The Global Innovation Index (GII) Conceptual Framework

The rationale for the Global Innovation Index

The Global Innovation Index (GII) project was launched by INSEAD in 2007 with the simple goal of determining how to find metrics and approaches that better capture the richness of innovation in society and go beyond such traditional measures of innovation as the number of research articles and the level of research and development (R&D) expenditures.[1]

There were several motivations for setting this goal. First, innovation is important for driving economic progress and competitiveness—for both developed and developing economies. Many governments are putting innovation at the centre of their growth strategies. Second, the definition of innovation has broadened—it is no longer restricted to R&D laboratories and to published scientific papers. Innovation could be and is more general and horizontal in nature, and includes social innovations and business model innovations as well as technical ones. Last but not least, recognizing and celebrating innovation in emerging markets is seen as critical for inspiring people—especially the next generation of entrepreneurs and innovators.

The GII helps to create an environment in which innovation factors are under continual evaluation, and it provides a key tool and a rich database of detailed metrics for refining innovation policies.

The GII is not meant to be the ultimate and definitive ranking of economies with respect to innovation. Measuring innovation outputs and impacts remains difficult; hence great emphasis is placed on measuring the climate and infrastructure for innovation and on assessing related outcomes.

Although the end result takes the shape of several rankings, the GII is more concerned with improving the 'journey' to better measure and understand innovation and with identifying targeted policies, good practices, and other levers that foster innovation. The rich metrics can be used—on the level of the index, the sub-indices, or the actual raw data of individual variables—to monitor performance over time and to benchmark developments against countries in the same region or of the same income class.

Drawing on the expertise of the GII's Knowledge Partners and its prominent Advisory Board, the GII model is continually updated to reflect the improved availability of statistics and our understanding of innovation. This year, however, the model has reached a level of maturity that requires only minor updates (refer to Annex 2).

An inclusive perspective on innovation

The GII adopts a broad notion of innovation, originally developed in the *Oslo Manual* developed by the European Communities and the Organisation for Economic Co-operation and Development (OECD):[2]

> An innovation is the implementation of a new or significantly improved product (good or service), a new process, a new marketing method, or a new organizational method in business practices, workplace organization, or external relations.

This definition reflects the evolution of the way innovation has been perceived and understood over the last two decades.[3]

Previously economists and policy makers focused on R&D-based technological product innovation, largely produced in-house and mostly in manufacturing industries. This type of innovation was performed by a highly educated labour force in R&D-intensive companies. The process leading to such innovation was conceptualized as closed, internal, and localized. Technological breakthroughs were necessarily 'radical' and took place at the 'global knowledge frontier'. This characterization implied the existence of leading and lagging countries, with low- or middle-income economies only catching up.

Today, innovation capability is seen more as the ability to exploit new technological combinations; it embraces the notion of incremental innovation and 'innovation without research'. Non-R&D innovative expenditure is an important component of reaping the rewards of technological innovation. Interest in understanding how innovation takes

Box 1: Building a statistical and analytical framework of the highly skilled

Human capital is a central element of the innovation process, and the highly skilled play an especially important role in a knowledge-based economy. Significant efforts are now being devoted to improving both statistical and analytical frameworks and the availability and quality of the corresponding data to better understand the contribution of the human factor and its role in innovation. In particular, variables of interest for building indicators along the four different dimensions of measurement concerning the highly skilled, as elaborated as part of work being done by the Organisation for Economic Co-operation and Development (OECD), are set out in Figure 1.1. These dimensions are education, occupation, skills, and mobility.

A first set of indicators for measuring human capital focuses both on the role that education systems play in building competencies for science, technology, and innovation and on how this human capital is actually deployed in the labour market. These indicators position countries by looking at the performance of students from a young age and throughout the education system, with a special focus on those with scientific skills; those with science and engineering degrees; and doctoral holders, who are specifically trained for research.

Additional indicators look beyond the education systems to labour market outcomes (the occupation dimension), the dimension of skills and related mismatches, and finally the mobility dimension.

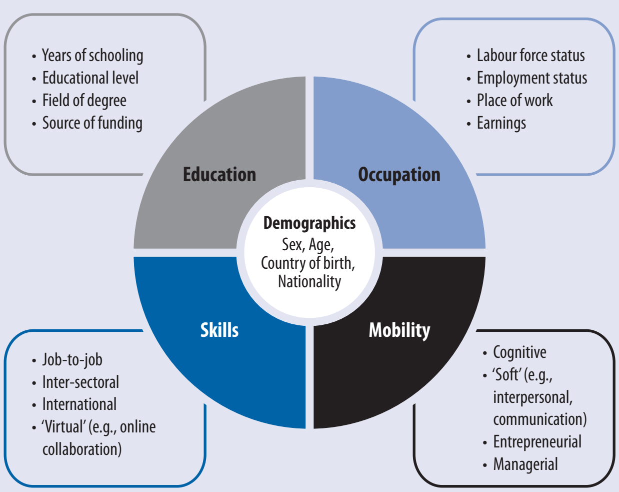
Different data sources may be used to look at the dimensions illustrated in Figure 1.1. Some may be dedicated to a specific dimension, such as education statistics; others are more general and cover several dimensions, such as population censuses. Efforts to measure highly skilled labour at the international level have long relied on standard statistical sources such as censuses or labour force surveys. These are particularly useful with regard to their international harmonization and comparability, but present a number of limitations in terms of their frequency (population censuses) and sample size (labour force surveys). It has also become increasingly apparent that aggregate numbers derived from such data mask very heterogeneous situations across degree levels, fields of education, occupations, industries, countries, and so on, calling for the use of complementary information from other data sources. Recent work by the OECD suggests that a statistical data framework and infrastructure characterized by the following statistical activities would meet the requirements for developing a comprehensive evidence base of the highly skilled population across the wide range of measurement dimensions illustrated in Figure 1.1:

1. analysis at different levels of aggregation: macro (basic aggregates), meso (e.g., industries), and micro (individual data);
2. consistent coverage of relevant populations of interest (e.g., researchers, doctorate holders, publishing scientists, etc.); and
3. access to and analysis of data at the micro level (e.g., enabling the linking of data collected from different sources and econometric analysis at the level of decision-making units).

