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KNOWLEDGE INDICATORS FOR POLISH PROVINCES

Abstract

Knowledge-based economy (KBE) has been recently the subject of many analyses and academic research. Methods of its assessment have been worked out by a few international institutions such as the World Bank. Their experts has estimated knowledge index for 128 countries in knowledge assessment methodology (KAM 2005), by normalizing each variables. The author of the article used KAM to calculate knowledge index for Polish provinces, through making modification from macro level to mezo level. All variables are divided into five pillars: variables of economic regime, governance, innovation systems, education, and ICT (information and communication technology). All provinces received own knowledge index, that is the arithmetic average of normalized variables. Mazovia province achieved the highest result (7.07) of knowledge index but Podlasie province the lowest (3.65), according to calculation based on KAM from the World Bank.

Key words: Knowledge-based economy, knowledge index, Polish provinces, region.

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1. Introduction

Since the mid 1990s the concept of knowledge-based economy has been present in works of many international organizations such as the World Bank, World Development Report (1999), UNESCO (2003), OECD (2000) and the European Commission. The latter, in its fundamental document – the Lisbon Strategy established in 2000, set an ambitious goal for the European Union to become one of the most dynamic and competitive knowledge-based economies in the world by 2010. The achievement of the goal is conditioned by the following regulatory-systematic actions, together with appropriate concentration of public sources, Okoń-Horodyńska, Streżyńska, Wiczorek (2003):

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- entering a knowledge-based economy developmental path including support for the informative society, research and innovations;
- liberalization and integration of markets and sectors such as telecommunication, energetics, transport, postal service, financial services and the whole market of services;
- development of industrialization in broad sense;
- increase in employment and improvement of a social model by the means of more flexible workforce market, better education, modernization of social security system, reduction of poverty and social exclusion;
- focusing on permanent fundamentals of development and environment by reducing climate changes and preserving natural resources.

Recent meetings at the European Commission level devoted to the analysis of current progress in implementation of the Lisbon Strategy revealed considerable discrepancies between expectations and results. The realization of the goals included in the Lisbon Strategy is being declared at present with the aim of avoiding developmental stagnation Okoń-Horodyńska, Streżyńska, Wieczorek (2003).

The Lisbon Strategy implementation in each European Union country is taking place accordingly with both directives and Open Coordination Method. The method consists of four stages, Okoń-Horodyńska, Streżyńska, Wieczorek (2003):

- agreement over the common goals,
- realization of these goals through international and regional strategies,
- agreement over the ways of measurement of the goals (indicators, benchmarks),
- monitoring, evaluation, comparison and exchange of the best practices.

The strategic documents in Poland that refer to Lisbon Strategy are the National Development Plan (NDP), National Strategy of Regional Development (NSRD), and the Concept of Physical Planning of the Country. On the basis of the strategic plans, Regional Strategies of Development, Regional Innovation Strategies and other operating programs such as the Territorial coherence and regional competitiveness are established in particular provinces (2005). Each of the plans emphasizes creation, working out knowledge-based economy. What is the essence of knowledge-based economy? How can it be measured? The answers to these questions will be given in the following parts of the article.

2. The concept of knowledge-based economy

In the knowledge-based economy a knowledge factor is underlined as a leading one, the one that determines economic increase besides traditional capital and work exchange. It does not mean, however, that the importance of

knowledge was neglected in the past centuries. Knowledge was the subject of research and disputes of philosophers, economists as well as people of business or politics Nonaka, Takeuchi (2000).

The literature of the subject does not propose one definition that would explain the concept of KBE. A definition by OECD that encapsulates KBE as „economy in which knowledge is disseminated, acquired, distributed and used more efficiently by enterprises, organisations, individuals and societies, contributing to more rapid economic and social development” is frequently quoted, Kukliński (ed.), (2001). Polish scientists define KBE as „economy in which many enterprises function competitively through knowledge”. (A. K. Koźmiński); according to B. Domański „KBE consists of human, cultural and social capital”. This concept is defined in a slightly different way by R. Golar, who considers „KBE as a structure seeking solutions, KBE cannot be constructed, conditions for KBE development should be prepared” (Kukliński (ed.), 2003a).

According to the definitions mentioned above KBE, the author create own definitions: „KBE is the one which taking into account historical and current properties of microeconomic agents as well as risk and uncertainty is able to overcome experienced difficulties in institutional, organizational and technological dimension owing to the usage of tactic and implicit knowledge for ensuring socio-economic growth”.

