

ADJUSTMENTS TO THE GLOBAL INNOVATION INDEX FRAMEWORK AND YEAR-ON-YEAR COMPARABILITY OF RESULTS

The Global Innovation Index (GII) is a cross-country performance assessment, compiled on an annual basis, which continuously seeks to update and improve the way innovation is measured. The GII report pays special attention to making accessible the statistics used in the Country/Economy Profiles and Data Tables, providing data sources and definitions, and detailing the computation methodology (Appendices I, II, III, and IV, respectively). This annex summarizes the changes made this year and provides an assessment of the impact of these changes on the comparability of rankings.

Adjustments to the Global Innovation Index framework

The GII model is revised every year in a transparent exercise. This year no change was made at either the pillar or the sub-pillar level.

Beyond the use of World Intellectual Property Organization (WIPO) data, we collaborate with both public international bodies such as the International Energy Agency; the United Nations Educational, Scientific and Cultural Organization (UNESCO); the United Nations Industrial Development Organization (UNIDO); the International Telecommunication Union (ITU); and the Joint Research Centre of the European Commission (JRC); as well as with private organizations such as the International Organization for Standardization

(ISO), IHS Global Insight, QS Quacquarelli Symonds Ltd, Bureau van Dijk (BvD), ZookNIC Inc, Wikimedia Foundation, and AppAnnie to obtain the best globally available data on innovation measurement.

Table 1 provides a summary of adjustments to the GII 2018 framework for quick reference. A total of 12 indicators were modified this year: one indicator was removed, one indicator was replaced, and 10 indicators underwent methodological and/or name changes. Indicators that retained the same name as last year but are derived from a source that changed its methodology are not identified in Table 1.

The statistical audit performed by the JRC (see Annex 3) provides a confidence interval for each ranking following a robustness and uncertainty analysis of the modelling assumptions.

Sources of changes in the rankings

The GII compares the performance of national innovation systems across economies, and it also presents changes in economy rankings over time.

Importantly, scores and rankings from one year to the next are not directly comparable (see Annex 2 of the GII 2013 for a full explanation). Making inferences about absolute or relative performance on the basis of year-on-year

Table 1: Changes to the Global Innovation Index framework

GII 2017	Adjustment	GII 2018
1.3.3 Ease of paying taxes	Removed	
2.1.2 Gov't expenditure/pupil, secondary, % GDP/cap	Indicator changed at source	2.1.2 Government funding/pupil, secondary, % GDP/cap
4.2.2 Market capitalization, % GDP	Methodology changed	4.2.2 Market capitalization, % GDP (3 year avg.)
5.1.1 Knowledge-intensive employment, %	Methodology changed	5.1.1 Knowledge-intensive employment, %
5.1.5 Females employed w/advanced degrees, % total	Name changed	5.1.5 Females employed w/advanced degrees, %
5.3.2 High-tech imports less re-imports, % total trade	Name changed	5.3.2 High-tech net imports, % total trade
6.1.2 PCT patent applications/bn PPP\$ GDP	Name changed	6.1.2 PCT patents by origin/bn PPP\$ GDP
6.2.5 High- & medium-high-tech manufactures, %	Methodology changed	6.2.5 High- & medium-high-tech manufactures, %
6.3.2 High-tech exports less re-exports, % total trade	Name changed	6.3.2 High-tech net exports, % total trade.
7.2.3 Global ent. & media market/th pop. 15–69.	Name changed	7.2.3 Entertainment & Media market/th pop. 15–69
7.2.4 Printing & publishing manufactures, %	Name and methodology changed	7.2.4 Printing publications & other media, % manufacturing
7.3.4 Video uploads on YouTube/pop. 15–69	Replaced	7.3.4 Mobile app creation/bn PPP\$ GDP

Note: Refer to Annex 1 and Appendix III for detailed explanations of terminologies and acronyms. Indicators whose name did not change but methodology at the source did are not part of this list. Refer to Appendix III for detailed explanations of methodological changes at the source.

differences in rankings can be misleading. Each ranking reflects the relative positioning of that particular country/economy on the basis of the conceptual framework, the data coverage, and the sample of economies in the given year, also reflecting changes in the underlying indicators at the source and data availability.