The following links give examples of OECD statistical data work and analyses that use such a framework in different ways:

- Database on education statistics: http://www.oecd.org/education/database.htm.
- Statistics and indicators on the Careers of Doctorate Holders: www.oecd.org/sti/cdh.
- Evidence on the mobility of scientists, based on bibliometric affiliation data: http://www.oecd.org/sti/researchers-on-the-move-the-impact-of-brain-circulation.pdf.
- Database on immigrants in OECD and non-OECD countries: http://www.oecd.org/els/mig/dioc.htm.
- Programme for the International Assessment of Adult Competencies (PIAAC): http://www.oecd.org/site/piaac/.

Figure 1.1: Measurement dimensions of interest for a statistical and analytical framework of the highly skilled



Source: OECD Secretariat.
Note: The variables listed in the figure are not exhaustive, but rather are a minimal set of variables for which data are considered most informative.

place in low- and middle-income countries is increasing, along with an awareness that incremental forms of innovation can impact development. Furthermore, the process of innovation itself has changed significantly. Investment in innovation-related activity has consistently intensified at the firm, country, and global levels, adding both new innovation actors from outside high-income economies and nonprofit actors. The structure of knowledge production activity is more complex and geographically dispersed than ever.

A key challenge is to find metrics that capture innovation as it actually happens in the world today.[4] Direct official measures that quantify innovation outputs remain extremely scarce.[5] For example, there are no official statistics on the amount of innovative activity—defined as the number of new products, processes, or other innovations—for any given innovation actor, let alone for any given country (see Box 1, Annex 1 of Chapter 1 in the GII 2013). Most measures also struggle to appropriately capture the innovation outputs of a wider spectrum of innovation actors, such as the services sector or public entities.

The GII aims to move beyond the mere measurement of such simple innovation metrics. To do so will require the integration of new variables, with a trade-off between the quality of the variable on the one hand and achieving good country coverage on the other hand.

The timeliest possible indicators are used for the GII: 28.3% of data obtained are from 2013, 34.6% are from 2012, 11.6% are from 2011, 5.0% from 2010, and the small remainder (5.3%) from earlier years.[6]

Further, the *Oslo Manual* states that the human factor is important for enabling innovation at the firm level because 'much essential knowledge, particularly technological knowledge, is unwritten.'[7]

The theme of this year's GII, the 'Human Factor in Innovation', explores the role of the individuals and teams behind the innovation process. Statistically capturing this human contribution to innovation is a daunting challenge.

The organizations—such as the OECD and the National Science Foundation (NSF)—specializing in developing new innovation metrics, for instance, have started to address this lack of data by attempting to better understand precisely what is needed to measure the impact of talented human capital.

The OECD Innovation Strategy addresses four key areas when assessing the role of the highly skilled: education, occupation, skills, and mobility (see Box 1).

The NSF's *Science and Engineering Indicators 2014* report points out that measuring R&D human resources is not the only way to assess the human factor in innovation (Box 2). Other metrics—including employment in knowledge and technology-intensive industries and business sectors other than those specific to R&D—also need to be assessed.

The GII conceptual framework

The GII is an evolving project that builds on its previous editions while incorporating newly available data and that is inspired by the latest research on the measurement of innovation. This year the GII model includes 143 countries/economies that represent 92.9% of the world's population and 98.3% of the world's GDP (in current US dollars). The GII relies on two sub-indices—the Innovation Input Sub-Index and the Innovation Output Sub-Index—each built around pillars. Four measures are calculated (see Figure 1):

1. **Innovation Input Sub-Index:** Five input pillars capture elements of the national economy that enable innovative activities.
2. **Innovation Output Sub-Index:** Innovation outputs are the results of innovative activities within the economy. Although the Output Sub-Index includes only two pillars, it has the same weight in calculating the overall GII scores as the Input Sub-Index.
3. **The overall GII score** is the simple average of the Input and Output Sub-Indices.
4. **The Innovation Efficiency Ratio** is the ratio of the Output Sub-Index to the Input Sub-Index. It shows how much innovation output a given country is getting for its inputs.

Each pillar is divided into three sub-pillars, each of which is composed of individual indicators, for a total of 81 indicators. The GII pays special attention to presenting a scoreboard for each economy that includes strengths and weaknesses (Appendix I Country/Economy Profiles), making accessible the data series (Appendix II Data Tables), and providing data sources and definitions (Appendix III) and detailed technical notes (Appendix IV). Adjustments to the GII framework, including a detailed analysis of the factors influencing year-on-year changes, are detailed in Annex 2. In addition, since 2011 the GII has been submitted to an independent statistical audit performed by the Joint Research Centre of the European Union (results are detailed in Annex 3).

