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The Innovation Output Indicator 2021

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Contents

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Abstract

This report presents the 2021 update of the Innovation Output Indicator (IOI), which is a composite indicator periodically published by the European Commission since 2013 aiming to quantify the extent to which ideas for new products and services carry an economic added value and are capable of reaching the market.

The report presents the latest figures for the composite index and its underlying indicators for 40 countries, including European Union (EU) Member States (MSs) and selected EFTA, OECD and emerging economies. The four components of the IOI provide a benchmark for countries and the European Union as an aggregate in terms of patent-based technological innovation, skilled labour force feeding into the economic structure of a country, competitiveness of knowledge-intensive goods and services, and employment in fast-growing enterprises in innovative sectors. The methodology is unchanged with respect to the refinements introduced in the 2017 edition and adopted in the 2019 version.

Results show that the overall IOI international ranking remained broadly unchanged since 2011. The EU continues to be outperformed by Israel, Japan, the UK and the US, but there is some evidence of convergence, as the gap between the leader (Israel) and some top-performers countries (Japan, the UK and the EU) has somewhat declined since 2011. As compared to 2019, EU performance in innovation output remained broadly unchanged. Within EU MSs, Ireland, Finland, and Sweden are the top-performers in terms of innovation output, and Croatia, Lithuania and Romania those with the lowest IOI. As compared to 2019, the largest relative increases in IOI scores are observed in Greece, Lithuania and Malta, and the strongest relative falls in Romania, Slovakia and Sweden.

The analysis also documents the importance of benchmarking a country's performance not only according to its composite scores, but also according to the various components. Most notably, the multivariate analysis on the relationship between the component indicators shows that the component measuring employment in fast-growing enterprises in innovative sectors (DYN) has a weak, positive association with the rest of the components and, as a consequence, with the IOI aggregate index. This may suggest that innovation performance of countries is constituted by two rather distinct underlying dimensions: one referring to the performance of the technology- and knowledge-based economy and the second one concerning entrepreneurship and business dynamism in innovative sectors. Strong performance in one of these two dimensions does not automatically imply strong performance in the other, suggesting that innovation policy should carefully monitor and foster the development of both in their own merits.

1. Introduction

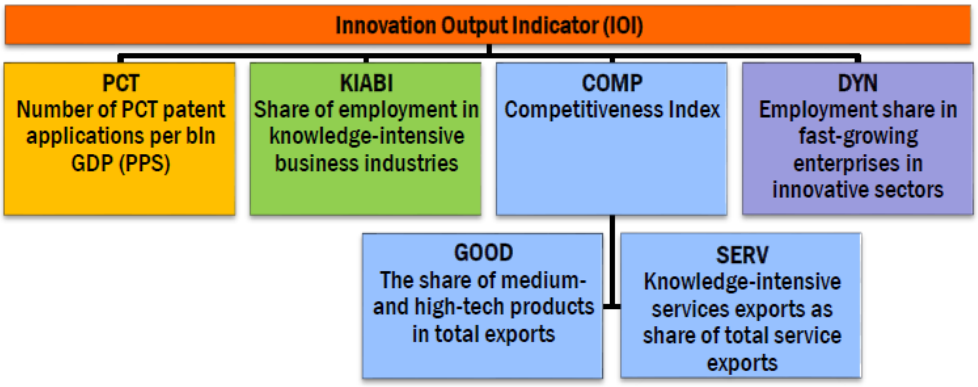
This report illustrates the 2021 update of the European Commission's Innovation Output Indicator (IOI) by reporting on country performance in the overall index and presenting the most recent data for each of its components.

The indicator aims to support policy-makers by offering an output-oriented measure of innovation performance at the country and EU levels, which is directed at capturing countries' capacity to derive economic benefits from innovation and the dynamism of innovative entrepreneurial activities. It complements other benchmarking tools, such as the R&D spending targets and the European Innovation Scoreboard[1].

The IOI was introduced in the 2013 Communication and Staff Working Document (European Commission, 2013) and refined in 2014, 2016 and 2017 Methodology Reports[2]. The Commission is currently in the process of further revising and updating the methodological development of the index to improve its statistical properties, capture the latest developments in countries' economic systems and innovation processes and align it with the new priorities set by the organisation. The next edition of the IOI will be based on the updated methodology, which will be described in detail in the related technical report.

In line with the previous versions of the index, the 2021 edition of the IOI includes four components, which are depicted in **Figure 1** and are presented in more detail in the next section.

Figure 1 The Innovation Output Indicator framework



The first component, referred to as 'PCT', is given by the number of patent applications per billion GDP falling under the legal framework of the Patent Cooperation Treaty (PCT). It proxies technological innovation by patent applications and accounts for the ability of the economy to transform knowledge into marketable technology[3].

The second component, 'KIABI', measures the number of persons employed in knowledge-intensive business industries within total employment. It aims to capture the structural orientation of the business economy towards knowledge-intensive activities.

Thirdly, the 'COMP' component aims to capture the competitiveness of knowledge-intensive goods and services in the export markets[4]. This is a fundamental dimension of a well-functioning economy, given the close link between growth, innovation and internationalization. Competitiveness-enhancing measures and

[1] The European Innovation Scoreboard aims to the latter providing a comparative analysis of innovation performance in EU countries, other European countries, and regional neighbours based on the relative strengths and weaknesses of national innovation systems. Further information is available here: https://ec.europa.eu/info/research-and-innovation/statistics/performance-indicators/european-innovation-scoreboard_en

[2] See Vertesy and Tarantola, 2014; Vertesy and Deiss, 2016; Vertesy, 2017.

[3] Patent indicators are known to have drawbacks when it comes to measuring technological innovation. On the one hand, many patented inventions will not become innovations due to practices of strategic patenting. On the other hand, patents are sector-specific (and even within manufacturing industries where patenting is more pervasive, firms may have alternative ways for protecting intellectual property, i.e. through secrecy or lead-time); see Griliches, 1990, 1998; Pavitt, 1985. At the same time, patents were found to be reliable proxies for knowledge production and innovation (Acs et al., 2002; Hall et al., 1986). Furthermore, while the number of granted patents may be a more accurate measure of marketable innovations, this suffers even more from timeliness issues than applications data, nevertheless, the two correlate highly at the country level. PCT applications are used as a good compromise between allowing a global comparison and relatively more timely (although with at least 2 years lag) data.