A few particular factors influence the year-on-year ranking of a country/economy:

- the actual performance of the economy in question;
- adjustments made to the GII framework;
- data updates, the treatment of outliers, and missing values; and
- the inclusion or exclusion of countries/economies in the sample.

Additionally, the following characteristics complicate the time-series analysis based on simple GII scores or rankings:

- **Missing values.** The GII produces relative index scores, which means that a missing value for one economy affects the index score of other economies. Because the number of missing values decreases every year, this problem is reduced over time.
- **Reference year.** The data underlying the GII do not refer to a single year but to several years, depending on the latest available year for any given variable. In addition, the reference years for different variables are not the same for each economy. The motivation for this approach is that it widens the set of data points for cross-economy comparability.

- **Normalization factor.** Most GII variables are normalized using either GDP or population. This approach is also intended to enable cross-economy comparability. Yet, again, year-on-year changes in individual variables may be driven either by the variable's numerator or by its denominator.
- **Consistent data collection.** Finally, measuring year-on-year performance changes relies on the consistent collection of data over time. Changes in the definition of variables or in the data collection process could create movements in the rankings that are unrelated to true performance.

A detailed economy study based on the GII database and the country/economy profile over time, coupled with analytical work on grounds that include innovation actors and decision makers, yields the best results in terms of grasping an economy's innovation performance over time as well as possible avenues for improvement.

Methodology and data

The revision of the computation methodology for certain individual indicators is detailed below.

Indicator 1.3.3, which measured ease of paying taxes from the World Bank's Ease of Doing Business survey, has undergone several revisions in the past year that caused significant

year-on-year fluctuations and certain criticism from surveyed countries. The indicator is currently under review,¹ hence it was removed from GII 2018 model.

Indicator 2.1.2, which measured government expenditure per pupil at the secondary school level as a percentage of GDP per capita, will no longer be produced by UNESCO and has been replaced by initial government funding per secondary student as a percentage of GDP per capita. The difference between the two is that the new indicator no longer accounts for international transfers. This indicator has been renamed accordingly.

The methodology underpinning indicator 4.2.2 was updated to measure the average of the most recent three years in order to produce a more stable reflection of this indicator.

The names of indicators 5.1.5, 5.3.2, 6.1.2, 6.3.2, and 7.2.3 were changed to be concise and better reflect what these indicators measure. This is a cosmetic change without change to the underlying measurement approach.

For indicator 5.1.1 on knowledge-intensive employment, the methodology was refined to capture a country's labour force engaged in knowledge-related activities more accurately. This indicator now uses only International Standard Classification of Occupations (ISCO)-88 (Legislators, senior officials and managers, Professionals, Technicians and associate professionals) and ISCO-08 (Managers, Professionals, and Technicians and associate professionals). The process now takes data from ISCO-08 when available and from ISCO-88 when not.

The underlying methodology for 6.2.5 has changed; it now captures a wider range of manufactured goods by assuring that when three-digit values for particular product families are absent, it is calculated using the four-digit values composing these product families. For each year, and only the same-year data are used in these calculations.

Indicator 7.2.4 now only measures a country's production of printing and recorded media outputs as classified by the International Standard Classification of All Economic Activities (ISIC Rev. 4 Division 18, group 181 with class 1811 and 1812 and group 182 with class 1820) and no longer captures the paper industry output or publishing activity. It would be desirable to continue capturing the latter creative activity. Yet in current classifications this component has been moved to services

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Table 2: Top 15 GII economies in mobile app creation

Economy	GIJ score	GIJ rank
Cyprus	100.00	1
Finland	66.11	2
Lithuania	63.35	3
Israel	59.41	4
Estonia	52.44	5
Sweden	50.17	6
Denmark	49.65	7
Korea, Republic of	48.88	8
Moldova, Republic of	45.90	10
Hong Kong (China)	44.50	10
Lebanon	44.09	11
Slovenia	42.84	12
Switzerland	41.96	13
United States of America	41.79	14
Serbia	39.48	15

industry classifications (ISIC Rev. 4 Division 58, groups 581 and 582), which most countries—in particular non-OECD countries—do not yet report on.