A table is included here for each pillar. That table provides a list of the pillar's indicators, specifying their type (composite indicators are

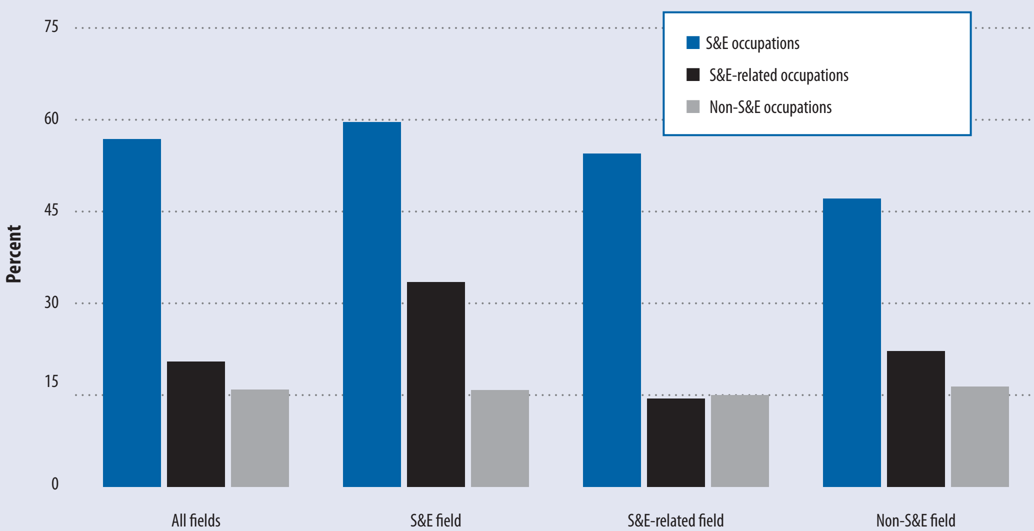
Box 2: New measurement approaches show innovation outside of R&D laboratories

Measuring the human factor in innovation is an important part of understanding the economic and social conditions that foster innovation and assessing its impact. The National Science Foundation's National Center for Science and Engineering Statistics (NCSES) has indicators on the human factor in innovation largely from data on the education, occupations, and activities of highly skilled people in the United States of America and worldwide. The NCSES reports much of this human innovation–related data in the National Science Board's biannual publication *Science and Engineering Indicators (SEI)*.

SEI 2014 reported several findings that shed light on the human factor in innovation. The first highlights the important role of scientists and engineers who use their knowledge in research and development (R&D).[1] The 2010 data are from the National Science Foundation's SESTAT database,[2] which indicate that 27% of employed US scientists and engineers reported R&D as a primary or secondary work activity (Figure 2.1). Although the scientists and engineers employed in S&E occupations are those most likely to perform R&D (57%) as a primary or secondary work activity, a considerable proportion of those in S&E-related (21%) or non-S&E occupations (16%) also reported R&D as a primary or secondary activity.

To get at a more refined notion of the human factor in commercial innovation, for the first time in 2014, *SEI 2014* reported employment in US knowledge- and technology-intensive industries (Table 2.1). This group consists of eight industries comprising

Figure 2.1: Employed scientists and engineers with R&D activity, by broad field of highest degree and broad occupational category, 2010



Source: NSF/NCSES, 2010.

Notes: Scientists and engineers include those with one or more S&E or S&E-related degrees at the bachelor's level or higher or those who have only a non-S&E degree at the bachelor's level or higher and are employed in an S&E or S&E-related occupation. R&D activity here refers to the share of workers reporting basic research, applied research, design, or development as a primary or secondary work activity in their principal job—activities ranking first or second in work hours.

(Continued)

identified with an asterisk '*', survey questions with a dagger '†', and the remaining indicators are hard data); their weight in the index (indicators with half weight are identified with the letter 'a'); and the direction of their effect (indicators for which higher values imply worse outcomes are identified with the letter 'b'). The table then provides each indicator's average values (in their respective units) per income group (World Bank classification) and for the whole sample of 143 economies retained in the final computation (Tables 1a through 1g).

The Innovation Input Sub-Index

The first sub-index of the GII, the Innovation Input Sub-Index, has five enabler pillars: Institutions, Human capital and research, Infrastructure, Market sophistication, and Business sophistication. Enabler pillars define aspects of the environment

Box 2: New measurement approaches show innovation outside of R&D laboratories *(continued)*

Table 2.1: Employment and R&D for selected US industries, 2012 or most recent year

Industry	Employment (millions of persons)	S&E share	Average salary (actual US dollars)	Business R&D (2009) (US$ billions)
All industries	**133.7**	**4.4**	**45,000**	**282.4**
Commercial KI services	18.4	15.8	68,000	78.8
HT manufacturing	1.8	26.4	70,000	135.9

Sources: BEA, Annual Industry Accounts, available at http://www.bea.gov/industry/index.htm#annual; BLS, Current Employment Statistics, available at http://www.bls.gov/ces/; BLS, Occupational Employment Statistics, special tabulations, accessed 15 July 2013; NSF/NCSES, 2013; NSB, 2014.

Notes: Business R&D consists of domestic funding by companies' own internal funds and funds from other sources. Employment consists of the nonagricultural workforce. HT manufacturing industries and KI services are classified by the Organisation for Economic Co-operation and Development. HT manufacturing includes computers, communications, semiconductors, electronic and measuring instruments, aircraft and space vehicles, and pharmaceuticals. KI services include health, education, business, information, and financial services. Commercial KI services include business, information, and financial services. Business R&D of commercial KI services consists of professional and technical services and information. Coverage of some industries may vary among data sources due to differences in classification of industries. Salaries are rounded to the nearest thousand.

three commercial knowledge-intensive (KI) services—business, financial, and telecommunications; and five high-technology (HT) industries—aircraft and spacecraft, communications and semiconductors, computers, pharmaceuticals, and scientific instruments. US commercial KI services industries employ 18 million workers, or 14% of the non-government US labour force; US HT manufacturing industries employ 1.8 million workers, or 16% of the US manufacturing labour force (this comes to 1% of the total US non-government labour force). Both commercial KI services and HT manufactures pay higher-than-average wages because, in part, of their high concentration of highly skilled S&E workers. These data together cover a fuller range of human contributions to innovative business sectors, going beyond direct R&D personnel alone.