[4] We note that the measurement of competitiveness has a long literature offering many alternative ways of measurement, including unit labour costs, price, market share, etc. for a recent discussion of potential alternatives, see i.e. Castellani and Koch (2015).

innovation strategies can be mutually reinforcing for the growth of employment, export shares and turnover at the firm level. This component is built by integrating in equal weights the share of high-tech and medium-tech product exports to the total product exports (GOOD) and knowledge-intensive service exports as a share of the total services exports of a country (SERV). It reflects the ability of an economy, notably resulting from innovation, to export goods and services with high levels of value added, and successfully take part in knowledge-intensive global value chains.

Finally, the last component, referred to as 'DYN', measures the employment dynamism in fast-growing[5] enterprises in innovative sectors. It compares countries in terms of employment share in sectors that scored above average in terms of innovation. The component reflects the innovativeness of successful entrepreneurial activities. The specific target of fostering the development of high-growth enterprises in innovative sectors is an integral part of modern R&D and innovation policies.

Most data in this report refers to 2020, which implies that the initial impact of the Covid-19 pandemic is only partly captured and mainly for those countries that have been firstly affected. The implications of the pandemic for country innovation performance will be more visible in future editions of this report when all components will cover data from 2021 and onwards.

The report is structured as follows. The next section defines and presents the scores for each component, after reviewing the conceptual and empirical choices used to define and compute them. Following the JRC-OECD (2008) ten-step methodology for the development of composite indicators, Section 3 provides descriptive statistics of the entire dataset and discusses their statistical relationship, as well as methods applied to compute the aggregate measures. Section 4 discusses country performance in terms of the composite score, both when comparing EU Member States with one another and when comparing the EU as a whole with other benchmark countries. Section 5 assesses the robustness and sensitivity of the IOI to the methodological choices.

[5] High-growth is defined by annual average employment growth of 10% over three years.

2. Definition and update of components

This section presents the definition of each component and illustrates country performance over the last ten years. Data were collected between August 2021 and November 2021. As the most recent data for most components refer to 2020, the overall index refers to country performance in 2020. In this section, we indicate the components for which older data is used alongside the year lags with respect to 2020.

In line with the previous editions of the index, figures are provided for 40 countries including European Union Member States and selected EFTA, OECD and emerging economies, namely Brazil, Israel, Japan, United Kingdom, United States and New Zealand. The aggregate performance of the European Union (labelled as "EU27_2020" in the tables and charts) is also illustrated.

2.1 PCT: PCT Patent applications per billion GDP (PPS)

The purpose of the PCT component is to measure the ability of the economy to transform knowledge into marketable innovations. The focus on patents filed under the Patent Cooperation Treaty (PCT)[6] allows identifying the inventions that the applicant organization expects to bring a higher market impact. The PCT component of the IOI is identical to indicator 3.3.1 of the 2021 European Innovation Scoreboard and counts the number of PCT patent applications per billion GDP (PPS). The numerator is defined as the number of patent applications filed in the international phase, i.e. at the European Patent Office (EPO). Patent counts are based on the priority date, the inventor's country of residence and fractional counts to account for patents with multiple attributions. The denominator is the GDP in purchasing power standards. Due to the two-stage procedure in the PCT application process (see footnote 6), there may be a lag of almost 2.5 years between the priority date and the date when PCT applications enter the national or regional phase (where the actual decision is made about approval or rejection of a patent), posing a considerable constraint to timeliness (OECD, 2009). A summary of the key parameters of this component is provided in **Table 1**.

Table 1 Key parameters of the PCT component

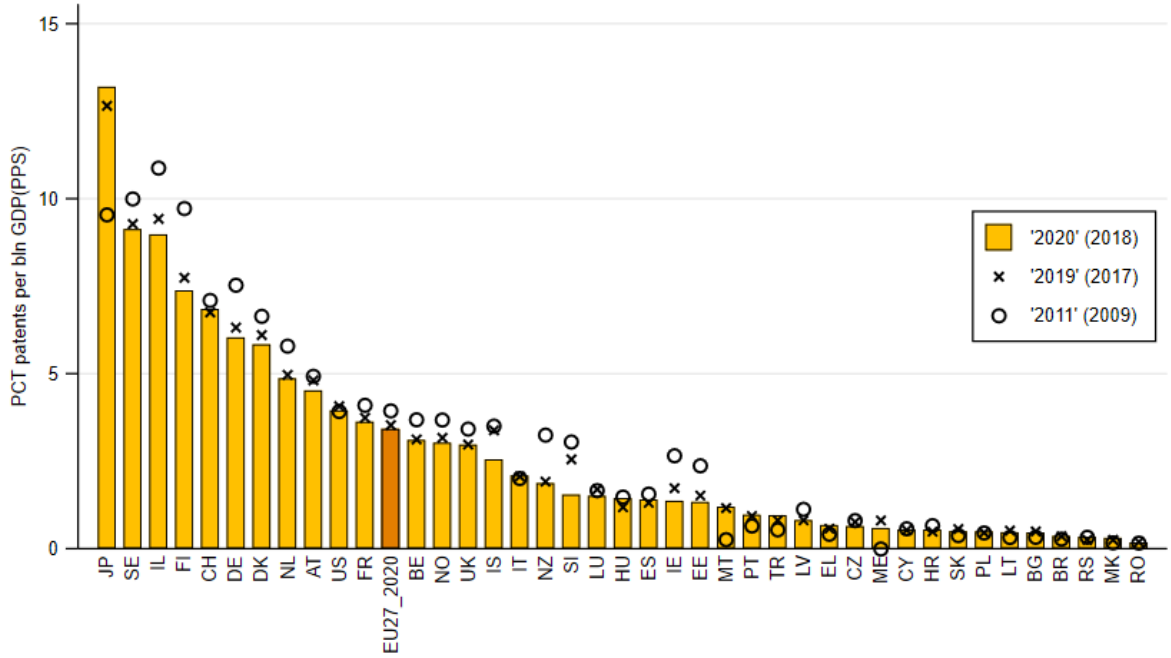
	Numerator	Denominator
Definition	Number of PCT patent applications	GDP PPS
Source	OECD MSTI if available OECD PATSTAT otherwise. OECD REGPAT Microdata used to compute missing countries (incl. RS, ME)	Eurostat nama_10_gdp (CP_MPPS), naida_10_gdp + OECD PPP, ESA2010
Notes	Indicator is flagged unreliable if PCT count is less than 10 per year.	Release: t+9 month
Most recent year used [Nr. Years lag vs. 2020]	2018 [2]	
Corresponding EIS indicator	3.3.1 PCT patent applications per billion GDP (in PPS €)	

