SSIC Secretariat Working Paper 3/2015

Measuring Innovation

A Discussion of Innovation Indicators at the National Level

Prof. Dirk Meissner
Research Laboratory for Science and Technology Studies
Institute for Statistical Studies and Economics of Knowledge
National Research University – Higher School of Economics
Moscow
Russia

Analysis conducted on behalf of the SSIC Secretariat

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Swiss Science and Innovation Council

The Swiss Science and Innovation Council

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The present analysis, contracted on behalf of the Secretariat of the Swiss Science and Innovation Council, discusses measures of innovation based on three well-known rankings: the Global Innovation Index, the Innovation Union Scorecard, and the Knowledge Economy Index. It examines some basic characteristics of these indexes, including the only partial reflection of the latest developments or of country-specific aspects, the great difficulty of obtaining comparable data, and the lack of information about causal connections between input and output data. Bibliometric data, the number of tertiary degrees by age group, and patent statistics, whose respective limitations are discussed, are among the indicators widely used to create the various indexes.

The analysis comes to the conclusion that the relevant dimensions of a higher education, research, and innovation system are not fully covered by these systems of indicators. The author finds the reason for this lies not only in lacking data but also because not all areas in higher education, research, and innovation are measurable. Trying to express the innovative performance of a country by aggregating indicators is problematic since there is little empirical evidence about the reciprocal effects of indicators on one another. A further weakness lies in the insufficient reflection of qualitative aspects in innovation indicators. As a consequence, one runs the danger that policy measures will be adopted based on quantitative data without, or with inadequate consideration, given to qualitative dimensions even though these are of particular importance in higher education, research and innovation. Despite these limitations – and even if indicators at best can only identify strengths and weaknesses rather than explain them – the analysis also points to the usefulness of indicators in providing a general impression of the innovation system of a given country.

F

L'analyse réalisée sur mandat du secrétariat du Conseil suisse de la science et de l'innovation porte sur les indicateurs permettant de mesurer l'innovation. Les sources de l'étude sont trois classements renommés, à savoir: l'Indice mondial de l'innovation, le Tableau de bord de l'innovation (Innovation Union Scoreboard) et l'Indice de l'économie du savoir (Knowledge Economy Index). Ce rapport fait état des caractéristiques de base des indices comme la représentation incomplète des évolutions récentes et des spécificités nationales, la difficulté majeure d'obtenir des données qui soient comparables et le manque de connaissances sur les liens de causalité entre les données d'inputs et d'outputs. Le rapport discute plus spécifiquement les limites de trois indicateurs couramment utilisés pour créer les différents indices, à savoir les données bibliométriques, le taux de diplômés de niveau tertiaire par groupe d'âge et les statistiques sur les brevets.

L'auteur conclut que les systèmes d'indicateurs ne couvrent pas toutes les dimensions pertinentes du système de la formation, de la recherche et de l'innovation. Il identifie comme causes possibles l'absence de certaines données ainsi que la difficulté à mesurer certains aspects relevant des domaines de la formation, de la recherche et de l'innovation. Par ailleurs, décrire les performances d'innovation d'un pays par le biais de l'agrégation de plusieurs indicateurs est problématique, car il y a encore trop peu d'évidence empirique quant aux effets réciproques de ceux-ci. De même, les aspects qualitatifs sont insuffisamment pris en compte par les indicateurs d'innovation. Le risque existe que des mesures politiques soient développées sur la base d'indicateurs quantitatifs sans, ou avec peu, de considération pour la dimension qualitative qui est particulièrement importante pour la formation, la recherche et l'innovation. Malgré ces réserves – et même si, dans le meilleur des cas, les indicateurs ne peuvent qu'identifier des forces et des faiblesses, sans pour autant les expliquer – l'analyse souligne que les indicateurs peuvent avoir une certaine utilité en livrant une impression générale du système d'innovation d'un pays.

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Die Analyse im Auftrag der Geschäftsstelle des Schweizerischen Wissenschafts- und Innovationsrats diskutiert die Innovationsindikatorik auf der Basis dreier renommierter Rankings, dem «Global Innovation Index», dem Leistungsanzeiger der Innovationsunion («Innovation Union Scoreboard») und dem «Knowledge Economy Index». Dabei verweist der Bericht auf grundlegende Eigenschaften der Indizes. Dazu gehören die nur teilweise Abbildung von jüngsten Entwicklungen und landesspezifischen Besonderheiten, die grosse Herausforderung, vergleichbare Daten zu erhalten, sowie das fehlende Wissen über kausale Zusammenhänge zwischen Input- und Output-Daten. Weiter werden die Grenzen der bibliometrischen Daten, der Anzahl Tertiärabschlüsse pro Altersgruppe und Patentstatistiken diskutiert, die alle zu den verbreitet genutzten Indikatoren gehören.

