supporting the development of the pillars of the knowledge-based economy (KBE) has become then the objective of policy development at both national and regional levels. The increase of innovativeness, development of human capital, entrepreneurship or ICT system became the main aim of the European Union and many of its member states' strategies and programs. Poland is not the exemption. Since Polish accession to the European Union (EU) structures, most of the development policy funds come directly from the EU budget. They are allocated both by the central government (central programs) and local authorities (regional operational programs) but the distribution must be consistent with the objectives set on the EU level. In the 2007-2013 programming period a huge part of EU funds was dedicated for the Lisbon Strategy for jobs and growth's goals[2]. The main aim of this strategy was to create "the most competitive and dynamic knowledge-based economy by 2010" (CEC, 2000). In the new 2014 – 2020 programming period the funds should be basically directed to the achievement of Europe 2020 Strategy objectives, so they should be focused on stimulating smart sustainable and inclusive growth. Smart growth means based on knowledge and innovation (CEC, 2010).

If the instruments aimed at supporting KBE development are effective, first of all the this phenomenon has to be clarified and measured. The aim of this article is to present one of the most popular methodology of measuring KBE development and try to assess the transformation of Poland to knowledge based economy. The analysis of change will be used to compare the performance (strengths and weaknesses) of Polish economy in 2004[3] and

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2 More on this issue in: Sokołowska-Woźniak and Woźniak (2008), Sokołowska-Woźniak (2013).
3 The analysis of strengths and weaknesses of the Polish economy in making the transition to the knowledge economy can be found in Sokołowska-Woźniak (2004)

2014 (and 1995 if possible) with regard to the main aspects of knowledge based economy.

2. The concept of knowledge-based economy developed by the World Bank

The concept of knowledge-based economy developed by the World Bank assumes that the country could fully profit from the knowledge-based economy, if the pillars of the knowledge economy have the following characteristics (www.*web.worldbank.org › ... › Knowledge Economy):*

- Innovation Systems (SI) – a network of research centers, universities, private companies and social groups that can contribute to adaptation of the existing global knowledge to local needs, but also to creation of the new knowledge;
- Education and Training (Human Capital) (E&HC) – suitably qualified and educated society that it is able to create, disseminate and use knowledge effectively;
- Dynamic Information and Communication Technologies (ICT) – including a variety of tools which support effective communication and processing of information (radio, the Internet, among others).
- Economic Incentive and Institutional Regime – allowing free movement and creation of knowledge, fostering entrepreneurship and enabling flexibility adjustments of enterprises, institutions and markets.

Also in modern economic theories, the importance of human capital, innovation, R & D or institutional system in creating long-term economic growth is stressed. The positive and high correlation between economic performance and the development of the Knowledge Economy (calculated on the bases of World Bank Methodology) was stated in the Study: "Measuring Knowledge in the World's Economies" and is visualized in Figure 1. Although this positive correlation does not determine a causal relationship between the level of knowledge economy and economic development, further econometric tests revealed a statistically significant causal relationship which suggests that the level of knowledge accumulatio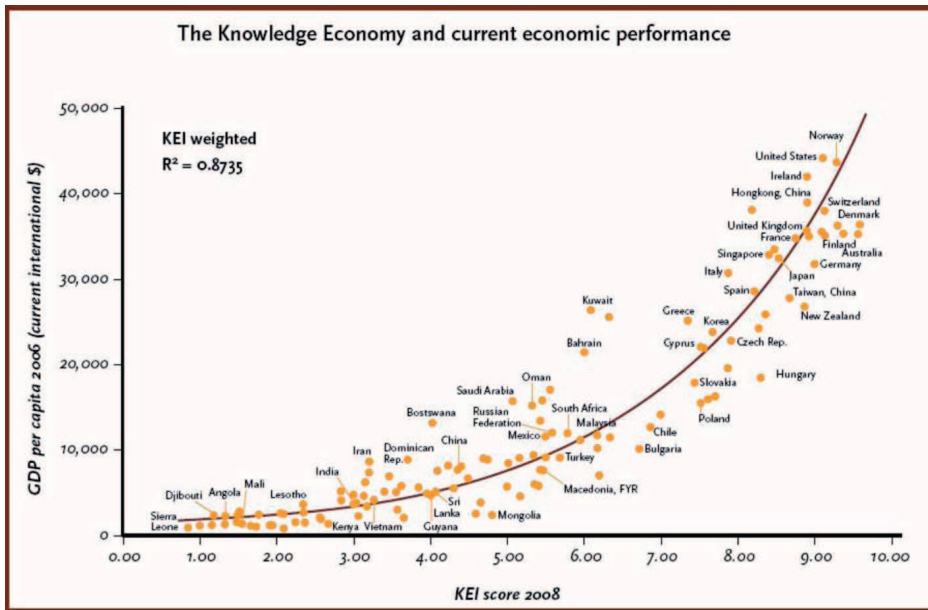n influences future economic growth (World Bank Institute, http://siteresources.worldbank.org/INTUNIKAM/ Resources/KAMbooklet.pdf).