Country performance in PCT in 2011, 2019 and 2020 is shown in **Figure 2**. Japan stands out as the global leader, whereas the top-performing EU Member States are Sweden, Finland and Germany. In the period considered, the EU value has slightly decreased mainly due to an increase of GDP which was stronger than the increase in the number of patent applications. A large decrease was recorded in a number of Member

[6] PCT is an international patent law treaty concluded in 1970, unifying procedures for filing patent applications. An application filed under PCT is called an "international application". An international patent is subject to two phases. The first one is the "international phase" (protection pends under a single application filed with the patent office of a contracting state of the PCT). The second one is the "national and regional phase" in which rights are continued by filing documents with the patent offices of the various PCT states.

States including Sweden, Finland, Germany, Slovenia, Ireland and Estonia, which was partly compensated by an increase in Malta, Portugal and Greece.

Figure 2 PCT applications per billion GDP (in PPS)



Source: See Table 1. *Notes:* Years in quotation marks indicate 2-year shift relative to patent priority years (i.e., '2020' refers to data from 2018).

Table 2 PCT: PCT Applications per billion GDP (PPS)

Time Point (Actual year)	'2011' (2009)	'2013' (2011)	'2015' (2013)	'2017' (2015)	'2018' (2016)	'2019' (2017)	'2020' (2018)
JP	9.5	12.0	11.4	11.0	12.2	12.7	13.2
SE	10.0	8.9	9.3	8.9	9.5	9.3	9.1
IL	10.9	10.1	10.0	10.5	9.8	9.4	9.0
FI	9.7	9.3	9.1	7.4	7.7	7.8	7.4
CH	7.1	7.2	6.6	6.3	6.5	6.8	6.9
DE	7.5	7.2	6.6	6.2	6.3	6.3	6.0
DK	6.6	6.7	6.3	6.0	6.1	6.1	5.8
NL	5.8	6.0	5.8	5.8	5.5	5.0	4.9
AT	4.9	5.1	5.0	4.8	4.7	4.8	4.5
US	3.9	4.2	4.9	4.1	4.2	4.1	4.0
FR	4.1	4.2	4.2	4.0	3.7	3.8	3.6
EU27_2020	3.9	4.0	3.8	3.6	3.6	3.5	3.4
BE	3.7	3.7	3.5	3.1	3.5	3.1	3.1
NO	3.7	3.0	3.0	2.8	3.6	3.2	3.0
UK	3.4	3.3	3.4	3.0	3.0	3.0	3.0
IS	3.5	3.3	3.3	3.2	2.4	3.4	2.6
IT	2.0	2.0	2.2	2.2	2.1	2.1	2.1
NZ	3.3	3.1	3.1	2.5	2.1	1.9	1.9
SI	3.1	3.0	3.4	1.7	1.9	2.6	1.5
LU	1.7	1.9	1.6	1.7	2.0	1.7	1.5
HU	1.5	1.5	1.4	1.4	1.3	1.2	1.4
ES	1.6	1.6	1.6	1.5	1.4	1.3	1.4
IE	2.7	2.7	2.5	1.8	2.0	1.7	1.4
EE	2.4	1.6	1.2	0.9	1.3	1.5	1.3
MT	0.3	0.2	0.9	1.0	1.6	1.2	1.2
PT	0.7	0.7	0.8	1.0	0.9	0.9	1.0
TR	0.5	0.5	0.6	0.7	0.8	0.8	1.0
LV	1.1	0.8	1.0	0.8	0.6	0.8	0.8
EL	0.4	0.4	0.6	0.5	0.6	0.6	0.7
CZ	0.8	0.8	1.1	1.0	0.8	0.8	0.6
ME	0.0	0.0	0.4	0.4	0.2	0.8	0.6
CY	0.6	0.5	0.7	0.5	0.5	0.5	0.6
HR	0.7	0.6	0.6	0.4	0.7	0.5	0.5
SK	0.4	0.5	0.6	0.5	0.7	0.6	0.5
PL	0.5	0.4	0.6	0.7	0.5	0.5	0.5
LT	0.3	0.4	0.8	0.4	0.6	0.5	0.5
BG	0.3	0.5	0.5	0.6	0.5	0.5	0.5
BR	0.3	0.3	0.3	0.3	0.4	0.4	0.4
RS	0.3	0.2	0.3	0.4	0.4	0.3	0.3
MK	0.2	0.1	0.3	0.1	0.0	0.3	0.3
RO	0.2	0.2	0.3	0.2	0.2	0.2	0.2

Source: see Table 1. *Notes:* Actual figures are lagged by 2 years (thus, 2020 refers to 2018). Figures for all years are provided in Table A3 in the Annex.

2.2 KIABI: Share of employment in knowledge-intensive business industries

The KIABI component aims at capturing the structural orientation of the business economy towards knowledge-intensive activities. It is identical to indicator 4.1.1 of the European Innovation Scoreboard and measures the number of employed persons in knowledge-intensive activities (KIA) in business industries as a percentage of total employment. Knowledge-intensive activities provide products and services directly to consumers, such as telecommunications, and provide inputs to the innovative activities of other firms in all sectors of the economy. The KIABI component is calculated from EU Labour Force Survey data, as the share of employment in those NACE Rev.2 industries at 2-digit level with at least 33% of employment having a tertiary degree. Figures for Japan, the US and the UK were derived using the KIABI classification provided by Eurostat and the latest data published on the respective websites[7]. For a summary of key parameters, see **Table 3**.