However, more work remains if we are to fully measure the human factor in innovation. The current approach of using data from education and labour force surveys provides an incomplete picture of the human impact on innovation. One limitation to this approach is the lack of systematic data on the skills themselves, which is arguably as important as data on occupation or education in human capital. A further limitation is the lack of data on the technological know-how of employees and workers. Technological know-how is probably at least as important as formal education and training, and it becomes increasingly important as individuals advance in their careers. Advances in gathering data that allow for the more precise measurement of the skills and know-how of the people who work in these fields would help economies tailor policies to enhance the human factor of the innovative environment.

Notes

1 Scientists and engineers are defined as people who work in science and engineering (S&E) or S&E-related occupations or who hold at least a bachelor's level degree in an S&E or S&E-related field.

2 The Scientists and Engineers Statistical Data System (SESTAT) database is available at http://ncsesdata.nsf.gov/sestat/sestat.html.

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conducive to innovation within an economy.

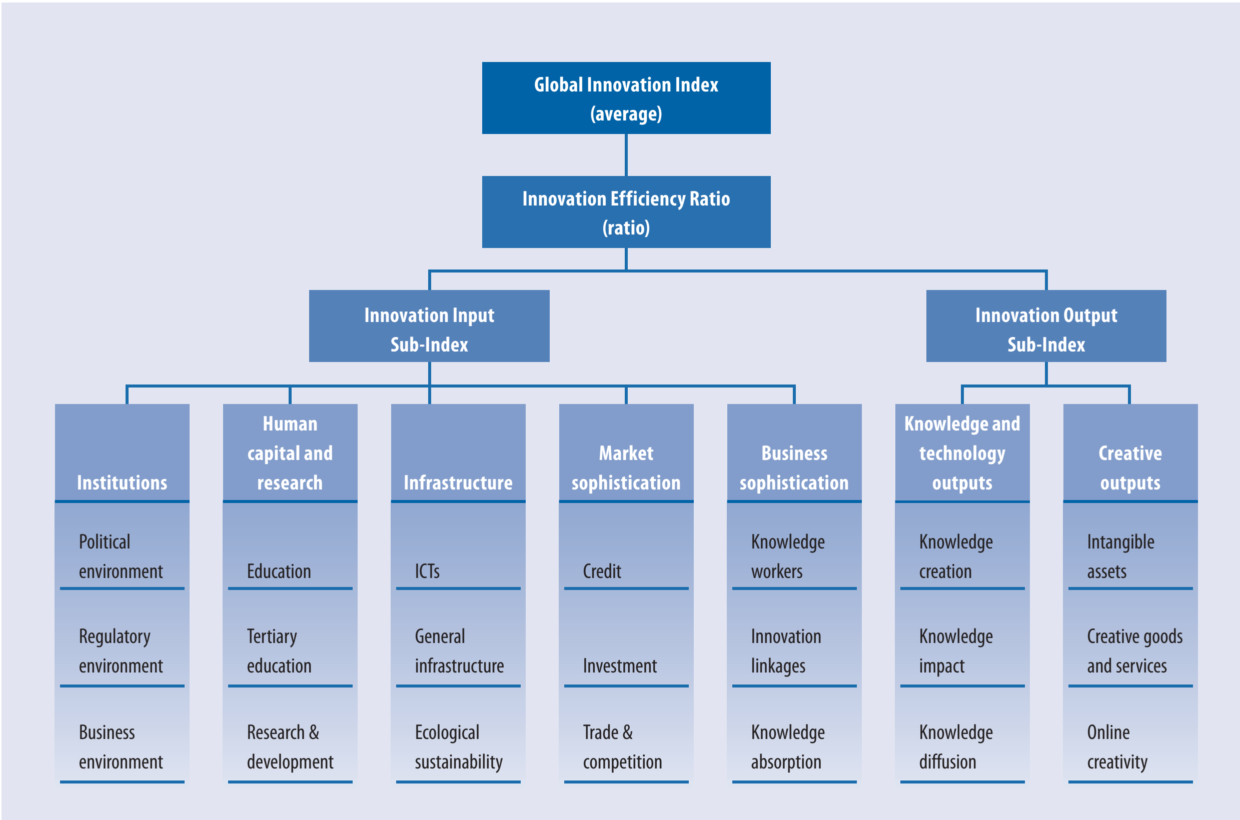
Pillar 1: Institutions

Nurturing an institutional framework that attracts business and fosters growth by providing good governance and the correct levels of protection and incentives is essential to innovation. The Institutions pillar captures the institutional framework of a country (Table 1a).

The political environment sub-pillar includes three indices that reflect perceptions of the likelihood that a government might be destabilized; the quality of public and civil services, policy formulation, and implementation; and perceptions of violations to press freedom.

The regulatory environment sub-pillar draws on two indices aimed at capturing perceptions on the ability of the government to formulate and implement cohesive policies that promote the development of the private sector and at

Figure 1: Framework of the Global Innovation Index 2014



evaluating the extent to which the rule of law prevails (in aspects such as contract enforcement, property rights, the police, and the courts). The third indicator evaluates the cost of redundancy dismissal as the sum, in salary weeks, of the cost of advance notice requirements added to severance payments due when terminating a redundant worker.

The business environment sub-pillar expands on three aspects that directly affect private entrepreneurial endeavours by using the World Bank indices on the ease of starting a business; the ease of resolving insolvency (based on the recovery rate recorded as the cents on the dollar recouped by creditors through reorganization, liquidation, or debt enforcement/foreclosure proceedings); and the ease of paying taxes.

