INNOVATION MEASUREMENT REVISITED: COMPARISON OF THREE MAIN MEASURES

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ABSTRACT
Innovation is interpreted as a tool enabling economic development, growth and international competition. It is vitally important in both macro and micro level, thus measuring of innovation also emerge as a crucial issue. The purpose of this study is to compare Global Innovation Index (GII), European Innovation Scoreboard (EIS) and Innovation Subindex of Global Competitiveness Index (GCI-Inn) to have insight of innovation understanding of different perspectives. The reports and previous studies are examined for this purpose in respect to structural formations, common grounds and outcome differences. It is found that innovation conceptualization and innovation measurement is not standardized. For a more thriving measurement, it is suggested to combine the advantages of three measures such as number of countries in GCI and GII, detailed perspective of GII and SME emphasis of EIS.
Keywords: *Innovation measures,Global Innovation Index, European Innovation Scoreboard, Global Competitiveness Index*

1. INTRODUCTION

Innovation has been centre of attention as a magical word to restore national economies and corporations after 1990s. Many international organizations and scholars dealt with the subject from different angles to create a clear theory of innovation and to conceive adequate measures. There are several indices, and scoreboards, published by institutions with some differences in measuring and with different rankings as a result. In this paper we would like to focus on the differences on measuring innovation to give an insight into the issue.

Our understanding on economics today, and particularly on economic growth, is rather different than neo-classics since it is well accepted that cognition plays an essential role along with material sources (Ickes, 1996; Sohn, Kim, & Yeon, 2016, p. 494). In micro level, concepts such as social capital, intellectual capital or cultural capital is widely referred in business studies in context with new ways of doing things. Besides, it is widely recognized that being able to produce information, in comparison with purchasing, is the criterion for development in macro level. Innovation, in this sense, evolved as a phenomenon evoking an economic unit's capacity to produce new ways in given circumstances. There are several definitions offered in the literature as discussed in the next sections.

2. CONCEPTUAL FRAMEWORK

Starting from Schumpeterian view of innovation as "new combinations", Lundvall (2005) stresses the difference between innovation and invention, thus offer a two-pillar definition as a process encompassing the discontinuity in "the technical characteristics or in the use of a new product or process" and "the introduction, diffusion and adaptation of the new artefact". This understanding is consistent with the definition of OECD as "innovation is the

implementation of a new significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations" (Crespo, & Crespo, 2016, p. 5265). Therefore it is asserted that innovation is a process, not a trait, and also a complex, non-linear, multi-dimensional phenomenon (Stone, Rose, Lal, & Shipp, 2008; Kazazoglu, 2013)

The second focal point we would like to offer is that innovation is as a catalyzer or actualiser for economic units to advance in their domains, as defined by European Commission's "Green Paper on Innovation Report" in 1995: "the renewal and enlargement of the range of products and services and the associated markets; the establishment of new methods of production, supply and distribution; the introduction of changes in management, work organisation, and the working conditions and skills of the workforce". Moreover, many scholars interpreted innovation as a result of this aspect and a the tool enabling economic development, growth and international competition of national economies (Freeman, 1987; Romer, 1994; Freeman, & Soete, 1997; Acemoglu, 2003; Edquist, 2005; Godin, 2005; Lundvall, 2007; Adam, 2014, p. 10).

Karaata (2012, p. 4) summarized conceptualization of innovation in time in four stages. From 1950 to 1970 input indictors were R&D, information technologies (IT), capital and technology and from 1970 to 1990 output indicators were used as patents, publications, products and quality management. After 1990's surveys, structured indices and innovation capacity comparisons became a current issue. And finally after the beginning of the century, process indicators such as information, intangible assets, networks, demand, management qualities, risks and system dynamics came out as subject of innovation. This leads to think innovation in two dimensions related to the two focal points referred; national policy and firm efficiency.

Turanli and Saridogan (2010) merges the two focal points mentioned above to an identification of innovation as a process which serves a function for economic units to improve benefits, effectiveness, efficiency or profitability. When speaking of such notions the first things to come to mind is conceivably research and development (R&D) practices, creativity and social capital. Education, commercial law, policies, culture and several other national factors are significantly effective in this respect. It is consequently both a macro and micro level phenomenon, thus, national economies are mainly selected as units of investigation in innovation literature.