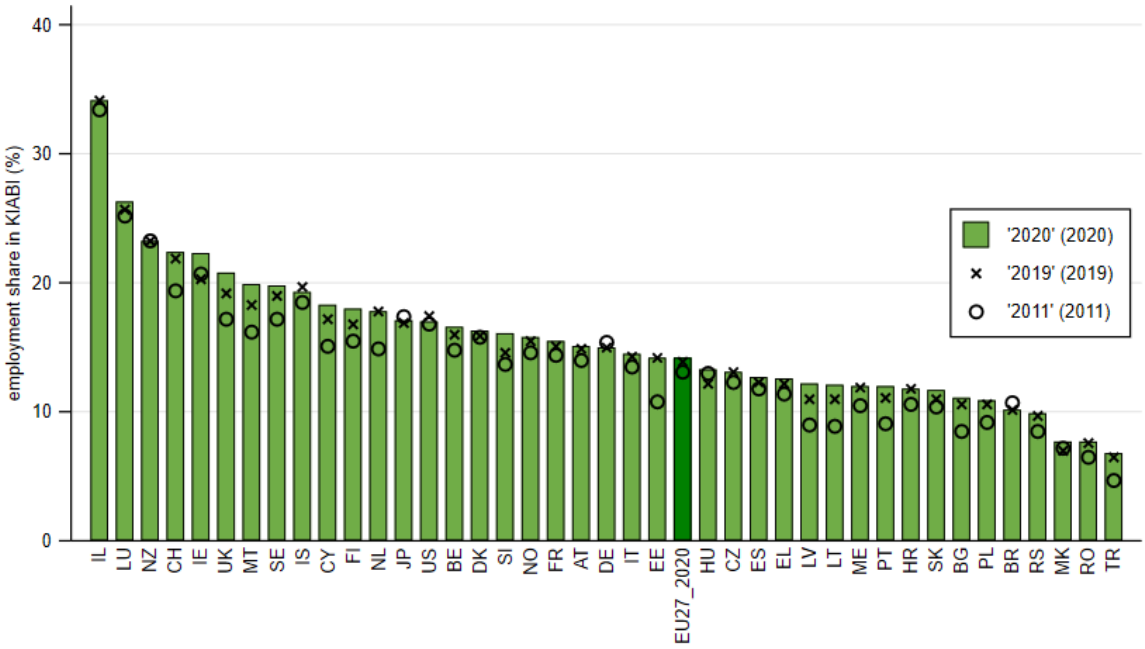
Table 3 Key parameters of the KIABI component

	Numerator	**Denominator**
Definition	Employment in knowledge-intensive business industries	Total employment
Sources	Eurostat, htec_kia_emp2; Japan Statistical Office, LFS; US BLS CPB; UK BRES, OECD, SSIS_BSC_ISIC4	
Notes	US, JP: data reporting discontinued on Eurostat website; figures were re-computed using national sources, following methodology described by Eurostat htec_esms. UK: data not available for 2020, figures were re-computed using national source for 2020, following methodology described by Eurostat htec_esms.	
Most recent year used [Nr. year lag vs 2020]	2020 [0]	
Corresponding EIS indicator	4.1.1 Employment in knowledge-intensive activities as percentage of total employment	

The most recent country performance in KIABI and its recent evolution across time are shown in **Figure 3**. Among the top performing countries, three are non-EU members, namely Israel, New Zealand and Switzerland, whereas Luxemburg and Ireland are the top performers in the EU. Overall, this result points to the importance of knowledge-intensive sectors for these economies. The EU aggregate showed a small improvement since 2011, with an increase in Cyprus, Estonia, Latvia, Lithuania, Portugal, Malta, and the Netherlands. Outside the EU, Turkey and the UK reported the largest increase with respect to 2011, while Japan, Brazil and Germany are the few countries showing a slight decreasing trend. Compared to 2019, the largest (positive) change was recorded for the UK, Ireland, Slovenia and Malta, while only Iceland and the United States showed a decrease. Given the structural nature of the indicator, the effect of Covid pandemic may not yet be captured by this indicator.

[7] For JP, data was obtained from Labour Force Survey Basic Tabulation Whole Japan Yearly, Table 2-2-1 "Employed person by age groups and industry (Since 2007) - With the 12th and 13th revision of the Japan Standard Industrial Classification" (URL: www.e-stat.go.jp, accessed: Aug 2019). For the US, data was obtained from the Bureau of Labor Statistics, Current Population Survey, Table 18b "Employed persons by detailed industry and age", multiple years (https://www.bls.gov/cps/tables.htm, accessed: Aug 2019). Sectoral aggregation follows the classification by Eurostat (htec_esms_an8 - Eurostat indicators on High-tech industry and Knowledge – intensive services Annex 8 – Knowledge Intensive Activities by NACE Rev. 2) Note that Industries are not mapping 1:1 to NACE sectors, which has an impact on the validity of comparison across countries. For the UK, data come from Eurostat, with the exception of 2020 figures for which the UK Office for National Source data source is used. More specifically, data were obtained from Business Register and Employment Survey (BRES), Table 2b "UK level of employment (thousands) by 2 and 3 digit SIC 2007 (full-time/part-time and public/private sector split)" (URL: https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/datasets/industry235digitsicbusinessregisterandemploymentsurveybrestable2. Accessed: Nov 2021).

Figure 3 Share of employment in knowledge-intensive activities in business industries (in %)



Source: See Table 3. *Notes:* Years in quotation marks are identical to actual year of data.

Table 4 KIABI: Share of employment in knowledge-intensive activities in business industries (%)