Der Bericht kommt zum Schluss, dass die Indikatorensysteme nicht alle relevanten Dimensionen eines Bildungs-, Forschungs- und Innovationssystems abdecken. Als Ursachen ortet der Autor sowohl fehlende Daten als auch die Schwierigkeit, dass nicht alle Bereiche von Bildung, Forschung und Innovation messbar sind. Die Innovationsleistung eines Landes mittels Aggregation von Indikatoren auszudrücken, wird als problematisch eingeschätzt, da es noch zu wenig empirische Evidenz über die wechselseitigen Wirkungen der Indikatoren gibt. Zudem sind qualitative Aspekte bei den Innovationsindikatoren zu schwach vertreten. Somit besteht die Gefahr, dass politische Massnahmen aufgrund quantitativer Daten entwickelt werden, ohne oder nur mit ungenügender Berücksichtigung der qualitativen Dimension, welche für Bildung, Forschung und Innovation besonders wichtig ist. Trotz dieser Einschränkungen – und auch wenn Indikatoren Stärken und Schwächen höchstens identifizieren, nicht aber zu erklären vermögen – weist die Analyse auch darauf hin, dass Indikatoren einen Nutzen haben können, indem sie einen allgemeinen Eindruck über das Innovationssystem eines Landes bieten.

1 The purpose of innovation indicators

The importance of innovation for economic development and growth, as well as for increasing the welfare of society, is broadly recognized. Numerous management concepts and policy approaches have been developed and implemented which aim to build and maintain a country's or a national economy's capacity for, and competence at, innovation. To make such initiatives and measures to support innovation more transparent, and to establish a common understanding, academics began developing indicators to better understand what drives innovation and what impact innovations have and also eventually generate. Traditionally, indicators for measuring national innovation performance have used expenditures on research and development (R&D) based on the assumption that it is only R&D which drives innovation. More recent indicators also take the value innovation adds to the economy, and to some extent to the society, into account.

The development of indicators was originally driven by politics and the need policy-makers had to justify public investments in science, technology and innovation (STI), particularly in R&D. The assumption was also that national innovation indicators would permit cross-national comparisons to be made, comparisons often used by politicians when justifying or developing policy measures aimed at stimulating innovation behavior. Furthermore, politicians often use rankings based on national innovation indicators for special purposes, such as when appreciating the nation's ability to innovate, or to raise awareness within a country for innovation-related subjects.

Academics have also begun to create innovation-related indicators and used them to develop models designed to understand the emergence and diffusion of innovation and the role different actors or stakeholders play in it. The academics' engagement in this effort was initiated and driven by political priorities, and this political interest has been sustained since such indicators first began being used. In the academic understanding, innovation is the main driver for creating sustainable value in economy and society. Academics have continued to use such indicators to find explanations for the diverging economic performance and development of countries, and want to identify and measure the impact of STI policy measures on the national innovation system. Moreover, academics use indicators for developing innovation models at company (micro) and national (macro) levels not only to gain a better understanding of the origin and diffusion of innovation but also to monitor emerging innovation-related trends which might potentially have value for the countries.

Ultimately, national innovation indicators have a strong psychological effect. People perceive them as expressing the ability of countries to innovate. In that sense, innovation indicators influence the reputation of a country in the STI domain, which is often a decisive factor in STI investment-related decisions made by companies, those in the tertiary educational sector, and by those employed in the STI sector itself.

2 The main STI indicators

Over the last decade, the concept of a National Innovation System (NIS) has become broadly accepted by scholars and politicians, as it provides a helpful approach for conducting a structured analysis of countries with respect to innovation activities. However, the NIS approach doesn't fully take into account the diversity of definitions and understandings of the meaning of innovation and innovation's broader implications. Because experience shows that a stakeholder's interests affect how a NIS analysis is interpreted, caution is needed when analyzing statements or findings based on these indicators.