In next part the author will measure KBE in regional perspective and than classify regions according to knowledge index.

3. The method of KBE assessment

In the field of KBE description and examination of special importance are among others methodical and statistical works by the World Bank that has worked out the method of KBE assessment at macro level by the use of 14 variables in simplified version and 80 variables in broader version. The latter version will be the starting point for further analyses (appendix – table 1), which were afterwards subdued to the following pillars (the World Bank 2005):

- a) variables of economic regime (10),
- b) variables of governance (7),
- c) variables for innovation systems (22),
- d) variables for education (14),
- e) variables of ICT (information and communication technology) (12),
- f) variables of performance (indicators of socio-economic level) of the country (9) and gender (6).

Variables of the KAM 2005 from The World Bank

Variables of performance (indicators of socio-economic level)	Variables of economic regime	Variables of governance	Variables for innovation systems	Variables for education	Variables of ICT	Variables of gender
GDP growth %	Gross Capital Formation	Regulatory Quality	Gross Foreign Direct Investment as % of GDP	Adult literacy rate (% age 15 and above)	Telephones per 1.000 people	Gender Development Index
GDP per capita	General Gov. budget balance as % of GDP	Rule of Law	Royalty and license fees payments	Average years of schooling	Main Telephone lines per 1.000	Females in Labor force (% of total labor force)
Human Development Index	Trade as % of GDP	Government Effectiveness	Royalty and license fees payments/mil. pop.	Secondary Enrollment	Mobile phones per 1.000	Seats in Parliament held by woman (as % of total)
Poverty index	Tariff & nontariff barriers	Voice and accountability	Royalty and license fees receipts	Tertiary Enrollment	Computers per 1.000 people	Females Literacy Rate (% of females ages 15 and above)
Composite ICRG Risk Rating	Intellectual Property is well protected	Political stability	Royalty and license fees receipts /mil. pop.	Life expectancy at birth, years	TV Sets per 1.000	School enrollment, secondary, female (% gross)
Unemployment rate	Soundness of banks	Control of Corruption	Science & engineering enrolment ratio (% of tertiary level students)	Internet access in schools	Radios per 1.000	School enrollment, tertiary, female (% gross)

Employment in industry	Exports of goods and services as % of GDP	Press freedom	Researchers in R&D	Public spending on education as % of GDP	Daily newspapers per 1.000	
Employment in service	Interest rate spread (lending rate minus deposit rate)		Researchers in R&D/ million	Prof. and tech. workers as % of the labor force	Internet hosts per 10.000	
GDP provinces (current)	Local competition		Total expenditure for R&D as % of GDP	8th grade achievement in mathematics	Internet users per 10.000 people	
	Domestic credit to private sector (% of GDP)		Manuf. Trade as % of GDP	8th grade achievement in science	International telecommunication s cost of call	
			University company research collaboration	Quality of science and math education	E-Government	
			Cost to register a business (% of GNI per capita)	Extent of Staff Training	ICT Expenditures as % of GDP	
			Cost to enforce a contract (% of GNI per capita)	Availability of management education		
			Scientific and technical journal articles	Well educated people do not emigrate abroad		
			Scientific and technical journal articles / mil pop			
			Admin. Burden for Start-Ups			

Table 1 (contd.)

Variables of performance (indicators of socio-economic level)	Variables of economic regime	Variables of governance	Variables for innovation systems	Variables for education	Variables of ICT	Variables of gender
			Availability of Ventura capital			
			Patent applications granted by the USPTO			
			Patent applications granted by the USPTO/ mil pop.			
			State of cluster development			
			High-Tech exports as % of manuf. exports			
			Private sector spending on R&D			

Source: <http://info.worldbank.org/etools/kam2005/html/methodology.htm#9>.

The present method of KBE assessment (knowledge assessment methodology KAM 2005) is a modification of the former versions. The aim of this analysis is an attempt to diagnose the condition of KBE in Polish provinces according to the above method. The first stage of diagnosis will be to choose variables for mezzo scale level and the analysis of the acquired data.