Pillar 2: Human capital and research

The level and standard of education and research activity in a country are prime determinants of the innovation capacity of a nation. This pillar tries to gauge the human capital of countries (Table 1b).

The first sub-pillar includes a mix of indicators aimed at capturing achievements at the elementary and secondary education levels. Education expenditure and school life expectancy are good proxies for coverage. Government expenditure per pupil, secondary gives a sense of the level of priority given to secondary education by the state. The quality of education is measured through the results to the OECD Programme for International Student Assessment (PISA), which examines 15-year-old students' performances in reading, mathematics, and science, as well as the pupil–teacher ratio.

Higher education is crucial for economies to move up the value chain beyond simple production processes and products. The sub-pillar on tertiary education aims at capturing coverage (tertiary enrolment); priority is given to the sectors traditionally associated with innovation (with a series on the percentage of tertiary graduates in science and engineering, manufacturing, and construction); and the inbound and mobility of tertiary students, which plays a crucial role in the exchange of ideas and skills necessary for innovation.

The last sub-pillar, on R&D, measures the level and quality of R&D activities, with indicators on researchers (headcounts), gross expenditure, and the quality of scientific and research institutions as measured by the average score of the top three universities in the QS World University Ranking of 2013. By design, this indicator aims at capturing the availability of at least three higher education institutions of quality within each economy (i.e., included in the global top 700), and is not aimed at assessing the average level of all institutions within a particular economy.

Pillar 3: Infrastructure

The third pillar includes three sub-pillars: information and communication technologies (ICTs), general infrastructure, and ecological sustainability (Table 1c).

Good and ecologically friendly communication, transport, and energy infrastructures facilitate the production and exchange of ideas, services, and goods and feed into the innovation system through increased productivity and efficiency, lower transaction costs, better access to markets, and sustainable growth.

The ICTs sub-pillar includes four indices developed by international organizations on ICT access, ICT use, online service by governments, and online participation of citizens.

The sub-pillar on general infrastructure includes the average of electricity output in kWh per capita; a composite indicator on logistics performance; and gross capital formation, which consists of outlays on additions to the fixed assets and net inventories of the economy, including land improvements (fences, ditches, drains); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings.

Table 1a: Institutions pillar

		Average value by income group (0–100)				
	Indicator	High income	Upper-middle income	Lower-middle income	Low income	Mean
1	**Institutions**					
1.1	*Political environment*					
1.1.1	Political stability*	0.69	–0.25	–0.56	–0.77	–0.08
1.1.2	Government effectiveness*	1.17	–0.10	–0.48	–0.82	0.13
1.1.3	Press freedom*[b]	21.07	34.51	37.50	33.96	30.57
1.2	*Regulatory environment*					
1.2.1	Regulatory quality*[a]	1.11	–0.06	–0.42	–0.68	0.16
1.2.2	Rule of law*[a]	1.13	–0.31	–0.59	–0.82	0.03
1.2.3	Cost of redundancy dismissal, salary weeks[b]	14.17	19.01	26.05	19.41	19.04
1.3	*Business environment*					
1.3.1	Ease of starting a business*	87.05	80.66	79.43	68.90	80.68
1.3.2	Ease of resolving insolvency*	66.44	37.93	27.95	22.45	43.01
1.3.3	Ease of paying taxes*	80.22	65.51	56.49	56.44	67.08

Note: (*) index, (†) survey question, (a) half weight, (b) higher values indicate worse outcomes.

Table 1b: Human capital & research pillar

		Average value by income group (0–100)				
	Indicator	High income	Upper-middle income	Lower-middle income	Low income	Mean
2	**Human capital and research**					
2.1	*Education*					
2.1.1	Expenditure on education, % GDP	5.28	4.69	4.67	4.23	4.81
2.1.2	Gov't expend on edu./pupil, secondary[1]	24.92	17.32	19.90	25.16	22.09
2.1.3	School life expectancy, years	15.90	13.69	11.67	9.84	13.36
2.1.4	PISA scales in reading, maths & science[a]	496.34	427.85	360.19	n/a	469.85
2.1.5	Pupil-teacher ratio, secondary[a,b]	11.18	16.16	20.03	28.17	17.54
2.2	*Tertiary education*					
2.2.1	Tertiary enrolment, % gross[a]	62.50	43.02	23.16	9.46	39.50
2.2.2	Graduates in science & engineering, %	22.57	23.01	18.57	16.82	21.08
2.2.3	Tertiary inbound mobility, %[a]	9.59	4.33	1.21	1.88	5.38
2.3	*Research and development (R&D)*					
2.3.1	Researchers, headcounts/mn pop.	4,918.58	1,192.64	508.06	122.86	2,155.99
2.3.2	Gross expenditure on R&D, % GDP	1.67	0.52	0.28	0.34	0.90
2.3.3	QS university ranking, average score top 3*	41.37	16.30	5.47	0.25	19.81

Note: (*) index, (†) survey question, (a) half weight, (b) higher values indicate worse outcomes.
1 Scaled by percent of GDP per capita.

The sub-pillar on ecological sustainability includes three indicators: GDP per unit of energy use (a measure of efficiency in the use of energy), the Environmental Performance Index of Yale and Columbia Universities, and the number of certificates of conformity with standard ISO 14001 on environmental management systems issued.

Pillar 4: Market sophistication

The ongoing global financial crisis has underscored how crucial the availability of credit, investment funds, and access to international markets is for businesses to prosper. The Market sophistication pillar has three sub-pillars structured around market conditions and the total level of transactions (Table 1d).