Figure 1. The Knowledge Economy and current economic performance

Source: World Bank Institute, Measuring Knowledge in the World's Economies, http://siteresources. worldbank.org/INTUNIKAM/Resources/KAMbooklet.pdf 15.07.2015.

3. World Bank's methodology of Knowledge Economy Assessment

In 1999, the World Bank initiated the programme Knowledge for Development (Knowledge for Development -K4D), which aims to help developing countries increase the usability of knowledge for economic and social development by assessing the state of development of KBE development programs. One of the tools under this programme is called KAM (Knowledge Assessment Methodology), a method of assessing the potential and the level of the country in building the knowledge-based economy, thus allowing for comparison of the economy with other countries. Using KAM the strengths and weaknesses of a country in transition to knowledge-based economy can be assessed (as well as the opportunities and threats) which may be used to determine the policy of the country, as well as priority investments.

The list of countries, as well as of the structural and qualitative indicators that served as proxies for the above-mentioned four pillars of the knowledge economy, was being developed in the period of the program (K4D) implementation. To compare: KAM 2004 index consisted of 76 and allowed to compare 121 countries and KAM 2012 index comprised 148 indicators and the performance of 146 countries could be measured.

The basic tool, which can be used to compare countries on the basis of transformation into knowledge economy, is the Knowledge Economy Index (KEI). KEI is calculated as the average of four sub- indexes, representatives of the four knowledge economy's pillars. Each sub-index (pillar) is calculated on the basis of three indicators. Figure 2 depicts the relation between knowledge indexes, sub-indexes and indicators used to calculate them.
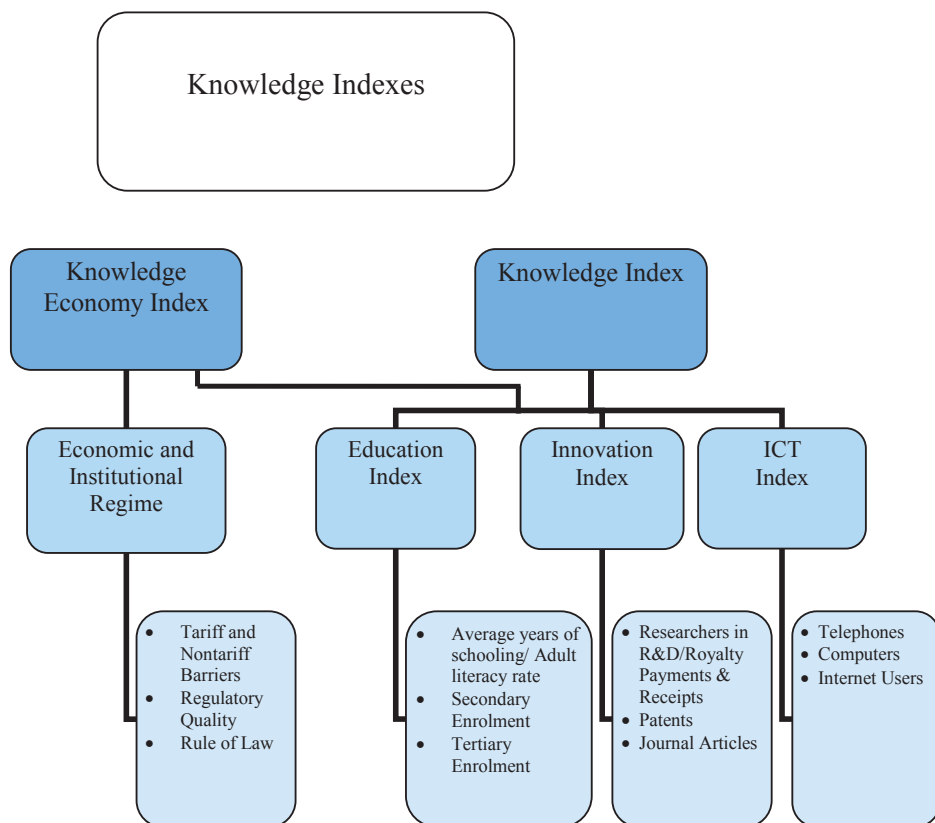