The variables presented for macro level, for the purpose of diagnosis of Polish provinces, thus mezzo level, have been modified. The total number of variables was 63, whereas 9 – variables concerned socio-economical level (performance) of provinces, 4 – variables of economic regime, 9 – variables of governance, 15 – variables for innovation systems, 16 – variables for education, and 10 – variables of ICT. It was due to the lack of some statistical data or replacement of former indicators by others that differentiate economy in regional aspect to a higher degree. The variables used after modification are given in table 2 of the appendix. Most of them are quantitative and stimulant, but some are qualitative.

The most considerable changes refer mainly to one of the KBE pillars, namely the variables of governance. The author of this work is not acquainted with the up-to-date results of examination of identical indicators in regional aspect in Poland as those included in the World Bank's method for each country in a macro scale. Thus, the variables from research conducted by a panel of scientists under the leadership of P. Swianiewicz (2003) will be given. The research that took place between November 1999 and January 2000 comprised a number of sources and was concerned with institutional efficiency of local governments determined by the following variables:

- quality of the public administration service,
- fairness in the action (behaviour) of administration,
- ability to take up innovative actions,
- quality of planning and financial management,
- quality of legislated law,
- political stability.

Another relevant variables that has been replaced or undergone counting methodology changes:

a) average GNP increase for 10 years from World Bank's method was replaced by average GNP increase in provinces for years 1999–2002. Only four-years' time statistical data is because of the fact that there are no appropriate time series due to the reform of administrative system of the country;

b) Other indicator that defines socio-economical level of the region is an indicator of human development (Human Development Index – HDI) first proposed in global Social Development Report in 1990. When calculating this indicator the variables from national economic survey conducted in 2002 were used. HDI is worked out on the basis of four variables Cellary, Abramowicz, Nowak (2002):

Variables used in methodology to estimate knowledge index in the Polish provinces

Variables of performance	Variables of economic regime	Variables of governance	Variables for innovation systems	Variables for education	Variables of ICT
GDP growth %	Gross Capital Formation	Quality of the public administration service	Number of investment	Population with secondary education (%)	Main Telephone lines per 1.000
GDP per capita [PLN]	General Gov. budget balance as % of GDP	Quality of legislated law	Fees receipts from B+R equipment in thousand PLN	Population with high education (%)	Domestic phone calls [number]
Human Development Index	Retail Trade as % of GDP	Ascertained crimes	Science & engineering enrolment ratio (% of tertiary level students)	Pupils in age 16–18 [%]	Computers per 1.000 people
Statutory poverty limit [%]	Wholesale Trade as % of GDP	Rate of detectability against property	Researchers in R&D [number]	Pupils and students in age 16–18 [%]	TV Sets per 1.000
Minimum of living standards [%]		Ability to take up innovative actions	Researchers in R&D/ million	Students in age 25–29 [%]	Cable television subscribers
Unemployment rate [%]		Quality of planning and financial management	Total expenditure for R&D as % of GDP	Achievement in the scientific contests by secondary pupils	Radios per 1.000
Employment in industry per 1000 population		Political stability	Manuf. Trade as % of GDP	Life expectancy at birth, years	Daily newspapers per 1.000
Employment in service per 1000 population		Level of Corruption	University company research collaboration in number	Internet access in schools	Company used in daily work internet

GDP provinces (current) [PLN]		Voter turnout to the district council %	Private sector spending on R&D in thousand	Public spending on education as % of GDP	Available of computers in schools
			Industrial company investment outlays on innovation in thousand	Public spending on education per one pupil in PLN	Access to the Internet at home [%]
			Proposed domestic invention	Academic textbooks (number of titles)	
			Patent applications granted by the Patent Office	Academic textbooks (edition in ths.)	
			Computers use to process control [number]	Number of postgraduate students	
			Scientific and technical journal articles (number of titles)	PhD candidates [number]	
			Scientific and technical journal articles (edition in ths.)	Migration of population a) absolute number b) per 1000 people	

Source: personal elaboration.

- average life span,
- general indicator of gross scholarization for all levels of education,
- indicator of ability of reading comprehension and writing,
- GNP (\$ USA) for one person counted at currency purchasing power parity (PPP \$).

The indicator of social development for Polish provinces has been calculated according to the formula worked out by UNDP:

$$H_j = \frac{1}{3} \sum_i^3 H_{ij} \quad (1)$$

$$H_{ij} = \frac{X_{ij} - \min_k \{X_{ik}\}}{\max_k \{X_{ik}\} - \min_k \{X_{ik}\}} \quad (2)$$

where:

j – a country (in the author's research this means a province),

$i = 1, 2, 3$ – number of a variable used to establish HDI,

k – minimum and maximum values of each variable.

