KNOWLEDGE ECONOMY AND INNOVATION INDICES: THEIR CONCORDANCE AND DIVERSITY

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Abstract

The paper provides an overview of seven systems which characterizes the quantitative aspects of knowledge managed economy (or economy's capacity to innovate). The first part of the paper discusses the concepts of knowledge and new economy. Its second part shortly describes seven summary innovation indices which are provided by European, American and international institutions: the Knowledge Index of World Bank, the New Economy Index and the Global Innovative Based Competitiveness Index – both provided by the American Information Technology and Innovation Foundation, the Global Innovation Index of the Boston Consulting Group, the Global Innovation Index by the INSEAD business school and World Intellectual Property Organization, the Global Innovation Quotient which is published by Bloomberg and the EU-27 Innovation Index produced by the Faculty of Business Administration of University of Economics. The third part of the contribution analyzes the concordance and diversity of the summary innovation indices. The Kendall's coefficient of concordance and Spearman's rank correlation coefficients are used as tools of this analysis.

Key words: new economy, knowledge economy, innovation index, Czech Republic

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Introduction: new and knowledge economy

In the paper, we will deal with the quantitative aspects of new (or rather knowledge) economy. Firstly, we have to define what we understand under the concept of new economy and only then we can express its quantitative aspects. The new economy concept was discussed among Czech economist in the first years of 21st century – see (Křovák, 2002), (Janáček, 2002) or (Baláž & Verček, 2002).

By the definition of OECD, "the term "New Economy" describes aspects or sectors of an economy that are producing or intensely using innovative or new technologies. This relatively new concept applies particularly to industries where people depend more and more

on computers, telecommunications and the Internet to produce, sell and distribute goods and services" ("OECD Glossary of Statistical Terms," 2004).

But from the historical perspective, the first sentence of this definition looks like a too strong statement. In any historical period there have been new economies, i.e. industries connected with new technologies. Steam engines and railroads represent new technologies or new economy in the second half of nineties century, mass production (cars, TVs, highways, and so on) takes place in the 40's and 50's of the 20th century.

The latest "new economy" is a term going hand in hand with a concrete state of development of world economy starting in the 90's of the 20th century. The emphasis is on structural changes in economy and macroeconomic development (especially in the USA, where the effects have appeared first). It is reason why the definition of new economy continues. The new economy is here connected with the application of informational and communicational technologies (ICT) to produce, sell and distribute goods and services.

Nevertheless, it looks as too narrow description for structural changes going during this period on. Structural changes are associated with the development of ICT but they are much broader.

The first feature is **high value added in goods and services require knowledge and education**. Alan Greenspan (former chairman of Fed – Federal Reserve System of the USA) said in 1996 that physical volume (weight) of the US product at the end of 20th century was the same as the one of the end of the 19th century. However, the real US product of the end of the 20th century was hundred times bigger than the one of the end of the 19th century. The reason is obvious – the structure of US product has changed. The ratio of services and intangible assets has increased and the ratio of heavy and bulky goods has decreased.

Informational technologies grant enterprises a tool for quick and efficient changes. Enterprises can change their structure. They can bind up relationships with their suppliers and customers in more efficient manner and their new products can quickly enter the market.

ICT has significantly **reduced impact of geographical distance between different places**. In the past, communities were limited by their geographical position. Nevertheless, ICT allow today's communities to form themselves only upon their common interest and the position on the map is less determinable. To give an example: in the past, most research teams had to be physically gathered in one place. High speed Internet or similar ICT tools of today allow us to distinguish between BIO and IP research workers. BIO workers physically gather in one place as they used to before (let's say in the USA for example). On the contrary, IP workers have no need to travel abroad (to the USA in this case). They can work from their

country (from Czech university for example) and communicate with their teammates via the Internet or using any other ICT. Enterprises financing research save a lot of money using this strategy. They can economise on their employees' families moving abroad, living costs in the USA, the salary outside of the USA is also probably lower etc. Furthermore, the IP workers and their families are in no need to break their social network in their homeland.