Figure 2. Knowledge economy indexes, sub-indexes and indicators in the World Bank's KAM

Source: World Bank, Knowledge Economy Index (KEI) 2012 Rankings, available: http://siteresources. worldbank.org/INTUNIKAM/Resources/2012.pdf.

It should be emphasized that the values of indicators used to calculate KEI index are normalized values on the scale from 0 to 10, where 10 implies relatively good performance as compared to other countries, and the score close to 0 indicates relatively poor development (thus KEI is also from 0-10). The usage of normative values, which show the comparative performance of

a country, to evaluate the change in time should thus be applied with caution. If a country's performance is worse with regard to a certain variable, it may mean that the situation of a country has deteriorated in absolute terms or the situation of a country improved but the countries to which it is compared made greater progress.

KEI is therefore a synthetic indicator. Such indicators are useful for estimating the complex, multi-dimensional concepts (which it is impossible to portray using one indicator) from various areas of socio – economic development such as the environment, competitiveness, integration of the single market and finally the knowledge economy. The analysis of such a synthetic index over time can capture the trends and direction of change, and in the context of economic policy, make it easier to create and evaluate effectiveness. Summary of advantages and disadvantages of synthetic indicators contained in the OECD (2008) manual for the construction of synthetic indicators is presented in Table 1.

Table 1. Advantages and disadvantages of synthetic indicators

Advantages	Disadvantages
• Sum and illustrate the complex, multidimensional phenomenon, supporting the decision making process. • They are easier to interpret than a set number of individual indicators. • Assist in evaluating the progress of the economy in terms of a given phenomenon. • Reduce the apparent size of a set of indicators without neglecting basic information, enabling more information to conclude within the existing size limit. • Situate topics related to the achievement of the results and progress of the economy at the center of attention in the political arena. • Support communication with the public and promote credibility. • Allow users to compare complex dimensions effectively.	• May send wrong signals to policy if poorly constructed or interpreted. • May cause political simplistic conclusions. • They can be poorly used, for example to promote desirable policies if the construction process is not clear and / or is not supported by solid statistics and conceptual basics. • The selection process for indicators and their weights can cause political disputes. • May conceal serious deficiencies in some dimensions and increased difficulties in identifying appropriate corrective action if the process of construction is not transparent structure. • Can lead to inappropriate policies if the dimensions which are difficult to measure are ignored.

Source: OECD (2008).

4. The classification of selected countries based on KEI in 1995, 2004 and 2012

The classification of selected countries (countries of Western Europe, 13 new members of the EU, US, Canada and Japan) based on Knowledge Economy Index, is shown in Table 2.

Table 2. Classification of selected countries using KEI

Place 2012	Place 2004	Place 1995	Place 1995-Place 2012	Country	KEI 1995	KEI 2004	KEI 2012
1	1	1	0	Sweden	9,20	9,25	9,43
2	2	2	0	Finland	9,14	9,14	9,33
3	3	3	0	Denmark	9,11	8,97	9,16
4	7	7	3	Netherlands	8,80	8,66	9,11
5	4	5	0	Norway	9,02	8,84	9,11
6	10	6	0	Canada	8,95	8,53	8,92
7	11	10	3	Germany	8,61	8,37	8,90
8	8	8	0	Switzerland	8,82	8,65	8,87
9	16	15	6	Irland	8,21	8,01	8,86
10	6	3	-7	United States	9,11	8,67	8,77
11	9	9	-2	United Kingdom	8,82	8,62	8,76
12	13	11	-1	Belgium	8,45	8,27	8,71
13	5	14	1	Iceland	8,83	8,73	8,62
14	12	13	-1	Austria	8,37	8,30	8,61
15	18	18	3	Estonia	7,82	7,75	8,40
16	17	17	1	Luxembourg	7,90	7,93	8,37
17	19	19	2	Spain	7,65	7,68	8,35
18	14	12	-6	Japan	8,48	8,25	8,28
19	15	16	-3	France	8,47	8,08	8,21
20	25	24	4	Czech Republic	7,15	6,79	8,14
21	24	25	4	Hungary	6,67	6,88	8,02
22	22	23	1	Slovenia	7,19	7,28	8,01
23	20	20	-3	Italy	7,57	7,38	7,89
24	28	28	4	Malta	6,15	6,60	7,88
25	27	29	4	Lithuania	5,91	6,70	7,80
26	31	30	4	Slovak Republic	5,67	6,31	7,64
27	21	21	-6	Portugal	7,25	7,32	7,61
28	29	26	-2	Cyprus	6,48	6,55	7,56
29	23	22	-7	Greece	7,15	7,06	7,51
30	26	31	1	Latvia	5,57	6,70	7,41
31	30	27	-4	Poland	6,47	6,53	7,41
32	32	32	0	Croatia	4,45	6,29	7,29
33	34	33	0	Romania	5,37	5,27	6,82
34	33	34	0	Bulgaria	6,03	6,19	6,80