Time Point (Actual year)	'2011' (2011)	'2013' (2013)	'2015' (2015)	'2017' (2017)	'2018' (2018)	'2019' (2019)	'2020' (2020)
IL	33.4	33.0	33.2	33.6	34.1	34.1	34.1
LU	25.2	26.2	22.9	22.0	24.5	25.7	26.3
NZ	23.3	23.5	23.3	23.3	23.3	23.3	23.3
CH	19.4	20.2	20.7	21.4	21.7	21.9	22.4
IE	20.7	21.3	21.5	20.8	20.2	20.3	22.3
UK	17.2	17.8	18.3	18.4	18.8	19.2	20.8
MT	16.2	17.2	19.3	19.0	18.6	18.3	19.9
SE	17.2	17.7	18.2	18.5	18.8	19.0	19.8
IS	18.5	17.2	18.6	19.3	20.0	19.7	19.3
CY	15.1	17.2	16.2	17.0	17.7	17.2	18.3
FI	15.5	15.7	16.1	16.2	16.4	16.8	18.0
NL	14.9	17.1	17.4	17.1	17.7	17.8	17.8
JP	17.4	16.1	16.0	16.3	16.4	16.9	17.1
US	16.8	17.2	17.0	17.3	17.3	17.4	17.0
BE	14.8	15.3	15.5	15.6	15.7	16.0	16.6
DK	15.8	15.4	15.9	15.2	15.4	15.9	16.3
SI	13.7	14.0	14.1	13.7	13.9	14.6	16.1
NO	14.6	15.9	15.8	15.4	15.8	15.5	15.8
FR	14.4	14.0	14.3	14.5	14.7	15.1	15.5
AT	14.0	14.6	14.5	15.0	15.0	14.9	15.1
DE	15.4	14.7	14.6	14.8	14.8	15.0	15.0
IT	13.5	13.5	13.7	13.7	14.0	14.3	14.5
EU27_2020	13.1	13.2	13.4	13.6	13.7	13.9	14.2
EE	10.8	11.9	12.4	13.5	14.1	14.2	14.2
HU	13.0	12.9	12.0	11.6	11.8	12.2	13.3
CZ	12.3	13.0	12.4	12.9	13.2	13.1	13.1
ES	11.8	12.4	12.4	12.5	12.2	12.3	12.7
EL	11.4	12.5	12.0	12.1	12.1	12.2	12.6
LV	9.0	10.8	11.2	12.1	11.1	11.0	12.2
LT	8.9	9.0	9.3	9.7	10.4	11.0	12.1
PT	9.1	9.4	10.7	10.6	10.9	11.1	12.0
ME	10.5	11.0	11.7	11.2	10.8	11.9	12.0
HR	10.6	10.6	11.0	11.6	12.5	11.8	11.8
SK	10.4	9.6	9.6	10.6	10.2	11.0	11.7
BG	8.5	9.0	10.1	10.2	10.2	10.6	11.1
PL	9.2	9.6	10.0	10.3	10.4	10.6	10.9
BR	10.7	10.7	10.2	10.2	10.2	10.2	10.2
RS	8.5	8.7	9.3	9.4	9.7	9.7	9.9
RO	6.5	6.6	7.0	7.7	7.7	7.6	7.7
MK	7.2	6.2	6.3	6.3	6.3	7.0	7.7
TR	4.7	5.3	6.2	6.7	6.3	6.5	6.8

Source: see Table 3. *Note:* Figures for all years are provided in Table A4 in the Annex.

2.3 The COMP Component

Increasing competitiveness is an intended consequence of innovative activities. The COMP component aims to capture international competitiveness in knowledge-intensive sectors and is defined as the arithmetic average (with equal weights) of two indicators: GOOD and SERV. GOOD measures the share of high-tech and medium-tech products in a country's exports and is identical to indicator 4.2.1 of the European Innovation Scoreboard. SERV, equally identical to indicator 4.2.2 of the European Innovation Scoreboard, measures the share of knowledge-intensive services exports to the total services exports of a country.

2.3.1 GOOD: The share of medium- and high-tech products in total export

As highlighted in the European Innovation Scoreboard, this indicator measures the technological competitiveness of countries, in other words, their ability to commercialize the results of research and development (R&D) and innovation in international markets. It also reflects product specialization. Creating, exploiting, and commercializing new technologies is vital for the competitiveness of a country. Medium- and high-technology products are positively associated with economic growth, productivity and welfare, as well as with high value-added and well-paid employment (e.g. Hausmann et al 2007, Yoo 2008, Falk 2009).

The numerator of GOOD is the total value of exports in the following Standard International Trade Classification (SITC) Rev.4 classes: 266, 267, 512, 513, 525, 533, 54, 553, 554, 562, 57, 58, 591, 593, 597, 598, 629, 653, 671, 672, 679, 71, 72, 731, 733, 737, 74, 751, 752, 759, 76, 77, 78, 79, 812, 87, 88 and 891 (see Table A1 in the Annex for a description of product classes). The denominator is the total value of product exports. The Eurostat COMEXT database was used as a data source for EU Member States and EFTA countries, whereas data for all other countries (i.e., OECD and BRIC countries) was obtained from the UN Comtrade, as described in **Table 5**.

For the EU, two different GOOD scores, namely 'EU27_2020x' and 'EU27_2020', were computed. The former is used to compare the EU as a whole with other non-EU countries (e.g., the US or Japan). It is derived by considering exclusively extra-EU trade, so that the EU, just like its partners, is treated as a single entity[8]. By contrast, the 'EU27_2020' score is used to compare the EU average performance against that of the Member States and is based on both intra- and extra-EU trade (or dispatches).

Table 5: Key parameters of the GOOD component

	Numerator	**Denominator**
Definition	Total value of exports of a country in Standard International Trade Classification (SITC) Rev.4 classes: 266, 267, 512, 513, 525, 533, 54, 553, 554, 562, 57, 58, 591, 593, 597, 598, 629, 653, 671, 672, 679, 71, 72, 731, 733, 737, 74, 751, 752, 759, 76, 77, 78, 79, 812, 87, 88 and 891	Total value of exports
Source	EU Member States: Eurostat, Comext 'DS-018995'; EFTA countries and others (including UK): UN Comtrade	
Most recent year used [Nr. Years lag vs. 2020]	2020 [0]	
Corresponding EIS indicator	4.2.1 Exports of medium and high technology products as a share of total product exports	