For each variable calculation as minimum and maximum values for the above formula it is assumed:

- average life span: 25–85 years, whereas 22.5–82.5 – men and 27.5–87.5 – women;
- general indicator of scholarization regardless of sex: 0–100%;
- ability of reading comprehension and writing regardless of sex: 0–100%;
- GNP by head at currency purchasing power parity (PPP \$) – 100–40.000\$.

4. Comparative analysis on the basis of KBE methodology

For each KBE pillar particular variables have undergone normalization. Average values of these indicators corresponding to KBE pillars were given afterwards. Normalization was conducted according to the method used by the World Bank up to the formula (3):

$$N = 10 * (N_w / N_c) \quad (3)$$

where:

N – X_i variable after normalization;

Table 3

Aggregated indexes of each of the pillars and aggregated knowledge indicator (regional aspect, method of normalization according to the World Bank)

Primary indicators	Lower Silesia province	Kujawy-Pomerania province	Lublin province	Lubuskie province	Łódź province	Małopolska province	Mazovia province	Opole province	Podkarpackie province	Podlasie province	Pomerania province	Silesia province	Świętokrzyskie	Warmia-Mazuria province	Wielkopolska province	West Pomerania province
Variables of economic regime	3.59	4.53	4.22	7.34	5.47	6.72	6.09	5.63	7.03	5.00	3.13	6.72	7.50	3.28	5.94	2.81
Variables of governance	4.79	6.18	3.33	6.67	5.49	5.00	4.51	6.94	5.35	3.19	5.42	7.08	3.47	4.17	6.53	6.39
Variables for innovation systems	7.67	5.46	4.67	2.13	6.54	8.50	9.17	3.04	4.50	1.79	6.63	8.54	2.50	2.75	7.50	3.58
Variables for education	6.48	4.22	5.35	3.05	5.66	8.05	7.93	2.70	4.53	4.18	6.29	4.80	4.88	3.79	7.11	5.20
Variables of ICT	6.88	6.19	2.94	5.25	6.88	4.69	7.63	3.31	2.06	4.06	7.63	6.75	2.50	4.56	7.19	6.38
Knowledge index	5.88	5.32	4.10	4.89	6.01	6.59	7.07	4.32	4.69	3.65	5.82	6.78	4.17	3.71	6.85	4.87
Ranking provinces	6	8	14	9	5	4	1	12	11	16	7	3	13	15	2	10

Source: own author calculation.

Table 4

Aggregated indexes of the pillars and aggregated knowledge indicator (regional aspect, method of normalization based on a standard deviation)

Primary indicators	Lower Silesia province	Kujawy–Pomerania province	Lublin province	Lubuskie province	Łódź province	Małopolska province	Mazovia province	Opole province	Podkarpackie province	Podlasie province	Pomerania province	Silesia province	Świętokrzyskie	Warmia–Mazuria province	Wielkopolska province	West Pomerania province
Variables of economic regime	-0.53	-0.33	-0.36	0.41	-0.17	0.49	0.58	0.57	0.33	-0.22	-0.61	0.49	0.54	-0.65	0.19	-0.72
Variables of governance	-0.01	0.29	-0.64	0.47	-0.05	0.07	-0.27	0.44	0.02	-0.99	0.06	0.72	-0.55	-0.56	0.51	0.48
Variables for innovation systems	0.34	-0.29	-0.46	-0.65	0.05	0.78	2.47	-0.52	-0.39	-0.77	0.02	0.95	-0.67	-0.60	0.28	-0.53
Variables for education	0.24	-0.35	-0.05	-0.57	-0.06	0.58	1.73	-0.79	-0.18	-0.16	0.11	-0.40	0.01	-0.32	0.29	-0.07
Variables of ICT	0.40	0.20	-0.64	-0.10	0.34	-0.20	1.08	-0.47	-1.26	-0.24	0.72	0.51	-0.89	-0.15	0.55	0.14
Knowledge index	0.09	-0.10	-0.43	-0.09	0.02	0.34	1.12	-0.15	-0.30	-0.48	0.06	0.45	-0.31	-0.46	0.36	-0.14
Ranking provinces	5	9	14	8	7	4	1	11	12	16	6	2	13	15	3	10

Source: own author calculation.