The credit sub-pillar includes a measure on the ease of getting credit

Table 1c: Infrastructure pillar

	Indicator	Average value by income group (0–100) High income	Upper-middle income	Lower-middle income	Low income	Mean
3	**Infrastructure**					
3.1	*Information and communication technologies (ICTs)*					
3.1.1	ICT access*	7.38	4.81	3.27	2.05	4.99
3.1.2	ICT use*	5.78	2.56	1.35	0.37	3.13
3.1.3	Government's online service*	0.72	0.49	0.40	0.28	0.51
3.1.4	E-participation*	0.49	0.24	0.19	0.06	0.29
3.2	*General infrastructure*					
3.2.1	Electricity output, kWh/cap[a]	9,476.98	2,808.78	1,305.40	577.56	4,816.63
3.2.2	Logistics performance*[a]	3.49	2.85	2.63	2.45	2.95
3.2.3	Gross capital formation, % GDP	20.24	25.52	25.16	25.37	23.59
3.3	*Ecological sustainability*					
3.3.1	GDP/unit of energy use, 2005 PPP$/kg oil eq	7.44	7.26	5.41	3.68	6.54
3.3.2	Environmental performance*	70.29	53.78	42.77	33.46	53.51
3.3.3	ISO 14001 environ. certificates/bn PPP& GDP[a]	4.54	3.30	0.49	0.30	2.79

Note: (*) index, (†) survey question, (a) half weight, (b) higher values indicate worse outcomes.

Table 1d: Market sophistication pillar

	Indicator	Average value by income group (0–100) High income	Upper-middle income	Lower-middle income	Low income	Mean
4	**Market sophistication**					
4.1	*Credit*					
4.1.1	Ease of getting credit*	70.41	63.65	61.36	50.54	63.33
4.1.2	Domestic credit to private sector, % GDP	110.96	55.82	36.39	23.23	65.19
4.1.3	Microfinance gross loans, % GDP	0.14	0.97	2.43	3.08	1.92
4.2	*Investment*					
4.2.1	Ease of protecting investors*	59.73	56.84	47.07	47.10	54.01
4.2.2	Market capitalization, % GDP[a]	67.46	42.21	26.03	31.10	49.31
4.2.3	Total value of stocks traded, % GDP[a]	39.85	13.08	3.71	3.66	22.20
4.2.4	Venture capital deals/tr PPP$ GDP[a]	0.21	0.02	0.02	0.09	0.13
4.3	*Trade and competition*					
4.3.1	Applied tariff rate, weighted mean, %[a,b]	2.34	5.63	6.44	8.35	5.10
4.3.2	Non-agricultural mkt access weighted tariff, %[a,b]	2.29	1.34	1.41	1.72	1.75
4.3.3	Intensity of local competition†	5.38	4.64	4.76	4.53	4.92

Note: (*) index, (†) survey question, (a) half weight, (b) higher values indicate worse outcomes.

aimed at measuring the degree to which collateral and bankruptcy laws facilitate lending by protecting the rights of borrowers and lenders, as well as the rules and practices affecting the coverage, scope, and accessibility of credit information. Transactions are given by the total value of domestic credit and, in an attempt to make the model more applicable to emerging markets, by the gross loan portfolio of microfinance institutions.

The investment sub-pillar includes the ease of protecting investors index as well as three indicators on the level of transactions. To show whether market size is matched by market dynamism, stock market capitalization is complemented by the total value of shares traded. The last metric is a hard data metric on venture capital deals, taking into account a total of 18,860 deals in 71 countries in 2013.

The last sub-pillar tackles trade and competition. The market conditions for trade are given by two indicators: the average tariff rate weighted by import shares and a measure capturing non-agricultural market access conditions to foreign markets (five major export markets weighted actual applied tariffs for non-agricultural exports). The third and last indicator is a survey question that reflects on the intensity of competition in local markets. Efforts made at finding hard data on competition have so far proved unsuccessful.

Pillar 5: Business sophistication

The last enabler pillar tries to capture the level of business sophistication to assess how conducive firms are to innovation activity (Table 1e). The Human capital and research pillar (pillar 2) made the case that the accumulation of human capital through education, and particularly higher education and the prioritization of R&D activities, is an indispensable condition for innovation to take place. That logic is taken one step further here with the assertion that businesses foster their productivity, competitiveness, and innovation potential with the employment of highly qualified professionals and technicians.

The first sub-pillar includes four quantitative indicators on knowledge workers: employment in knowledge-intensive services; the availability of formal training at the firm level; R&D performed by business enterprise (GERD) as a percentage of GDP (i.e., GERD over GDP); and the percentage of total gross expenditure of R&D that is financed by business enterprise. In addition, the sub-pillar includes an indicator related to the Graduate Management

Admission Test (GMAT).[8] The total number of GMAT test takers (scaled by population aged 20 to 34 years old) were taken as a proxy for the entrepreneurial mindset of young graduates).

Innovation linkages and public/private/academic partnerships are essential to innovation. In emerging markets, pockets of wealth have developed around industrial or technological clusters and networks, in sharp contrast to the poverty that may prevail in the rest of the territory. The innovation linkages sub-pillar draws on both qualitative and quantitative data regarding business/university collaboration on R&D, the prevalence of well-developed and deep clusters, the level of gross R&D expenditure financed by abroad, and the number of deals on joint ventures and strategic alliances. The latter covers a total of 2,978 deals announced in 2013, with firms headquartered in 127 participating economies.[9] In addition, the total number of Patent Cooperation Treaty (PCT) and national office published patent family applications filed by residents in at least three offices is included this year to proxy for international linkages.

In broad terms, pillar 4 on market sophistication makes the case that well-functioning markets contribute to the innovation environment through competitive pressure, efficiency gains, and economies of transaction and by allowing supply to meet demand. Markets that are open to foreign trade and investment have the additional effect of exposing domestic firms to best practices around the globe, which is critical to innovation through knowledge absorption and diffusion, which are considered in pillars 5 and 6. The rationale behind sub-pillars 5.3 on knowledge absorption (an enabler) and 6.3 on knowledge diffusion (a result)—two sub-pillars designed to be mirror images of each other—is precisely that together they will reveal how good countries are at absorbing and diffusing knowledge.