Source: Own calculations based on: http://info.worldbank.org/etools/kam2/KAM_page5.asp.

The analysis of the data in the table above indicates that in the period 1995- 2012 the Nordic countries are constantly leaders (the first three places) in this ranking. The biggest progress was achieved by Ireland, which occupied 15th place in 1995 and 9th place in 2012. The largest decrease in the ranking is experienced by countries such as Portugal, Greece, Japan and United States. The development of Polish economy toward knowledge economy is not impressive as our country dropped in the ranking to one of the last places (Slovak Republic, Lithuania and Latvia placed ahead of our country).

5. The change analysis of selected indicators used for KBE assessment

Looking at individual indicators, whose average constitutes the KEI, the strongest side of our economy from the perspective of building a knowledge-based economy in all analysed years is the educational system. A more detailed analysis is possible to be carried out when the 14 indicators included in the KEI for Poland are compared. Figure 3 depicts normalized variables for Poland which were taken into account for KEI 1995, KEI 2004 and KEI 2012 calculations.
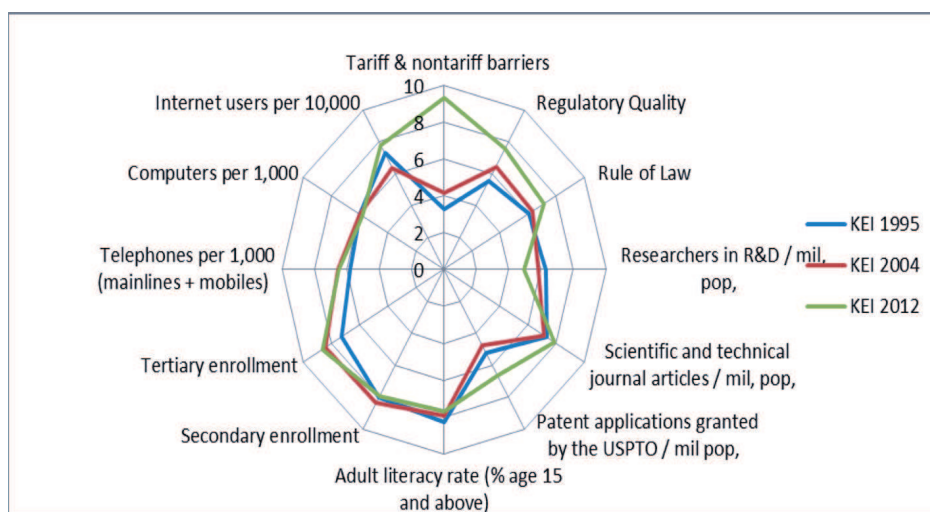

Figure 3. Comparison of KEI Indicators for Poland in 1995, 2004 and 2012

Source: Own study based on: http://info.worldbank.org/etools/kam2/KAM_page5.asp.