During the last decade, three main indicators have evolved and become recognized and accepted by the academic and political communities: the Global Innovation Index (INSEAD, WIPO, Cornell University), the Innovation Union Scoreboard (European Commission), and the Knowledge Economy Index (World Bank). Taken together, these three indicators provide a useful guide for assessing a country's performance.

2.1 The Global Innovation Index (INSEAD, WIPO, Cornell University)

The Global Innovation Index (GII) and the Innovation Efficiency Ratio are composites based on two sub-indexes: "innovation input" and "innovation output". The GII is the average of innovation input and innovation output, while the Innovation Efficiency Ratio is the ratio of the innovation output index to the innovation input index. The innovation input is composed of five input "pillars" describing institutions, human capital and research, infrastructure, market sophistication and business sophistication. The innovation output index is composed of two output "pillars" that capture evidence of knowledge and technology outputs and creative outputs. Each element in a pillar is composed of three indicators (see Appendix). The data is drawn from indexes and indicators compiled by international organizations (IEA, ILO, IMF, ISO, ITU, OECD, UN, UNIDO, UNESCO, World Bank, World Economic Forum) as well as by more specialized or commercial sources (Graduate Management Admissions Council, IHS Global Insight, Microfinance Information Exchange, Press Freedom Index, QS Quacquarelli Symonds Ltd, Reporters without Borders, SCImago, Standard and Poor's, Thomson Reuters, Wikimedia Foundation, ZookNIC Inc.).

In terms of innovation, Switzerland has been among the top-ranked countries for many years, and the GII for 2014 puts Switzerland at the very top (see Table 1). However, the values given for "percentage rank" indicate that the leading countries are rather closely bunched. Hence, the advantage Switzerland has over other countries is less striking than one might assume from only knowing it is ranked first.

However, one can challenge the top rank of Switzerland in the GII, as it was given only around two-thirds of the maximum points achievable. The counterargument is that other countries were awarded even less. Still, this is no reason for not achieving more points, and STI policy measures presumably are designed to help countries achieve even higher scores in future assessments.

The Innovation Efficiency Ratio looks more promising for Switzerland, though it was only ranked sixth on this measure. The top 20 countries have percentage ranks that are very close together, which is an argument for not worrying too much about the actual rank. In addition, the high value of the efficiency coefficient gives reason for satisfaction about Swiss performance.

Rank	Country	Score	Percentage Rank
Global Innovation Index			
1	Switzerland	64.8	1.00
3	Sweden	62.3	0.99
4	Finland	60.7	0.98
8	Denmark	57.5	0.95
13	Germany	56.0	0.92
20	Austria	53.4	0.87
Innovation Efficiency Ratio			
6	Switzerland	0.9	0.95
19	Germany	0.9	0.86
22	Sweden	0.8	0.85
41	Finland	0.8	0.80
61	Denmark	0.8	0.76
69	Austria	0.7	0.74

Table 1:
Global Innovation Index and Innovation Efficiency Ratio

Source: Dutta et al. (2014): Global Innovation Index 2014

2.2 The Innovation Union Scoreboard (European Commission)

The Innovation Union Scoreboard (IUS) is a composite indicator which uses data from sources including Eurostat, OHIM, OECD, Scopus, Thomson Reuters, and the UN. The indicator uses three innovation dimensions: Enablers, Firm Activities and Outputs. These dimensions are sub-divided and detailed (see Appendix). The IUS is calculated from the most recently available data, and 25 indicators, weighted equally, are included in the composite indicator.

At first sight, the composite IUS attests to Switzerland having designed and implemented a well-functioning national innovation system. This is especially clear when comparing Switzerland with the EU's average performance (see Table 2), as the two rates are almost the same.

The spread in overall innovation performance between EU member states is large, skewing the EU average. If one examines only the best-performing EU members, one obtains an indication of how strong Swiss performance is. Although these countries improved their innovation performance, they clearly grew less than Switzerland with the exemption of Austria (see Table 2). Average EU improvement is obviously more driven by countries which aren't among the strongest innovation performers in the EU. This is also reflected in the EU's political agenda to invest in member countries so as to enable them to catch up in innovation performance, and thus make the EU as a whole more powerful in terms of innovation.

The detailed indicators show that Switzerland possesses a uniquely powerful research system in every category (see Table 3) and that – as much as in the overall ranking over time (see Table 2) – the values for this country exceed those of the EU. In this regard, one might argue that R&D expenditure in the public sector has to be increased or that venture capital investment also needs to expand. However, this is misleading because the indicators express relative values, with both public R&D expenditure and venture capital investment expressed as a percentage of GDP (the high Swiss GDP). The picture looks different if one expresses public expenditures and venture capital investments in nominal figures.