Sub-pillar 5.3 includes four statistics that are linked to sectors with high-tech content or are key to innovation: royalty and license fees payments as a percentage of total imports; high-tech imports (net of re-imports) as a percentage of total trade; imports of communication, computer and information services as a percentage of total trade;[10] and net inflows of foreign direct investment (FDI) as a percentage of GDP.

Table 1e: Business sophistication pillar

		Average value by income group (0–100)				
	Indicator	High income	Upper-middle income	Lower-middle income	Low income	Mean
5	**Business sophistication**					
5.1	*Knowledge workers*					
5.1.1	Knowledge-intensive employment, %	37.42	22.37	17.48	6.71	26.63
5.1.2	Firms offering formal training, % firms	45.12	40.57	30.78	31.68	36.75
5.1.3	GERD performed by business, % GDP[a]	1.11	0.24	0.09	0.07	0.64
5.1.4	GERD performed by business, %[a]	52.68	32.68	21.92	17.05	40.15
5.1.5	GMAT test takers/mn pop. 20-34[a]	292.64	95.33	37.09	13.47	136.62
5.2	*Innovation linkages*					
5.2.1	University/industry research collaboration[†a]	4.49	3.58	3.20	3.07	3.75
5.2.2	State of cluster development[†]	4.34	3.65	3.63	3.33	3.85
5.2.3	GERD financed by abroad, %	12.37	9.26	12.87	30.97	14.33
5.2.4	JV-strategic alliance deals/tr PPP$ GDP[a]	0.07	0.03	0.03	0.05	0.05
5.2.5	Patent families filed in 3+ offices/bn PPP$ GDP[a]	1.11	0.08	0.03	0.06	0.50
5.3	*Knowledge absorption*					
5.3.1	Royaly & license fees pay'ts, % total trade[a]	1.55	0.51	0.38	0.10	0.77
5.3.2	High-tech imports less re-imports, % tot. trade	9.35	9.24	7.46	6.80	8.53
5.3.3	Comm., comp. & info services imp., % tot. trade	1.21	0.85	0.71	1.26	1.01
5.3.4	FDI net inflows, % GDP	4.55	4.19	4.80	5.17	4.61

Note: (*) index, (†) survey question, (a) half weight, (b) higher values indicate worse outcomes.

The Innovation Output Sub-Index

Innovation outputs are the results of innovative activities within the economy. Although the Output Sub-Index includes only two pillars, it has the same weight in calculating the overall GII scores as the Input Sub-Index. There are two output pillars: Knowledge and technology outputs and Creative outputs.

Pillar 6: Knowledge and technology outputs

This pillar covers all those variables that are traditionally thought to be the fruits of inventions and/or innovations (Table 1f). The first sub-pillar refers to the creation of knowledge. It includes five indicators that are the result of inventive and innovative activities: patent applications filed by residents both at the national patent office and at the international level through the PCT; utility model applications filed by residents at the national office; scientific and technical published articles in peer-reviewed journals; and an economy's number of articles (H) that have received at least H citations.

The second sub-pillar, on knowledge impact, includes statistics representing the impact of innovation activities at the micro- and macroeconomic level or related proxies: increases in labour productivity, the entry density of new firms, spending on computer software, and the number of certificates of conformity with standard ISO 9001 on quality

Table 1f: Knowledge & technology outputs pillar

	Indicator	High income	Upper-middle income	Lower-middle income	Low income	Mean
		Average value by income group (0–100)				
6	**Knowledge and technology outputs**					
6.1	*Knowledge creation*					
6.1.1	Domestic resident patent app/bn PPP$ GDP[a]	7.33	3.38	2.32	1.35	4.58
6.1.2	PCT resident patent app/bn PPP$ GDP[a]	3.28	0.38	0.11	0.11	1.46
6.1.3	Domestic res utility model app/bn PPP$ GDP	1.95	4.05	5.85	1.07	3.22
6.1.4	Scientific & technical articles/bn PPP$ GDP[a]	31.57	13.25	7.67	10.18	17.65
6.1.5	Citable documents H index[a]	314.53	113.79	74.91	60.17	164.98
6.2	*Knowledge impact*					
6.2.1	Growth rate of PPP$ GDP/worker, %	0.91	1.92	2.18	2.16	1.59
6.2.2	New businesses/th pop. 15–64[a]	5.82	2.96	0.79	0.36	3.38
6.2.3	Computer software spending, % GDP[a]	0.49	0.31	0.27	0.31	0.39
6.2.4	ISO 9001 quality certificates/bn PPP$ GDP[a]	16.61	12.65	3.34	1.26	10.09
6.2.5	High- & medium-high-tech manufactures, %[a]	33.10	22.78	16.45	7.27	25.00
6.3	*Knowledge diffusion*					
6.3.1	Royalty & license fees receipts, % total trade[a]	1.03	0.10	0.31	0.20	0.50
6.3.2	High-tech exports less re-exports, % tot. trade[a]	6.32	5.05	1.45	0.50	4.08
6.3.3	Comm., comp. & info. services exp., % tot. trade[a]	2.27	1.34	1.87	1.74	1.85
6.3.4	FDI net outflows, % GDP	12.69	19.91	0.28	(0.41)	10.46

Note: (*) index, (†) survey question, (a) half weight, (b) higher values indicate worse outcomes.