And finally the fourth feature of the knowledge economy is the fact that **mediators do not play as important role as they used to and can be even excluded**. To give an illustration: a customer does not have to rely on services of a travel agency. He or she can simply go on the Internet and buy a flight ticket and book a room in a hotel anywhere in the world all by him or herself.

The core of these structural changes is the capacity of an economy to develop and implement products, services and systems according to the state of the art in science, technology and business concepts. In other words: the capacity to innovate.

As the latest new economy is highly related to an economy's capacity to innovate, it seems worthwhile to apply for this period the notably older concept of knowledge-based economy.

The dissemination of the term knowledge based economy is commonly associated with Peter Drucker and his books "Effective Executive" and "The Age of Discontinuity" which were published in the late 60's of the 20th century.

The knowledge economy stresses the importance of knowledge and technological and informational background (i.e. know-how) for development of an economy. It places emphasis on know-how's being more important input than any other economic (scarce) factor of production. However, a good quality educational system is a must if a country wants to use and develop a certain level of knowledge and skills.

Three very closely connected factors can be mentioned within the context of the knowledge economy. These three factors can change the rules of entrepreneurship and a country's competitiveness. The globalisation process is first of the three factors. An economy's capacity to innovate is the second factor. And finally the third factor is intensity of proper usage of information and knowledge in these processes.

1. Quantitative characteristics of the knowledge economy

As the definition of the knowledge economy formulated above inclines, it is rather a diverse phenomenon. Bearing this in mind, research and statistical institutes model systems of indicators. The main purpose of the systems is to find quantitative characteristics for the

knowledge economy. In the next part of the paper we will shortly analyze several systems trying to quantify the state and development knowledge economy as the latest period of "new economy" in the global perspective.

The KAM 2012 (Knowledge Assessment Methodology) is a on-line tool created by the World Bank Institute to help countries identify the challenges and opportunities they face in making the transition to the knowledge-based economy. The access to this tool is on the web address (World Bank Institute, 2012).

The KAM derives a country's overall indices - Knowledge Economy Index (KEI) and Knowledge Index (KI). In this paper we will take account the **Knowledge Index (KI).** KI measures a country's ability to generate, adopt and diffuse knowledge. Methodologically, the KI is the simple average of the normalized performance scores of a country on the key variables in three knowledge economy pillars – (1) education and human resources, (2) the innovation system and (3) information and communication technology (ICT). For the purposes of calculating KI, each pillar is represented by three key variables.

The second system of indicators was created by the American Information Technology and Innovation Foundation (ITIF). **ITIF** publishes the New Economy index for the member U.S. states (ITIF, 2012) and report that assessed the global innovative-based competitiveness of the USA, EU-27 and several other nations (Argentina, Chile, Indonesia, Malaysia, South Africa and Turkey) – see (ITIF, 2011). The report relied on sixteen indicators from these broad categories: (1) human capital; (2) innovation capacity; (3) entrepreneurship; (4) IT infrastructure; (5) economic policy; and (6) economic performance.

The third analyzed system was created by the INSEAD business school and World Intellectual Property Organization (INSEAD & WIPO, 2012). Their **Global Innovation Index** (GII) relies on seven pillars: (1) institutions, (2) human capital and research; (3) infrastructure; (4) market sophistication, (5) business sophistication, (6) knowledge and technology outputs and (7) creative outputs. Each pillar is divided into three subpillars. Each sub-pillar is composed of three to six individual indicators.

Boston Consulting Group and the American National Association of Manufacturer s are authors of the index with the same name: **Global Innovation Index** (Boston Consulting Group, 2009). To rank the countries, the fourth system of knowledge economy quantitative characteristics measures both innovation inputs and outputs. Innovation inputs include government and fiscal policy, education policy and the innovation environment. Outputs include patents, technology transfer, and other R&D results; business performance, such as

labour productivity and total shareholder returns; the impact of innovation on business migration and economic growth. The index was published in March 2009.