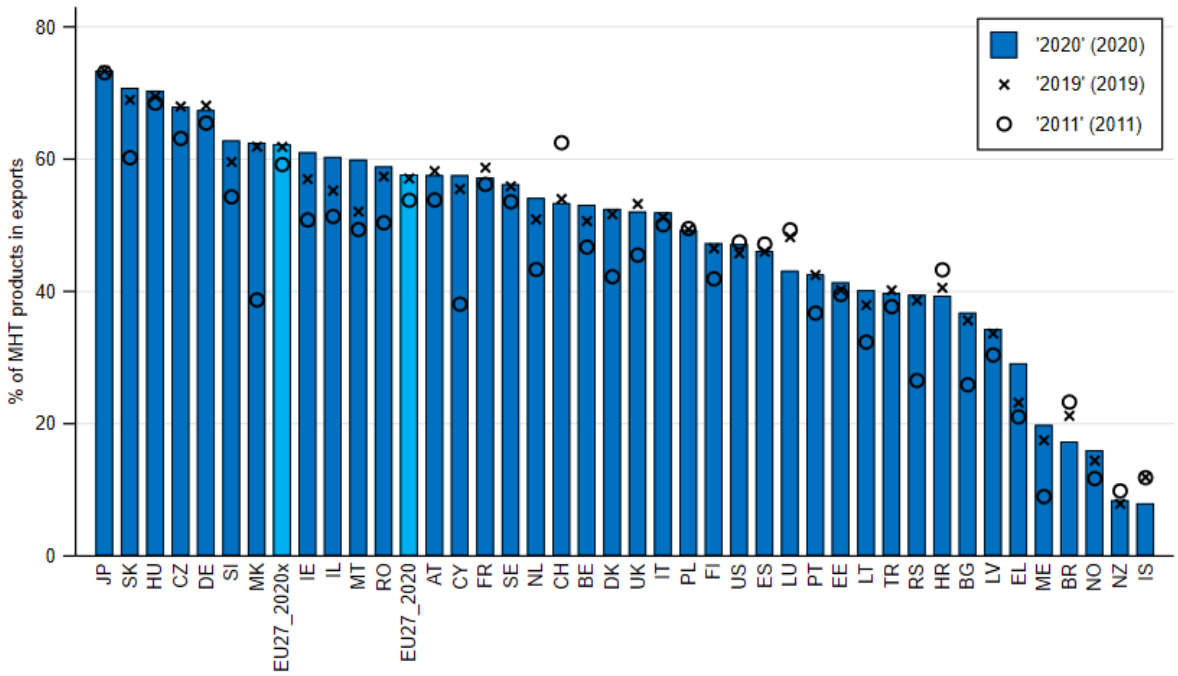
Note: See Table A1.1 for a description of the SITC codes.

[8] Likewise, interstate trade, for instance, is not considered in the computation of the US figures.

The most recent country performance in GOOD and its recent evolution across time are shown in **Figure 4**. The top performing country is Japan, followed by EU Member States Slovakia, Hungary, Czech Republic and Germany. The EU considered as a unique country (i.e. disregarding intra-EU trade) comes right after these countries, and before the US. The better performance of the EU when trade between MSs is excluded as compared to the case in which the latter is included reveals the greater share of medium- and high-tech products that are exported to extra-EU countries in the total EU exports. Among the EU medium- and high-tech products, radioactive and associated materials, arms and ammunition, and metalworking machinery and parts are those for which the share of extra-EU over total EU exports is the highest. These results should be taken with caution. Being this indicator based on gross trade figures and a product classification, it fails to differentiate between the exported medium- and high-tech products that entail the contribution of domestic technology capacity and those that are the results of mere imported components assembling.

Differently from the other components, changes across time are quite marked in both GOOD and SERV, most probably due to a higher exposure of exports to both local and global shocks. Compared to 2019, the largest decrease in GOOD was recorded in Brazil, Iceland and Luxembourg, whereas Malta, Israel and Greece reported the largest increase. While for the smaller countries these marked changes can be due to the sensitivity of the indicator to the country size, these results may as well partly point to an impact of the Covid-19 crisis resulting in a reduction of countries' exports and/or in compositional changes in their trade basket. The EU experienced a quite marked increase in GOOD, compared to 2011, due to rises in most countries. Particularly marked were the increases in Bulgaria, Cyprus, Denmark, Lithuania, The Netherlands, and Romania, which compensated a decline in Luxembourg and Iceland. Outside the EU, Brazil, Switzerland and New Zealand experienced the strongest decline.

Figure 4 The share of medium- and high-tech products in total exports (in %)



Source: see Table 5. *Notes:* The EU27_2020 aggregate is represented by two values: 'EU27_2020' refers to intra- plus extra-EU trade; 'EU27_2020x' refers to Extra-EU trade only. For all EU member states, both intra- and extra-EU trade are included. Years in quotation marks indicate actual year of data.

Table 6 GOOD: The share of medium- and high-tech products in total exports (in %)

Time Point (Actual year)	'2011' (2011)	'2013' (2013)	'2015' (2015)	'2017' (2017)	'2018' (2018)	'2019' (2019)	'2020' (2020)
JP	73.1	72.6	73.2	73.4	73.5	73.4	73.4
SK	60.3	63.6	66.6	67.2	67.8	69.0	70.8
HU	68.5	66.3	69.6	68.5	67.4	69.5	70.4
CZ	63.2	62.5	64.1	65.8	67.1	68.0	68.0
DE	65.5	66.2	67.6	68.6	68.5	68.1	67.4
SI	54.4	54.6	56.0	57.1	57.3	59.6	62.8
MK	38.8	45.6	56.0	57.4	60.6	61.9	62.5
EU27_2020x	59.2	59.1	61.5	61.7	61.5	61.9	62.3
IE	50.9	48.1	52.6	56.3	56.3	57.0	61.1
IL	51.4	52.3	54.9	57.3	56.8	55.3	60.4
MT	49.4	55.4	57.7	55.7	52.2	52.1	60.0
RO	50.4	50.7	52.8	55.8	57.2	57.4	58.9
EU27_2020	53.8	53.6	56.3	56.7	56.6	57.1	57.7
AT	53.9	56.6	57.6	58.0	57.4	58.3	57.6
CY	38.1	43.2	67.9	54.8	59.5	55.6	57.6
FR	56.2	57.2	58.6	58.6	58.3	58.8	57.3
SE	53.6	52.4	54.7	54.5	54.4	55.9	56.2
NL	43.4	42.1	48.6	49.7	49.9	50.9	54.2
CH	62.5	41.3	49.7	51.6	52.7	54.0	53.4
BE	46.8	45.9	48.3	48.0	48.0	50.7	53.1
DK	42.3	43.5	47.8	47.9	48.8	51.7	52.5
UK	45.6	43.5	53.3	56.3	52.3	53.3	52.1
IT	50.1	50.4	52.1	52.4	52.3	51.3	52.0
PL	49.6	48.7	49.4	48.8	48.6	49.4	49.3
FI	42.0	38.7	44.6	44.8	44.1	46.6	47.3
US	47.5	46.9	49.2	47.2	45.3	45.8	47.2
ES	47.2	46.0	47.8	46.8	45.8	46.0	46.1
LU	49.4	49.4	52.5	45.4	43.9	48.3	43.1
PT	36.8	35.2	36.8	38.5	40.1	42.5	42.6
EE	39.6	42.8	42.7	41.6	39.3	40.3	41.4
LT	32.4	31.1	34.5	36.9	36.8	38.0	40.2
TR	37.7	36.7	36.3	39.3	40.3	40.2	39.8
RS	26.6	41.1	39.1	38.6	38.4	38.7	39.5
HR	43.3	37.6	38.0	39.9	39.1	40.6	39.4
BG	25.9	26.8	31.0	33.0	34.7	35.7	36.8
LV	30.4	30.3	34.2	35.1	36.0	33.7	34.3
EL	21.1	18.0	22.5	21.2	21.4	23.2	29.1
ME	9.0	10.3	14.7	16.3	16.7	17.5	19.8
BR	23.3	25.7	24.9	25.1	25.1	21.3	17.3
NO	11.8	12.4	16.6	14.2	14.2	14.5	16.0
NZ	9.9	9.2	9.9	8.4	8.4	7.9	8.5
IS	11.9	10.0	9.6	10.3	8.7	12.0	8.0