Increasing overall spending with the intent of improving Swiss performance might eventually lead to building additional infrastructure. Yet this isn't required in terms of an efficient system, and it also creates a desire within the research community, since once an infrastructure exists, it needs to be maintained over long periods. In the case of venture capital investments, public policy cannot really influence it other than by designing framework-related stimuli for private venture funds (which might include accounting rules). Some countries have started public venture funds, and they enjoy public guarantees, meaning they are not driven by the market performance of the investments. Such funds thus can take higher risks in the projects they invest in. The research investments made by Swiss companies are at levels significantly above comparable investments in EU member states. On the other hand, it is also true that Switzerland is home to a number of large international companies whose investments are included in the consolidated balance sheets of domestic companies but the bulk of whose activities are in fact undertaken elsewhere. It is therefore strongly recommended to separately consider domestic and international R&D expenditure statistics provided by national statistical offices.

	2006	2007	2008	2009	2010	2011	2012	2013	Growth rate
EU	0.493	0.506	0.504	0.516	0.531	0.532	0.545	0.554	12.37 %
AT	0.516	0.527	0.583	0.597	0.571	0.583	0.599	0.599	16.09 %
DK	0.684	0.693	0.657	0.673	0.705	0.697	0.722	0.728	6.43 %
DE	0.646	0.656	0.671	0.687	0.701	0.694	0.708	0.709	9.75 %
FI	0.630	0.631	0.660	0.670	0.676	0.685	0.685	0.684	8.57 %
SE	0.732	0.729	0.732	0.737	0.739	0.746	0.752	0.750	2.46 %
CH	0.752	0.772	0.792	0.805	0.823	0.822	0.842	0.835	11.04 %

Table 2:
Innovation Union Scoreboard – overall ranking
The growth rate was calculated for the period 2006–2013

Source: European Union (2014): Innovation Union Scoreboard 2014

	Human resources	Research systems	Finance and support	Firm investments	Linkages and entrepreneurship	Intellectual assets	Innovators	Economic effects
EU	0.583	0.539	0.558	0.417	0.550	0.564	0.549	0.595
AT	0.614	0.542	0.482	0.493	0.774	0.810	0.559	0.464
DK	0.635	0.822	0.717	0.543	0.836	0.840	0.702	0.669
DE	0.633	0.491	0.613	0.650	0.742	0.805	0.914	0.728
FI	0.829	0.561	0.767	0.621	0.701	0.702	0.651	0.657
SE	0.869	0.803	0.741	0.655	0.813	0.787	0.788	0.600
CH	0.837	1.000	0.591	0.952	0.785	0.915	0.765	0.781

Table 3:
Innovation Union Scoreboard – detailed values

Source: European Union (2014): Innovation Union Scoreboard 2014

2.3 The Knowledge Economy Index (World Bank)

The Knowledge Economy Index (KEI) developed by the World Bank aims at showing a country's readiness to compete in the Knowledge Economy (KE). The "four pillars of the knowledge economy" – Economic and Institutional Regimes (EIR); Education; Innovation; Information and Communications Technologies (ICT) – are sub-indexes, with the KEI calculated as a simple average of all four and the KE as the average of the latter three (see Appendix). Each sub-index has three indicators. The EIR involves indicators surrounding knowledge creation and exchange in its broadest sense while the Education Index reflects the human resource-related capacity for innovation measured by enrollment figures in education. The Innovation Index is a composite of royalty payments & receipts, patent counts and journal articles produced in a country, while the ICT index counts the use of telephones, computers, and the internet in a country.

The KEI ranks Switzerland tenth, which is a rather low rank compared to the very good Swiss performance achieved in the GII and the IUS (see Table 4). Surprisingly, in 2000 Switzerland was clearly ranked better in the KEI than in 2012. In the IUS and the GII rankings, Switzerland continued to be ranked among the top performers and maintained its position during this period. The reason for this can be found in the construction of the different indicators, as the GII and IUS are more elaborate than the KEI (see Appendix for the details). The KEI was last calculated in 2012, so the underlying data and information only partly reflect current Swiss performance.