The fifth one is the **Global Innovation Quotient** which is published by Bloomberg every year. The Global Innovation Quotient is based on seven factors with different weights: (1) research and development as a percentage of gross domestic product, (2) GDP per employed person, per hour worked, (3) high-tech public companies (such as aerospace and defense, biotechnology, hardware, software, semiconductors, Internet software & services and renewable energy companies) as a percentage of publicly listed companies, (4) R&D researchers per one million people, (5) manufacturing value-added as a percentage of GDP, (6) enrollment ratio in all subjects for post-secondary students of labour force and (7) resident patent filings per million population and per $1 million R&D spent.

Al these indices are based on the global perspective. From the EU perspective, the **Innovation Union Scoreboard 2013** is available. The Scoreboard gives a comparative assessment of the innovation performance of the EU27 member states and the relative strengths and weaknesses of their research and innovation systems. The summary innovation index consists of three parts: (1) enables, (2) firm activities and (3) outputs. The enablers cover 3 innovation dimensions: a) human resources, b) open, excellent and attractive research systems and c) finance and support. Firm activities consist of 3 innovation dimensions: a) firm investments, b) linkages and entrepreneurship, c) intellectual assets. Outputs cover the effects of firms' innovation activities in two dimensions: a) innovators and b) economic effects. In the Innovation Union Scoreboard there are total 25 different indicators.

The study which compares the knowledge based economy in all 27 EU member states were prepared at the Faculty of Business Administration of University of Economics as a specific feedback to the Innovation Union Scoreboard. The first version of the **EU-27 Innovation Index 2008** was published in the (Kislingerová & kol., 2011). The index was based mainly on the 2007 year data, i.e. figures were calculated before the 2009 recession. English version of the EU-27 Innovation Index 2008 was published in the monograph (Breňová, Nečadová & Soukup, 2012).

The EU-27 Innovation Index was inspired by the State New Economy Index of the American Information Technology and Innovation Foundation (ITIF). It is reason why both indices are based on the same five pillars: (1) knowledge jobs, (2) globalization, (3) economic dynamism, (4) digital economy and (5) innovation capacity. The State New Economy Index is based on 26 characteristics. But due to the lack of the statistical data, the EU-27 Innovation Index is based only on 15 characteristics.

This year we are going to publish the second edition of this index. The monograph with the final version of the **EU-27 Innovation Index 2013** will be published in autumn this year. But the preliminary results based on the statistical data of 2011 years are already prepared and disposable.

2. Explanatory Power of the Innovation Indices

With regard to the length of the contribution we will published here only one overall output of all above mentioned systems which examine the quantitative aspects of knowledge economy. Table No. 1 provides information how different institutions evaluate 27 EU member states in their new (or innovation) indices. The table doesn´t contain score of each country, there are only rankings which were created on the base of these scores.

Tab. 1: Rankings in new (knowledge) economy

Country	FBA	ITIF	KI - BSW	GII - B	GII - INSEAD	GIQ	IUS
Austria	10	10	9	8	12	4	9
Belgium	11	6	7	13	11	9	7
Bulgaria	26	NA	27	26	24	24	27
Cyprus	21	21	21	14	16	NA	13
Czech Republic	14	11	14	17	15	13	18
Denmark	5	4	4	4	5	5	3
Estonia	12	12	11	11	10	19	14
Finland	3	1	3	2	2	2	4
France	8	7	10	10	13	6	11
Germany	2	9	5	9	8	1	2
Greece	25	23	18	23	27	23	19
Hungary	15	13	16	16	19	16	21
Ireland	9	8	6	1	6	8	10
Italy	22	19	15	20	21	14	15
Latvia	18	18	25	24	18	25	25
Lithuania	19	20	19	22	22	20	23
Luxembourg	4	NA	13	6	7	10	6
Malta	17	NA	20	21	9	22	22
Netherlands	6	5	2	5	4	7	5
Poland	23	22	24	25	25	18	24
Portugal	24	16	23	15	20	15	17
Romania	27	NA	26	27	26	26	26
Slovakia	20	17	22	19	23	21	20
Slovenia	13	15	17	18	14	12	12
Spain	16	14	12	12	17	17	16
Sweden	1	2	1	3	1	3	1
United Kingdom	7	3	8	7	3	11	8