Source: See Table 5. *Note:* Figures for all years are provided in Table A5 in the Annex.

2.3.2 SERV: Knowledge-intensive services exports as share of total service export

SERV is the second component of COMP and measures the share of knowledge-intensive services (KIS) in total services exports. It aims to capture the competitiveness of the services sector. The indicator reflects the ability of an economy to export services with high levels of value added and successfully take part in knowledge-intensive global value chains. As described in **Table 7**, SERV is defined as the sum of credits in Extended Balance of Payments Services (EBOPS) 2010 Classification items SC1, SC2, SC3A, SF, SG, SH, SI, SJ and SK1. The denominator is the total value of services exports (S).

Eurostat and the OECD are the most common sources of Balance of Payments (BPM) statistics. However, as data is missing for several EBOPS services in both the Eurostat and OECD databases for some or all years due to confidentiality or other reasons, we referred to estimates reported by the International Trade Centre (ITC) to avoid underestimating SERV in those cases. This data originates from the IMF or is directly estimated by the ITC. In cases where data were missing for a certain year, following the practice of the European Innovation Scoreboards, figures were taken from the nearest available year.

As in the case of GOOD, two different SERV scores were computed for the EU27 aggregate to accommodate both the EU-wide and global comparisons, labelled as 'EU27_2020x' and 'EU27_2020' scores. The former is adopted to compare EU figures with those of non-EU countries and is based on extra-EU service exports. The latter is used in the EU-wide comparison and includes both intra- and extra-EU service exports.

Table 7 Key parameters of the SERV component

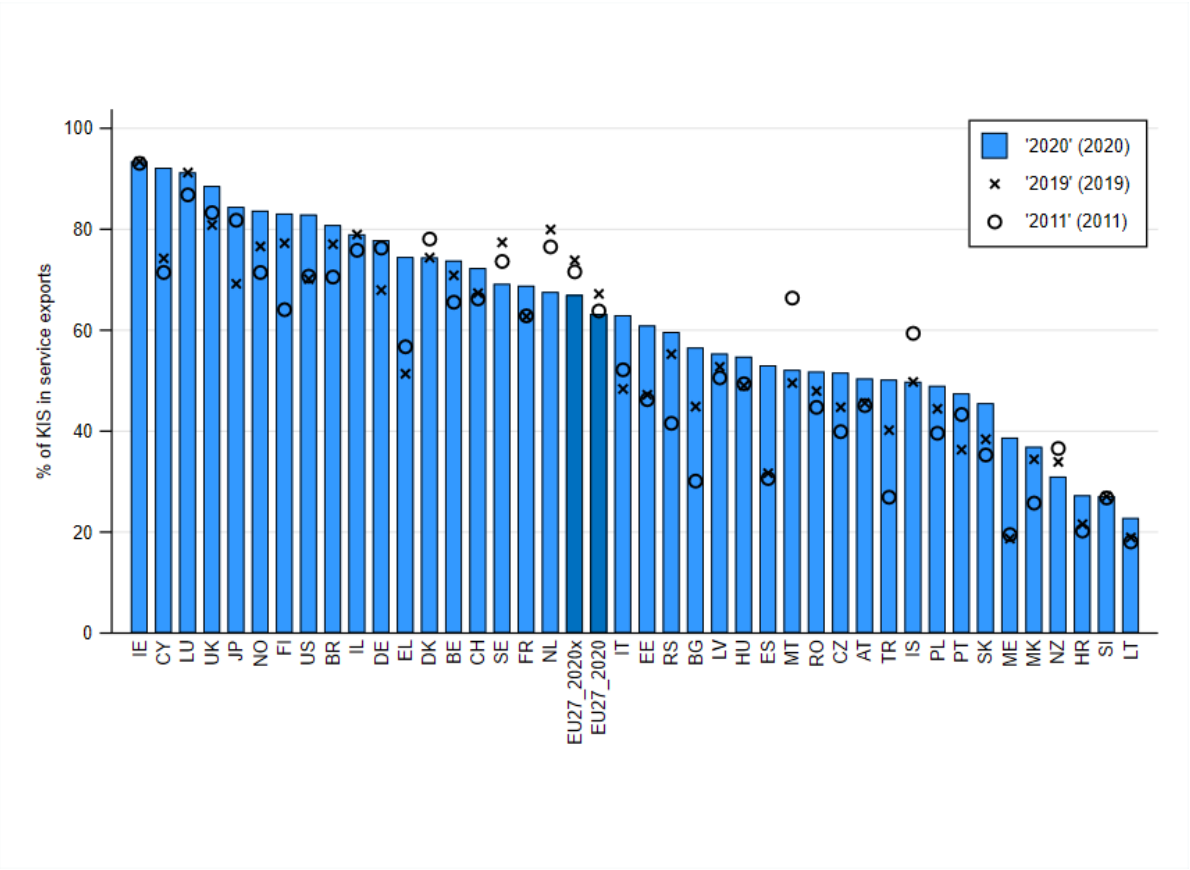
	Numerator	**Denominator**
Definition	Total value of exports in EBOPS 2010 items SC1, SC2, SC3A, SF, SG, SH, SI, SJ and SK1	Total value of service exports (EBOPS 2010 item S)
Source	Eurostat, bop_its6_det series for EU Member States; OECD TISP_EBOPS2010 data for other OECD countries; ITC (based on IMF) for all others	
Most recent year used [Nr. Years lag vs.2020]	2020[0]	
Corresponding EIS indicator	4.2.2 Knowledge-intensive services exports as percentage of total services exports	

Note: See Table A1.2 for a description of the EBOPS item codes.