From Schumpeterian perspective innovation has vital importance for economies as well as enterprises since productivity, profitability and competitiveness is related to innovative performances of economic units. Scholars recognize innovations role imputed as shifting "economic growth and success in global economy", therefore measuring innovation gains importance from an economical point of view (Sohn et al., 2016). For businesses, on the other hand, to be able to compete with rivals, obtaining technologies, new products and finding new markets are related to innovative performances, such as R&D, experience-based developments and technology and knowledge (Lundvall, 2005; Kiliç, 2016, pp. 30-31). Therefore, innovation measures not only demonstrate growth potential of the countries but also firms', since firms are inherently surrounded by the reciprocating innovative performances of economical environment (Adam, 2014, p. 17).

Many international institutions such as OECD, European Union, World Bank, IMF embraces innovation concept in consequence (Sharif, 2006). Nevertheless, measuring innovation is not a plain effort. There are several approaches, data sources and indicators used to objectify innovation (Crespo, & Crespo, 2016). Furthermore, as Mahroum and Al-Saleh (2013) noted, different countries with different instruments may have similar innovation performances, and vice versa, due to attributes or complex circumstances. It is then inherent to encounter differences in innovation measures depending on conceptual nuances. In the next section we would like to have a look at different innovation measures to provide an insight into theoretical base of the phenomenon.

3. MEASURING INNOVATION

As in the challenge on definition of innovation, measurement comprises many other questions in itself. Since the concept arises from an understanding that an economic unit may have many and sometimes nonapparent properties, qualities, possessions, experiences and so on, and since these are seen as crucial in a strategic thinking, an innovation measure should aim to digitize all these assets. Obviously it is not easy work to do, hence scholars have been dealing with the measurement question for many years, and are still working on it.

The first stage of measurement of innovation is about the level of analysis the measurement would take place. Stone et al. (2008) emphasized two approaches in measuring innovation as aggregate indices and monetizing innovation. While monetizing innovation infers the difference of value of an economic unit from the book value, using indices in innovation literature is more common. Using indices also define the level on a national dimension. Lundvall (2005, p. 8) admitted the theoretical problem of a national innovation concept, yet he argues that the original intention of innovation systems are "to confront national economic policy strategies and standard economics". Therefore, innovation measurement mostly focuses on national level, under the denotation of "national innovation systems" (NIS).

As an innovation influencing contributions set of different actors (Metcalfe, 1995, p. 463), NIS involves organizations and institutions, organizational associations, level and efficiency of intangibles and public policies (Crespo, & Crespo, 2016, p. 5266). This indicates a grounded theory approach (Lundvall, 2005), tendency for scholars to focus on internationally comparable indicators (Smith, 2006) and national economy comparisons through "assessing the innovation performance of countries relative to other countries" (Adam, 2014, p. 10). In this respect, many indices and scoreboards have been created, and are being updated constantly like European Innovation Scoreboard. Among them there are tools focusing on the outputs of innovation such as The Economist Intelligence Unit Innovation Report, Science and Technology Indicators of OECD and nationally designed country specific tools (Adam, 2014, pp. 9-13). Yet, we would like to focus on the more conceptually broad, unique and concurrent tools, Global Innovation Index (GII), European Innovation Scoreboard (EIS) and Global Competitiveness Index's innovation sub-index for comparison.

4. COMPARISON OF GII, EIS AND GCI-INN

We would like to compare the three measures in respect to their structural formations, common grounds and outcomes of the measures.

4.1. Measure Structures

Global Innovation Index (GII): With comprising innovation indicators from broad number of countries GII is probably the most academically preferred index in innovation research. It

emerged as an exertion of Cornell University, the business school European Institute of Business Administration (INSEAD), and the World Intellectual Property Organization to "to find metrics and approaches that better capture the richness of innovation, continuously adapting the GII framework to reflect the improved availability of statistics and the theoretical advances in the field" (GII, 2016, p. 71). The index deals with the issue from a broad perspective, consisting of five pillars for input and two pillars for output indicators of innovation (Sohn et. al, 2016). These factors are infrastructure as communication, general infrastructure and ecological sustainability; institution as political, business and regulatory environment; market sophistication; human capital and research as education, tertiary education and R&D; and business sophistication as knowledge workers, innovation links and knowledge absorption for input level. And output factors of innovation are knowledge and technology output and creativeness. We may argue that GII highly relates innovation with cognitive dimension and national policy level.