	2012 rank	KEI 2012	2000 rank	Change from 2000
AT	17	8.61	13	–4
DK	3	9.16	3	0
DE	8	8.9	15	7
FI	2	9.33	8	6
SE	1	9.43	1	0
CH	10	8.87	5	–5

Table 4:
Knowledge Economy Index

Source: World Bank (2012): Knowledge Economy Index 2012

3 Discussion

3.1 The basic characteristics of indicators

The GII, IUS and KEI enjoy good reputations both in the academic community and among policymakers. All indicators are highly aggregated composites of NIS, which allows for cross-national comparisons and global rankings, but they do not explicitly reflect regional differences. Although such regional disaggregation is possible, national-level data often cannot be easily attributed to individual regions. This is mainly due to the availability of data but also to spillovers between regional and national level STI-related activities such as matching funds and the like which are not included in the indicators.

Composite indicators are mainly ex post, which means the most recent developments in science, research, technology, economy and society are not or are only partly included in the indicators. The comparability of indicators remains a serious challenge because although the indicators themselves are designed to be comparable, the data itself, the procedures used for collecting it, and the interpretation of the data are not identical in all countries, and not identical for all science, technology and research fields. Moreover, country-specific features such as the underlying STI infrastructure is only partly encompassed by the indicators but not quantified. Instead, specific framework conditions are used for explaining or interpreting selected performance indicators.

The innovation output data are partially ambiguous, because the path dependency between input and output indicators remains “speculative”. This is mainly due to a persistent lack of understanding of the innovation process in both narrow and broader senses. Little is known, including empirically, about the relative importance of individual factors, the relevance of inputs, the causal link between input and output data, and about the frameworks and conditions for generating innovation. The lag between input and output is particularly unclear and unexplored: input or investment in innovation can’t be traced to specified outputs and causality, in particular, diminishes over time. Consequently, the indicators don’t mirror the time lag between investment in innovation activities (input) and an output. Not only is the time lag not known, but it is likely it varies between different innovation activities. In this regard, innovation indicators reflect selected determinants of innovation. A significant weakness remains because the process, adoption, and diffusion dimensions of innovation generation remain vague.

3.2 The special shortcomings of indicators

Indicators focus on NIS actors as entities, but the relationship between actors in NIS is not well described either in the composite indicators or in the sub-indexes. Links between industry and science are included to some extent in the composite indicators but they are limited to select types. This is also due to the broad range of channels which NIS actors typically use for their interactions, not all of which thus far can be converted into indicators. There is room for interpretation and justification of investments into STI with uncertain outcome.

Society is presumably “consuming” innovation to some degree (or seems to do so differently depending on the innovation), but the demand for innovation isn’t reflected in the composition of the indicators. The recent apparent shift between types of innovation (marginal innovation vs. radical innovation), the product, process, business model, and shifts between the target groups of innovation also aren't captured by the indictors. In this respect, population (B2C) or industry (B2B) are hardly measured and included as customers and users of innovation. Additionally, the spillovers on STI development as well as on customer attitudes and behavior which are initiated and caused by innovations aren't mirrored by the indicators.

Bibliometrics is increasingly used in sub-indexes to measure STI output. However, bibliometric analysis has its own weaknesses, mainly due to the nature of scientific networks and communities. The use of publication and citation indicators has caused scientists to publish ever more papers with a sometimes decreasing degree of novelty and originality. Bibliometric indicators are frequently used in evaluating scientists and institutions, but scientists are often closely affiliated with their colleagues in other countries. The analysis of bibliometric indicators allows one to depict science and technology realms or domains but hardly allows for an estimation of the spillovers between these fields.

Another frequently used indicator is related to the skilled workforce. This indicator mainly shows the share of the total workforce made up of workers with tertiary education. At first sight this sounds plausible, but it neglects that increasingly specialized and sophisticated skills are also essential for blue-collar workers, an aspect barely covered by the statistics. Hence, at the aggregate (composite indicator) level, educational background isn't adequately covered. It requires more detailed analysis for a proper interpretation.

Tertiary education is frequently considered a driver of the knowledge economy, but a focus on it neglects that the nature of education at the secondary and primary level is changing. There have therefore been many efforts to mirror the performance of primary and secondary education in recent years, but as there have been many changes and adjustments in education at these levels, the statistics are often more speculative than evidence-based.