N_w – the range of X_i feature for each province, the highest value (16) receives the province with the highest value of X_i feature, whereas 1 – the province with the lowest X_i feature;

N_c – the number of provinces, in this case – 16.

Aggregated indicators for each of the pillars after normalization of variables and establishing average values of indicator are presented in Table 3. After working out member variables corresponding to pillars an aggregated knowledge indicator was given for each province.

The highest aggregated value of knowledge indicator was received by Mazovia (7.07), then by Wielkopolska (6.85). The lowest value was noted in Podlasie (3.65). The lowest knowledge indicators appear in eastern and north-eastern provinces. It is essentially due to variables of innovation system and info-technological infrastructure. Statistical calculations for KAM are not complicated. All variables have the same weight as each pillars. Is that possible that the simplicity of this method is its greatest advantage? The biggest disadvantage of KAM method for which normalization has been presented is the information loss concerning absolute values of variables.

In order to compare the method of variables normalization in the following stage of the knowledge indicator examination KAM, the method of normalization was used by means of functions accessible in Excel sheet, which is based on standard deviation. The positions of leaders and outsiders have not changed, while the position of provinces from 2 to 12 has changed. It should be noticed that the choice of method of normalization affects the position of provinces in the rating.

5. Conclusion

The exact incorporation of World Bank's methodology into Polish conditions is at present impossible. In sheer World Bank's work indicators from 9 institutions cooperating with others organisations were used. In the following work the research conducted by Central Statistical Office, Polish Information and Foreign Investment Agency, Polish Statistical Association, The Gdańsk Institute for Market Economics, and *Perspektywy* Press were used. The analysis would be much more modest without the data from the last two institutions, since in current statistics there is deficiency in numerous new indicators that measure KBE pillars. Although some indicators, e.g. the number of hosts are collected by commercial firms through surveys on chosen samples, the access to these analyses is very expensive.

Nevertheless, it seems that the construction of methodology of KBE assessment in regional aspect is enormously necessary as it might help to

analyse regional changes in knowledge, which is nowadays one of the most competitive resources of an organisation, a region or a country. The problem that concerns the establishment of aggregated knowledge indicator is that of method of normalization of variables of quantity and quality. The adoption of a different normalization method results in the modification of knowledge indicator. In the analysis carried out by the means of two normalization methods the identical positions for four best and two worst provinces were received, whereas for others the positions were different. The vital element is also the choice of variables for the method.

It should be pinpointed, though, that the coherent concept of knowledge assessment for each of the provinces has not been worked out yet even though in some provinces the actions that are supposed to improve identification of KBE in the region has been started K u k l i ń s k i (ed.), (2003b). The goal of this work is thus to bridge the research gap in systematic observation of the directions of vital changes connected with the new economy (era of knowledge) at regional level. The establishment of KBE assessment is supposed to provide better analysis of the phenomena and result in more effective policies of the regional development as well as education policy, institutional infrastructure and innovativeness for the whole of the country.

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Wskaźniki wiedzy dla województw w Polsce

Gospodarka oparta na wiedzy (GOW) jest od kilku lat tematem wielu analiz i badań naukowych. Próby jej pomiaru i diagnozy w ujęciu skali makro dokonało kilka międzynarodowych instytucji, w tym zespół z Banku Światowego. W swej metodologii *knowledge assessment methodology* (KAM) eksperci z Banku Światowego jako wynik analiz dla każdego ze 128 krajów podają wskaźnik wiedzy, który jest obliczony na podstawie znormalizowanych wcześniej zmiennych. Na podstawie zaktualizowanej metody pomiaru wiedzy KAM 2005 autor artykułu przeprowadził analizę gospodarki opartej na wiedzy dla województw Polski. Po zmodyfikowaniu zmiennych dla poziomu skali mezo ujęto je w następujące filary GOW: infrastruktura instytucjonalna, polityka regulacyjna, edukacja, infrastruktura teleinformacyjna i innowacyjność. Dla każdego województwa dokonano obliczenia wskaźnika wiedzy, będącego średnią poszczególnych zmiennych, uprzednio poddanych normalizacji. Bazując na metodzie KAM z Banku Światowego, najwyższa wartość indeksu wiedzy wyniosła w województwie mazowieckim (7.07), a najniższa w podlaskim (3.65).