Table 1: Innovation indicators of GII, EIS and GCI-Inn

GII	**EIS**	**GCI-Inn**

Input:
• Infrastructure
  ○ ICTs
  ○ General infrastructure
  ○ Ecological sustainability
• Institutions
  ○ Political Environment
  ○ Regulatory Environment
  ○ Business management
• Market sophistication
  ○ Credit
  ○ Investment
  ○ Trade, competition & market sophistication
• Human capital and research
  ○ Education
  ○ Tertiary education
  ○ Research & Development
• Business sophistication
  ○ Knowledge workers
  ○ Innovation linkages
  ○ Knowledge absorbtion
 	
Output:
• Knowledge and technology output
  ○ Knowledge creation
  ○ Knowledge impact
  ○ Knowledge diffusion
• Creativeness
  ○ Intangible assets
  ○ Creative goods or services
  ○ Online creativity
	Enablers:
	• Human resources
	• Open, excellent and attractive research
	• Systems
	• Finance and support
	
	Firm activities:
	• Firm investments
	• Linkages & entrepreneurship
	• Intellectual assets
	
	Outputs:
	• Innovators
	• Economic effects
		• Capacity for innovation
		• Quality of scientific research institutions
		• Company spending on R&D
		• University-industry collaboration in R&D
		• Government procurement of advanced technology products
		• Availability of scientists and engineers
		• PCT patent applications

European Innovation Scoreboard (EIS): Lisbon Strategy in 2000 shaped European technology policies and set goals for R&D to be supported by the Union as well as own

resources (Hollanders, & van Cruysen, 2008). The scoreboard prepared, by Maastricht Economic and Social Research and Training Centre on Innovation and Technology (MERIT), in collaboration with Joint Research Centre (JRC) of the European Commission was renamed and updated to Innovation Union Scoreboard (Adam, 2014, p. 15), yet the name EIS turns back in 2016 once again. The European perspective also results in the broadness of the reports since the EIS reports mainly include European countries. The three pillar design of enablers, firm activities and outputs is preserved. The sub-factors of the scoreboard are presented as human resources, open-excellent reserach systems and finance and support for the enablers; firm investments, linkages & entrepreneurship and intellectual assets for firm activities; and finally innovators and economic effects for outputs (EIS, 2016a, p. 8). At first glance, emphasis on cognitive level is easily recognized yet sub-factors are bounded by the chain-link approach grounded indicators offered rather than conceptual scrutinizing. Also, we would like to note that main difference of EIS is that SME activities are in the core of innovation measurement, while many indicators are directly about SME innovation performance in the second pillar of the scoreboard (EIS, 2016b, p. 5).

Global Competitiveness Index (GCI)-innovation sub-index (GCI-Inn): The competitiveness report presented by the World Economic Forum annually scores countries listed in twelve different aspects. The 12th indicator the report is categorized as "innovation subindex" (GCI, 2016, p. 5). It is strongly advocated in the literature that NIS is directly relevant with competitiveness via improving productivity and bolstering national economies in general (Nelson, & Rosenberg, 1993). The GCI report thusly renders the understanding that wealth of nations, in respect to competitiveness, is bound to innovative characteristics of economical environment, yet it has a different viewpoint by comparison to GII and EIS. GCI, in general is about competitive performances of national economies, therefore the measure embraces innovation in a restricted layer respect to competitiveness. Another important feature of GCI-Inn is that the data is combined from a survey, The Executive Opinion Survey, mostly. The six indicators of GCI-Inn comes from this survey, and only one from hard data. For this reason objectivity of GCI-Inn may be questionable in comparison with GII and EIS, while they are mainly comprised of hard data.

The sub-dimensions and indicators of innovation are listed in Table 1 for further comparison. The table reveals that the conceptual aim of GII and EIS are also not equivalent, since it is easily recognized that some output factors in GII exists as an enabler or firm activity in EIS, or while GCI-Inn focuses on basic innovation causatives, EIS embraces it more structured. Thus, it can be said that while GII directly deals with innovation as a complex process, EIS and GCI-Inn are more basic in real terms.

4.2. Common Grounds

Some indicators of innovation are referred in the literature as major indicators in measuring innovation. R&D expenditures/institutions, patents (applications - revenues) and bibliometric data (scientific publications/activities) are the three key indicator classes of innovation in this respect (Smith, 2006, p. 152). When we examined the indicators of the data classes indicated in Table 1, we have determined three other classes in common. These other common classes are education, exports of medium&high tech product and university-industry collaboration. Ultimately, we would like to assert the common grounds of these three innovation measures as demonstrated in Table 2.