The demand for tertiary education graduates also is barely reflected in the indicators, although there are frequent calls by policymakers to increase the share of graduates with secondary and tertiary education (measured as the share of total pupils and students, respectively). This is despite the empirical evidence that the careers of graduates don't necessarily match the expectation that there is a connection between real economic development and tertiary education. Instead, the policymakers react by considering a higher number of doctoral students or doctorates. Accordingly, the number of doctoral students has become a common indicator for the performance assessment of professors in many countries. This has led to a rapid increase in the number of doctoral students, with implications for the quality of doctoral work done, as well as for the quality of professors' work (the supervision of doctoral students is time-consuming and hence takes the attention of professors away from their own work).

Another frequently used indicator is drawn from patent statistics. Such indicators often count individual patents or patent families as expressing the inventive activities of individuals typically employed in larger organizations. Patent indicators are static, and have a considerable time lag. They focus on the application and granting of the patent but less on its enforcement. The number of patents in the respective indicators is usually counted with reference to technology fields, but the real value of patents is in terms of claims, meaning the scope of application of a patent, an aspect barely included in patent statistics.

The patent strategies of applicants or patent holders also are not considered in patent statistics. Yet one should consider not just how broad the scope of the patent claim is but what the initial or actual purpose of patenting was and is. Left to one side are motivations such as the protecting of an application, or the blocking functions it might perform. It may even serve as misinformation in the competition between large organizations. It has become common in industrial research to not patent all inventions, so the share of patented inventions versus secret information relating to innovations remains unknown.

The aggregate patent data for countries also do not necessarily reflect the innovative activities of organizations. Patents are accounted to the country in which the patent holder resides, but in many cases the patent holder is a subsidiary of a large international enterprise with subsidiaries in selected countries. Thus, a patent owner may not even engage in any innovative activity in the country where the patent is registered. Patent statistics therefore reflect legal ownership but not necessarily the inventive performance of a country.

The motivation and incentives of individuals and organizations for investing in STI are not mirrored in the indicators even when these are important determinants of STI. So if one does not consider the STI and the innovation culture, the assumptions about why actors engage in STI will be incomplete. The STI and innovation culture can be defined as the willingness of actors, organizations and society to change, adapt and anticipate change, and reflects the basic understanding of innovation.

The indicators also do not, and perhaps cannot, fully display the strategic intentions of NIS actors, whether they are companies or research institutions. These strategic agendas are the actual drivers of a country's future innovation performance. The STI strategies companies adopt are a major determinant of national STI performance but they are not mirrored in indicators because it is difficult to capture, describe, or quantify company STI strategies and make them comparable, not least because a company's strategies often have a longer time horizon.

3.3 Concluding remarks

Composite indicators do not cover all the dimensions relevant to STI and innovation. This is partly due to lacking data and partly because certain STI-related issues are not measurable. The aggregation of several indicators into one composite indicator expressing a nation's innovation performance also is problematic because at this point there is still insufficient empirical evidence of the impact of individual indicators on one another, including the potential time lag of spillovers between the indicators.

Finally, innovation indicators are characterized by a weakness in the quality dimension. So far, indicators mainly express quantities, and even the innovation efficiency indicator is a pure input/output ratio. Hence, STI policy measures run the danger of being developed based on quantitative measures with no or limited consideration given to a dimension which is especially important for education, research, and science. STI policy measures need to reflect the actual importance and meaning of science or research, but this is barely reflected in the indicators, especially in increasingly overlapping and merging science and technology fields.

4 Outlook

Despite the limitations of the composite indicators discussed, national innovation indicators do give a general idea about national innovation systems. This is especially useful and important if the intention is to learn about national innovation systems from a perspective outside a given national innovation system. However, this learning remains at the level of collecting information. Assessing the strengths and weaknesses of countries requires more in-depth analysis of the overall national innovation system and its features. Moreover, the composite indicators don't provide explanations about causality or the interrelationship of sub-indexes.

Still, aggregate indicators might be used to point to weak elements in a national innovation system or in STI policy. STI policy responses to detected weaknesses still require the in-depth analysis of institutions, their internal processes, and the interactions between actors and institutions. The indicators discussed may show the weaknesses of a country in its national innovation system but cannot explain those weaknesses.