Table 3. Comparison of KEI 1995, KEI 2004 and KEI 2012 variables

Variable	KEI 1995 normalized	KEI 2004 normalized	KEI 2012 normalized	KEI 1995 actual /	KEI 2004 actual	KEI 2012 actual
Adult literacy rate (% age 15 and above)	8,26	7,93	7,67	99,7	99,7	99,51
Average years of schooling	n.a	8,65	6,69	na	9,84	9,87
Secondary enrolment	8,02	8,35	7,93	97,6	101,35	98,94
Tertiary enrolment	7,27	8,42	8,65	34,97	55,54	71,35
Researchers in R&D / mil, pop,	6,3	5,83	4,93	1360	1474,59	1928,73
Royalty Payments & Receipts / pop	n.a.	n.a	6,96	n.a	n.a.	43,12
Scientific and technical journal articles / mil, pop,	7,33	7,17	7,86	108,48	117	187,24
Patent applications granted by the USPTO / mil pop,	5,23	4,77	6,64	0,21	0,41	1,08
Telephones per 1,000 (mainlines + mobiles)	5,79	6,53	6,48	150	657,7	1420
Computers per 1,000	6,02	6	5,82	28,5	85,4	170
Internet users per 10,000	7,27	6,36	7,79	65	983	590
Tariff & nontariff barriers	3,25	4,17	9,3	4	6	87,6
Regulatory Quality	5,54	6,45	7,6	0,34	0,67	0,93
Rule of Law	6,08	6,36	7,12	0,44	0,65	0,68

Source: Own study based on: http://info.worldbank.org/etools/kam2/KAM_page5.asp.

Educational system is represented by three indicators, namely Adult Literacy Rate (% age 15 and above) Gross Secondary Enrollment rate Gross Tertiary Enrollment rate. All three indicators in all years have the relative values around 8, which suggests strong performance of our country within this field. It has to be mentioned that in KEI 2012 "adult literacy rate", (which slightly decreased in the last period of analysis in absolute and relative terms) was replaced by "average years of schooling" (the normative value of this

indicator decreased in the last period of analysis although its actual value slightly increased, which suggests that other countries improved even faster). The indicator of secondary enrolment increased in KEI 2004 but decreased in 2012 in both absolute and relative values. The ratio of tertiary enrollment increased in the whole period and the improvement is also reflected in normalized scores.

Innovation system, which is the second pillar of KBE, is represented by three indicators: Researchers in R&D (which was replaced in KEI 2012 by Royalty Payments & Receipts per population with normalized value for Poland less than 7), Patent applications granted by the USPTO and Scientific & Technical journal articles. Although the value of the first indicator increased significantly in the last year of analysis, its normalized score decreased from 6.3 to less than 5. The indicator which represents scientific and engineering articles published in the following fields: physics, biology, chemistry, mathematics, clinical medicine, biomedical research, engineering and technology, and earth and space sciences per million of population improved slightly both in actual and relative terms. The last indicators used to assess innovation system in KEI show the number of U.S. patent documents (i.e., utility patents, design patents, plant patents, reissue patents, defensive publications, and statutory invention registrations) granted per million of people. The progress both in absolute and relative values can be observed in the last period, which is a positive signal.

Telephones, Computers and Internet Users (per 1,000) are the next three indicators taken into account while assessing the ICT System. The normalized values of these indicators did not change much in the years under research. Although the indicator of telephone mainlines + mobile phones almost doubled, its comparative value slightly decreased. The same can be observed in case of number of personal computers per 1,000 inhabitants. Due to the change of the source of data, Internet users per 10,000 people in actual values can not be compared. In terms of normalized values Poland improved its performance with regard to this issue.

The last pillar, Economic and Institutional Regime, is measured by the following indicators: Tariff & nontariff barriers, Regulatory Quality and Rule of Law. All the normative values of these indicators improved, but the biggest improvement was achieved in the score assigned to each country on the basis of tariff and non-tariff barriers to trade (import bans and quotas as well as strict labeling and licensing requirements) analysis. Probably such an improvement was caused by the accession to the European Union structures. Again, it is not possible to assess the change of absolute values due to the change of the methodology used to calculate Tariff & nontariff barriers indicator. The indicators which measure the incidence of market-unfriendly policies and the

extent to which agents have confidence in and abide by the rules of society increased in actual and comparative values.

6. Conclusion

From the analysis above, the following conclusions can be drawn:
- In terms of the level of development of the knowledge-based economy (measured by KEI) Polish position in the ranking (compared to some 34 countries) decreased by 4 places in 2012 compared to 1995.
- Looking at individual variables which are used to calculate KEI, despite the increase in current value, the decrease in normalised values of some values can be observed, which implies faster development of the other countries in this regard.
- We need to analyze the movements of other indicators showing KBE

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