Table 2. Common Grounds of GII, EIS and GCI-Inn

- R&D expenditures / institutions
- Education / educated people existence – capacity – potential
- Universities and industry collaboration
- Patents (applications – revenues)
- Scientific (publications – activities)
- Export of medium&high tech products

4.3. Outcomes

It is natural that methodological differences create differences in innovation scores and country rankings in result. Consisting of countries with best and worst innovation scores in EIS 2016 and rest of the best scored countries in GII 2016, table 3 is brought together to reveal these differences in measuring innovation in the last two years.

Table 3. Outcomes of the Three Indices in 2014/2015 and 2015/2016 Period

	2014 / 2015						**2015 / 2016**					
	GII	**Rank**	**EIS**	**Rank**	**GCI-Inn**	**Rank**	**GII**	**Rank**	**EIS**	**Rank**	**GCI-Inn**	**Rank**
Denmark	57,7	10/141	0,675	3/36	5,055	11/140	58,45	8/128	0,700	3/36	5,114	10/144
Finland	59,97	6/141	0,658	4/36	5,782	1/140	59,9	5/128	0,649	4/36	5,726	2/144
Germany	57,05	12/141	0,655	5/36	5,465	6/140	57,94	10/128	0,632	5/36	5,508	6/144
Ireland	59,13	8/141	0,607	10/36	4,679	20/140	59,03	7/128	0,609	7/36	4,812	21/144
Israel	53,54	22/141	0,620	8/36	5,562	3/140	52,128	21/128	0,581	12/36	5,647	3/144
Japan	53,97	19/141			5,536	4/140	54,52	16/128			5,538	5/144
Netherland	61,58	4/141	0,639	6/36	5,251	8/140	58,29	9/128	0,631	6/36	5,365	8/144
Romania	38,2	54/141	0,223	33/36	3,283	66/140	37,9	48/128	0,180	35/36	3,239	75/144
Singapore	59,36	7/141			5,183	9/140	59,16	6/128			5,242	9/144
South Korea	56,26	14/141			4,827	17/140	57,15	11/128			4,829	19/144
Sweden	62,4	3/141	0,719	2/36	5,371	7/140	63,57	2/128	0,704	2/36	5,457	7/144
Switzerland	68,3	1/141	0,793	1/36	5,696	2/140	66,28	1/128	0,791	1/36	5,764	1/144
Turkey	37,81	58/141	0,205	35/36	3,415	56/140	39,03	42/128	0,267	32/36	3,353	60/144
Ukraine	36,45	64/141	0,182	36/36	3,155	81/140	35,72	56/128	0,178	36/36	3,413	54/144
United Kingdom	62,42	2/141	0,580	12/36	4,959	12/140	61,93	3/128	0,602	9/36	5,018	12/144
USA	60,1	5/141			5,493	5/140	61,4	4/128			5,581	4/144

As revealed in table 3, in country rankings there are significant differences. United Kingdom in 2015-2016 rankings is listed third in GII, and 12th in GCI-Inn. Israel, on the other hand, is ranked 21th in GII, and 3rd in GCI-Inn. But when the measurement of USA a relative

consistency can be alleged. Also, it is easily noticed that Switzerland is the most innovative country in all three indices. Therefore the methodological gaps between the three tools, clearly indicate differences in the understanding of innovation.

5. CONCLUSIONS

The three important and unique innovations measures GII, EIS and GCI-Inn are discussed in this study in comparison to identify a general understanding of the differences in between. Methodological frameworks presented in their reports and theoretical explanations in the literature are investigated for this purpose, thus structural formations, common grounds and outcome differences are ascertained.

The first implication of the findings is that conceptual explanations and thereby measurement of innovation is not plenary, differing in many aspects. Therefore innovation reports of different institutions have significant differences. Thus we may conclude that innovation and innovation measurement is not standardized.

It is found that the most significant virtue of EIS is the importance given in SMEs relative to GII and GCI-Inn. The understanding behind SME emphasis is the fact that innovation is strictly related to cognitive assets of firms which is on a large scale the core of innovation. This also represents itself in the difference of outcomes of the three measures. Thus public investments on innovation increase innovation scores of in GII, while private sector investments increase in EIS measurement. This may be one of the reasons why the results, as indicated in Table 3, differ between these measures.

The comparison of the three main measures indicate a difference in scope of countries. While GII and GCI-Inn have a broader list of countries, EIS mainly deal with European countries. We would like to offer institutions and scholars to emphasis on the differences of the measures to come up with a more standardized and valid measure of innovation. It is underlined in this study that both GII and EIS have significant advantages. We would like to suggest a compilation of these advantages, as in the number of countries in GCI and GII, detailed perspective of GII and SME emphasis of EIS to create a better way to measuring innovation.

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