Table 1g: Creative outputs pillar

	Indicator	High income	Upper-middle income	Lower-middle income	Low income	Mean
		Average value by income group (0–100)				
7	**Creative outputs**					
7.1	*Intangible assets*					
7.1.1	Domestic res trademark app/bn PPP$ GDP	60.53	61.17	92.92	26.96	62.79
7.1.2	Madrid trademark applications/bn PPP$ GDP[a]	2.01	0.73	0.73	0.10	1.33
7.1.3	ICTs & business model creation†	4.90	4.22	4.12	3.87	4.39
7.1.4	ICTs & organizational model creation†	4.68	4.04	3.90	3.59	4.18
7.2	*Creative goods and services*					
7.2.1	Cultural & creative services exp., % total trade[a]	0.51	0.30	0.11	0.04	0.30
7.2.2	National feature films/mn pop. 15–69[a]	7.92	2.69	5.26	0.68	5.15
7.2.3	Global ent. & media output/th pop. 15–69[a]	1.30	0.24	0.05	0.06	0.84
7.2.4	Printing & publishing manufactures, %	2.65	0.02	0.01	0.02	0.02
7.2.5	Creative goods exports, %	1.77	2.20	1.01	0.12	1.48
7.3	*Online creativity*					
7.3.1	Generic TLDs/th pop. 15–69	38.54	9.65	1.68	0.41	16.22
7.3.2	Country-code TLDs/th pop. 15–69	51.61	28.80	13.03	3.66	28.93
7.3.3	Wikipedia monthly edits/mn pop. 15–69	19,630.51	4,827.56	2,107.01	173.15	8,568.66
7.3.4	Video uploads on YouTube/pop. 15–69	84.55	67.09	46.56	22.78	72.00

Note: (*) index, (†) survey question, (a) half weight, (b) higher values indicate worse outcomes. Scores rather than values are presented for indicators 7.3.1, 7.3.2, and 7.3.4.

management systems issued. To strengthen the sub-pillar, the measure of high- and medium-high-tech industrial output over total manufactures output was added this year.

The third sub-pillar, on knowledge diffusion, is the mirror image of the knowledge absorption sub-pillar of pillar 5. It includes four statistics all linked to sectors with high-tech content or that are key to innovation: royalty and license fees receipts as a percentage of total trade; high-tech exports (net of re-exports) as a percentage of total trade; exports of communication, computer and information services as a percentage of total trade;[11] and net outflows of FDI as a percentage of GDP.

Pillar 7: Creative outputs

The role of creativity for innovation is still largely underappreciated in innovation measurement and policy debates. Since its inception, the GII has always emphasized measuring creativity as part of its Innovation Output Sub-Index. The last pillar, on creative outputs, has three sub-pillars (Table 1g).

The first sub-pillar on intangible assets includes statistics on trademark applications by residents at the national office; trademark applications under the Madrid System by country of origin,[12] and two survey questions regarding the use of ICTs in business and organizational models, new areas that are increasingly linked to process innovations in the literature.

The second sub-pillar on creative goods and services includes proxies to get at creativity and the creative outputs of an economy. This year, in an attempt to include broader sectoral coverage, a global entertainment and media output composite was added. In addition, the indicator on audio-visual and related services exports was renamed 'Cultural and creative services exports' and expanded to include information services, advertising, market research and public opinion polling, and other personal, cultural, and recreational services (as a percentage of total trade). These two indicators complement the remainder of the sub-pillar, which measures national feature films produced in a given country (per capita count); printing and publishing output (as a percentage of total manufactures output); and creative goods exports (as a percentage of total trade), all which are aimed at providing an overall sense of the international reach of creative activities in the country.

The third sub-pillar on online creativity includes four indicators, all scaled by population aged 15 through 69 years old: generic (biz, info, org, net, and com) and country-code top level domains, average monthly edits to Wikipedia, and video uploads on YouTube. Attempts made to strengthen this sub-pillar with indicators in areas such as blog posting, online gaming, the development of applications, and have so far proved unsuccessful.

Notes

1 For a fuller introduction to the Global Innovation Index, see the GII 2011. Examples of other composite innovation indices were reviewed there too. The Global Innovation Policy Index of the Information Technology and Innovation Foundation, which is quite complementary to the GII, was formulated in 2012.

2 Eurostat and OECD, 2005.

3 OECD, 2010; INSEAD, 2011; and WIPO, 2011.

4 INSEAD, 2011; OECD Scoreboard, 2013; WIPO, 2011.

5 INSEAD, 2011; OECD, 2011; WIPO, 2011

6 For completeness, 2.1% of data points are from 2009, 1.2% from 2008, 0.7% from 2007, 0.5% from 2006, 0.4% from 2005, and 0.3%. In addition, the GII is calculated on the basis of 9,820 data points (compared to 11,583 with complete series), implying that 15.22% of data points are missing. Data Tables (Appendix II) include the reference year for each data point and mark missing data as not available (n/a).

7 Eurostat and OECD, 2005, p. 21.

8 The GMAT is a standardized test aimed at measuring aptitude to succeed academically in graduate business studies. It is an important part of the admissions process for nearly 5,600 graduate management programmes in approximately 2,000 business schools worldwide.

9 These data were determined from a query on joint ventures/strategic alliances deals announced in 2013 from Thomson Reuters SDC Platinum database. A count variable was created: each participating nation of each company in a deal (*n* countries per deal) gets, per deal, a score equivalent to 1/*n* so that all country scores add up to the total number of deals.

10 In previous editions of the GII, indicators 5.3.1, 5.3.2, and 5.3.3 were scaled by total services imports.

11 In previous editions of the GII, indicators 6.3.1, 6.3.2, and 6.3.3 were scaled by total services exports.

12 Domestic resident trademarks and the Madrid System trademarks are now counted by number of applications, not by registrations, as was the case in previous editions of the GII.

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