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Appendix

1 The Global Innovation Index

Source: http://globalinnovationindex.org/content.aspx?page=gii-full-report-2014

Sub-indexes	**"Pillars"**	**Indicators**
Innovation input	Institutions	Political environment
		Regulatory environment
		Business environment
	Human capital and research	Education
		Tertiary education
		Research & development
	Infrastructure	ICTs
		General infrastructure
		Ecological sustainability
	Market sophistication	Credit
		Investment
		Trade & competition
	Business sophistication	Knowledge workers
		Innovation linkages
		Knowledge absorption
Innovation output	Knowledge and technology outputs	Knowledge creation
		Knowledge impact
		Knowledge diffusion
	Creative outputs	Intangible assets
		Creative goods & services
		Online creativity

2 The Innovation Union Scoreboard

Source: http://ec.europa.eu/enterprise/policies/innovation/files/ius/ius-2014_en.pdf

ENABLERS	**Human resources**	New doctorate graduates (ISCED 6) per 1000 population aged 25–34	Percentage population aged 30–34 having completed tertiary education	Percentage youth aged 20–24 having attained at least upper secondary level education		
	Open, excellent and attractive research systems	International scientific co-publications per million population	Scientific publications among the top 10 % most cited publications worldwide as % of total scientific publications of the country	Non-EU doctorate students as a % of all doctorate students		
	Finance and support	R&D expenditure in the public sector (% of GDP)	Venture capital investment (% of GDP)			
FIRM ACTIVITIES	**Firm investments**	R&D expenditure in the business sector (% of GDP)	Non-R&D innovation expenditures (% of turnover)			
	Linkages & entrepreneurship	SMEs innovating in-house (% of SMEs)	Innovative SMEs collaborating with others (% of SMEs)	Public-private co-publications per million population		
OUTPUTS	**Intellectual assets**	PCT patent applications per billion GDP (in PPS€)	PCT patent applications in societal challenges per billion GDP (in PPS€)	Community trademarks per billion GDP (in PPS€)	Community designs per billion GDP (in PPS€)	
	Innovators	SMEs introducing product or process innovations (% of SMEs)	SMEs introducing marketing or organisational innovations (% of SMEs)	Employment in fast-growing enterprises in innovative sectors (% of total employment)		
	Economic effects	Employment in knowledge-intensive activities (% of total employment)	Contribution of medium and high-tech products exports to the trade balance	Knowledge-intensive services exports as % total services exports	Sales of new-to-market and new-to-firm innovations as % of turnover	License and patent revenues from abroad as % of GDP

3 The Knowledge Economy Index

Source: http://siteresources.worldbank.org/INTUNIKAM/Resources/2012.pdf

Economic and institution regime index	**Education index**	**Innovation index**	**ICT index**
Tariff & nontariff barriers	Average years of schooling	Royalty payments & receipts	Telephones
Regulatory quality	Secondary enrollment	Patent count	Computers
Rule of law	Tertiary enrollment	Journal articles	Internet users

List of Tables

Abbreviations

AT	Austria
B2B	Business-to-business
B2C	Business-to-consumer
CH	Switzerland
DE	Germany
DK	Denmark
EIR	Economic and Institutional Regimes
EU	European Union
FI	Finland
GDP	Gross Domestic Product
GII	Global Innovation Index
ICT	Information and Communications Technologies
IEA	International Energy Agency
ILO	International Labour Organization
IMF	International Monetary Fund
INSEAD	Institut Européen d'Administration des Affaires, Business School
ISCED	International Standard Classification of Education
ISO	International Organization for Standardization
ITU	International Telecommunication Union
IUS	Innovation Union Scoreboard
KE	Knowledge Economy
KEI	Knowledge Economy Index
NIS	National Innovation System
OECD	Organisation for Economic Co-operation and Development
OHIM	Office for Harmonization in the Internal Market
PCT	Patent Cooperation Treaty
PPS	Purchase Power Standard
R&D	Research and development
SE	Sweden
SME	Small and Medium-sized Enterprise
SSIC	Swiss Science and Innovation Council
STI	Science, technology and innovation
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNIDO	United Nations Industrial Development Organization
WIPO	World Intellectual Property Organization

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Swiss Science and Innovation Council SSIC
Secretariat
Einsteinstrasse 2, CH-3003 Bern
T 0041 (0)58 463 00 48
F 0041 (0)58 463 95 47
swir@swir.admin.ch
www.swir.ch

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Swiss Science and Innovation Council SSIC
Secretariat
Einsteinstrasse 2
CH-3003 Bern

T 0041 (0)58 463 00 48
F 0041 (0)58 463 95 47
swir@swir.admin.ch
www.swir.ch