Note: FBA - EU-27 Innovation Index 2013 (FBA UE, Prague), ITIF - The Atlantic Century 2011 (ITIF), KI – BSW - Knowledge Index - Basis Scoreboard, weighted by population (World Bank), GII – B - Global Innovation Index 2009 (Boston Consulting Group), GII – INSEAD - Global Innovation Index 2012 (INSEAD), GIQ - Global Innovation Quotient 2013 (Bloomberg), IUS - Innovation Union Scoreboard 2013 (European Commission), NA – not available

Source: own computation based on Bloomberg (2013, February 01), Boston Consulting Group (2009), INSEAD, & WIPO (2012), ITIF (2011), UNU-MERIT (2013) and World Bank Institute (2012).

Here we don´t analyze the development of knowledge based economy in concrete EU member states. We will focus on a different question. We will be interested to what extent the explanatory power of different indices produced by different institutions is equal. For this purpose, we will apply the Kendall's coefficient of concordance. If we use the formula published in (Hindls, Hronová & Novák, 1999) the value of the Kendall's coefficient of concordance is $r_K = 0{,}9003$. It means all rankings show significant similarity (if the rankings are the same the value of Kendall's coefficient is 1). It may result in the conclusion the information capability of these indices is virtually the same and it is not necessary to apply them all. On the other hand, it means the explanatory power of the EU-27 Innovation Index is practically the same as ones of its competitors.

We can examine in more detail particular ranking pairs if we apply Spearman's rank correlation coefficient. The table No. 2 summarize the values of concrete ranking pairs.

Tab. 2: Spearman's rank correlation coefficients

	ITIF	KI - BSW	GII - INSEAD	GIQ	GII - B	IUS
FBA	0,9232	0,9097	0,9435	0,8611	0,8634	0,8814
ITIF		0,9017	0,9458	0,825	0,9063	0,8611
KI - BSW			0,9029	0,8521	0,904	0,9334
GII - INSEAD				0,7911	0,9063	0,878
GIQ					0,8125	0,8995
GII - B						0,8566

Note: see table No. 1.
Source: own computation based on the Table No. 1 data

The results show the EU-27 Innovation Index of FBA UE, Prague, the Atlantic Century 2011 of ITIF, the Knowledge Index of the World Bank and the Global Innovation Index of INSEAD are very similar as its explanatory power concerns.

The results of the second group of summary indices (the Global Innovation Index of Boston Consulting Group and the Global Innovation Quotient of Bloomberg) are slightly different against previous four indices.

The Innovation Union Scoreboard 2013 of the European Commission is in the middle of two previous groups.

Conclusion

There are two main findings which are formulated in the paper.

First one concerns the concept of "new economy". In any historical period there have been "new economies", i.e. industries connected with new technologies. The knowledge managed economy is therefore regarded as the latest "new economy" connected with the development of world economy starting in the 90's of the 20th century. Three very closely connected factors can be mentioned within the context of the knowledge economy. These three factors which characterize current "new economy" are the globalisation, an economy's capacity to innovate and the intensity of usage of information and knowledge.

The second statement concerns the concordance and diversity of the summary knowledge economy and innovation indices. The paper analyzes seven systems which make efforts to capture the quantitative aspects of the knowledge economy.

If we apply the Kendall's coefficient of concordance we find its value is relatively high ($rK = 0,9$). It means all rankings show significant similarity. It may result in the conclusion the information capability of these indices is virtually the same and it is not necessary to apply them all.

If we apply Spearman's rank correlation coefficients for the particular ranking pairs we find the explanatory power of the EU-27 Innovation Index of FBA UE, Prague, the Atlantic Century 2011 of ITIF, the Knowledge Index of the World Bank and the Global Innovation Index of INSEAD is very similar. The results of the second group of summary indices (the Global Innovation Index of Boston Consulting Group and the Global Innovation Quotient of Bloomberg) are slightly different against previous four indices. The Innovation Union Scoreboard 2013 of the European Commission is in the middle of these two groups.

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