Indicator 7.3.4 previously measured video uploads on YouTube in a country. Despite its imperfections—for example, diverse uptake of this video portal across countries, lack of clear assessment of what is being uploaded, and so on—this indicator was an important marker within the GII to proxy online user creativity in the last years (see Box 2, Annex 1 of the GII 2012). A new indicator that measures the number of mobile apps created in a country replaced the indicator measuring video uploads this year (see Table 2 for the top 15 economies in this new indicator). These changes target a measurement of the innovative creative outputs produced in a country. Apps represent global commerce in completely digital goods, and therefore provide insight into how innovation, production, and trade of digitized products and services are evolving in an increasingly globalized digital economy.

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Missing values

Since its inception, the GII has had a positive influence on data availability, increasing awareness of the importance of submitting timely data. The number of data points submitted by economies to international data

Table 3: GII economies with the most missing values

Economy	Number of missing values	Economy	Number of missing values
Trinidad and Tobago	26	Kuwait	20
Côte d'Ivoire	23	Jamaica	20
Togo	23	Nepal	20
Guinea	21	Benin	20

Table 4: GII economies with the fewest missing values

Economy	Number of missing values	Economy	Number of missing values
Romania	0	Estonia	3
Mexico	0	Belgium	3
Colombia	0	Spain	3
Czech Republic	1	Slovakia	3
Hungary	1	Croatia	3
Malaysia	1	Costa Rica	3
Poland	1	Serbia	3
Thailand	1	India	3
Russian Federation	1	South Africa	3
Chile	1	Kazakhstan	3
Turkey	1	Indonesia	3
Korea, Republic of	2	Switzerland	4
France	2	Netherlands	4
Austria	2	Luxembourg	4
Slovenia	2	Australia	4
Italy	2	Malta	4
Portugal	2	Cyprus	4
Bulgaria	2	Latvia	4
Ukraine	2	Lithuania	4
Brazil	2	Morocco	4
Sweden	3	Argentina	4
United Kingdom	3	Ireland	5
Finland	3	Greece	5
Denmark	3	Moldova, Republic of	5
Germany	3	Tunisia	5
Israel	3	Panama	5
Japan	3	Philippines	5
Norway	3	Egypt	5
New Zealand	3		

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agencies has substantially increased in recent years. In the GII 2018, coverage remains at a level similar to last year's, with 10.3% of data points missing.

When it comes to country coverage, the objective is to include as many economies as possible. However, it is also important to maintain a good level of data coverage within each of these economies. Because the GII results are linked to data availability (see the JRC Statistical Audit presented in Annex 3 for more details), which affects the overall GII ranks, in 2016 and 2017 the threshold rule for countries with missing data and the minimum coverage necessary per sub-pillar were progressively tightened. To be included in the GII 2018, an economy must have a minimum symmetric data coverage of 35 indicators in the Innovation Input Sub-Index (66%) and 18 indicators in the Innovation Output Sub-Index (66%), and it must have scores for at least two sub-pillars per pillar. Missing values are indicated with 'n/a' and are not considered in the sub-pillar score. This has led to the exclusion of countries that fail to meet the desired minimum coverage for indicators in any sub-pillar (see Appendix I for more details).

This adjustment derives from a sensitivity that is the result of the data availability, which is less satisfactory in the case of the Output Sub-Index: two countries that were part of the GII 2017 have data coverage below the 66% threshold in the 27 variables in the Output Sub-Index. In contrast, data coverage is satisfactory in all of these cases in the Input Sub-Index (all of these economies have indicator coverage of more than 66% over the 53 input variables). As a result, Burundi and Ethiopia, which were included in the GII 2017, dropped out this year.²

Despite requiring minimum levels of coverage, for several economies the number of missing data points remains very high. Table 3 lists the countries that have the highest number of missing data points (20 or more), ranking them according to how many data points are missing.

Conversely, Table 4 lists those economies with the best data coverage, ranking them according to the least number of missed data points. These economies are missing at most only five data points; some are missing none at all.

Notes

- 1 See <http://www.worldbank.org/en/news/statement/2018/01/13/world-bank-group-statement-on-doing-business-index> for the World Bank Group's Statement on the Doing Business Index, issued on 13 January 2018.
- 2 Conversely, Ghana—which was not included in the GII 2017—enters the GII this year with the required coverage in both sub-indices and sufficient data availability per pillar.