The most recent country performance in SERV and their recent evolution over time are shown in **Figure 5**. The top performing countries are Ireland, Cyprus and Luxembourg, followed by the UK. The EU taken as a unique entity comes after with a 67% share of exported knowledge-intensive services in 2020, which is similar to the ones reported by The Netherlands, France and Sweden, but well behind Japan (84.5%) and the US (82.9%). Analogously to the GOOD component's case, the better performance of the EU considered as a single country than that of the EU analysed as a collection of independent countries – i.e. when trade between MSs is excluded as compared to the case in which the latter is included – indicates that the share of knowledge-intensive services exported outside the EU is larger than the share of knowledge-intensive services exported to EU MSs. Large fluctuations are observed across time with the EU experiencing a decrease between 2019 and 2020, which is driven by Sweden and the Netherlands and which may partly be caused by the Covid pandemic.

In the 2011-2020 period, the countries experiencing the largest increase are Bulgaria, Spain, Turkey and Montenegro. By contrast, the largest drop was observed in Malta, Iceland, and the Netherlands

Figure 5 Knowledge-intensive services exports as percentage of total services exports (%)



Source: see Table 7. Notes: 'EU27_2020x' refers to Extra-EU 27 trade only, 'EU27_2020' refers to both intra- and extra-EU trade for EU27_2020 aggregate. Years in quotation marks indicate actual year of data.

Table 8 SERV : Knowledge-intensive services exports as percentage of total services exports (in %)

Time Point (Actual year)	'2011' (2011)	'2013' (2013)	'2015' (2015)	'2017' (2017)	'2018' (2018)	'2019' (2019)	'2020' (2020)
IE	93.1	93.0	92.3	93.3	92.9	93.5	93.5
CY	71.5	68.7	73.5	73.2	73.6	74.3	92.2
LU	86.9	87.3	90.2	90.6	90.8	91.3	91.3
UK	83.3	81.7	80.5	81.8	82.7	80.9	88.6
JP	81.9	79.1	74.6	72.6	70.0	69.3	84.5
NO	71.5	78.8	78.8	76.9	77.2	76.7	83.7
FI	64.1	74.5	77.0	76.0	74.6	77.3	83.1
US	70.8	69.6	68.3	70.0	69.6	70.2	82.9
BR	70.6	70.6	77.7	78.1	75.5	77.1	80.9
IL	75.9	76.6	74.3	76.3	78.2	79.0	79.0
DE	76.3	74.9	74.8	75.4	74.6	68.0	77.9
EL	56.8	52.0	51.0	52.9	53.6	51.4	74.5
DK	78.1	78.2	74.7	71.6	69.6	74.4	74.4
BE	65.6	67.2	69.8	71.5	71.4	70.9	73.8
CH	66.3	66.3	68.7	68.9	68.1	67.4	72.3
SE	73.7	75.4	75.2	72.0	74.9	77.5	69.2
FR	62.9	63.1	63.1	61.8	62.9	62.8	68.8
NL	76.6	76.6	78.3	77.9	78.8	80.0	67.6
EU27_2020x	71.6	71.7	73.2	73.1	73.0	73.9	67.0
EU27_2020	63.9	64.4	66.3	66.1	66.3	67.3	63.2
IT	52.2	51.7	50.5	51.2	49.4	48.4	63.0
EE	46.3	45.0	44.4	49.7	50.3	47.3	61.0
RS	41.6	44.4	47.6	50.9	51.4	55.3	59.7
BG	30.2	31.9	43.3	41.0	41.4	44.9	56.6
LV	50.6	50.5	50.5	51.3	53.4	52.8	55.4
HU	49.5	47.9	47.3	49.4	49.5	49.1	54.8
ES	30.7	29.6	32.2	31.4	30.4	31.7	53.1
MT	66.4	66.3	57.9	50.3	52.0	49.6	52.2
RO	44.8	44.8	44.0	44.2	46.1	48.0	51.8
CZ	40.0	42.7	41.6	43.0	43.7	44.8	51.6
AT	45.1	44.8	44.1	43.9	44.8	45.7	50.5
TR	27.0	38.6	38.0	42.1	42.6	40.3	50.3
IS	59.4	59.4	57.1	51.7	50.3	49.8	49.8
PL	39.7	38.3	40.1	41.5	42.8	44.5	49.0
PT	43.4	43.7	41.9	37.7	36.9	36.4	47.5
SK	35.4	35.4	34.4	38.3	39.2	38.5	45.6
ME	19.6	20.0	19.6	18.6	19.3	18.8	38.8
MK	25.8	26.7	25.3	29.5	31.2	34.5	36.9
NZ	36.6	36.7	31.7	32.4	33.0	34.0	31.0
HR	20.3	17.9	20.3	20.1	20.9	21.6	27.3
SI	26.8	24.9	27.0	28.1	27.5	27.2	27.2
LT	18.1	19.0	18.8	20.1	14.3	19.0	22.8

Source: see Table 7. *Note:* Figures for all years are provided in Table A6 in the Annex.

2.4 DYN: Employment share in fast-growing enterprises in innovative sectors

This indicator aims to capture the dynamism of fast-growing firms in innovative sectors as compared to all fast-growing business activities. It captures the capacity of a country to rapidly transform its economy to respond to new needs and take advantage of emerging demand. While DYN continues to represent a bottleneck for international comparison since data is unavailable for most non-European countries that lack comparable business demography statistics, we notice some improvement in data availability for European countries, including Greece, Iceland and Switzerland. For a detailed explanation of the establishment of the methodology to compute DYN, the identification of the most innovative sectors, the reader is referred to the IOI 2017 Methodology Report (Vertesy, 2017).

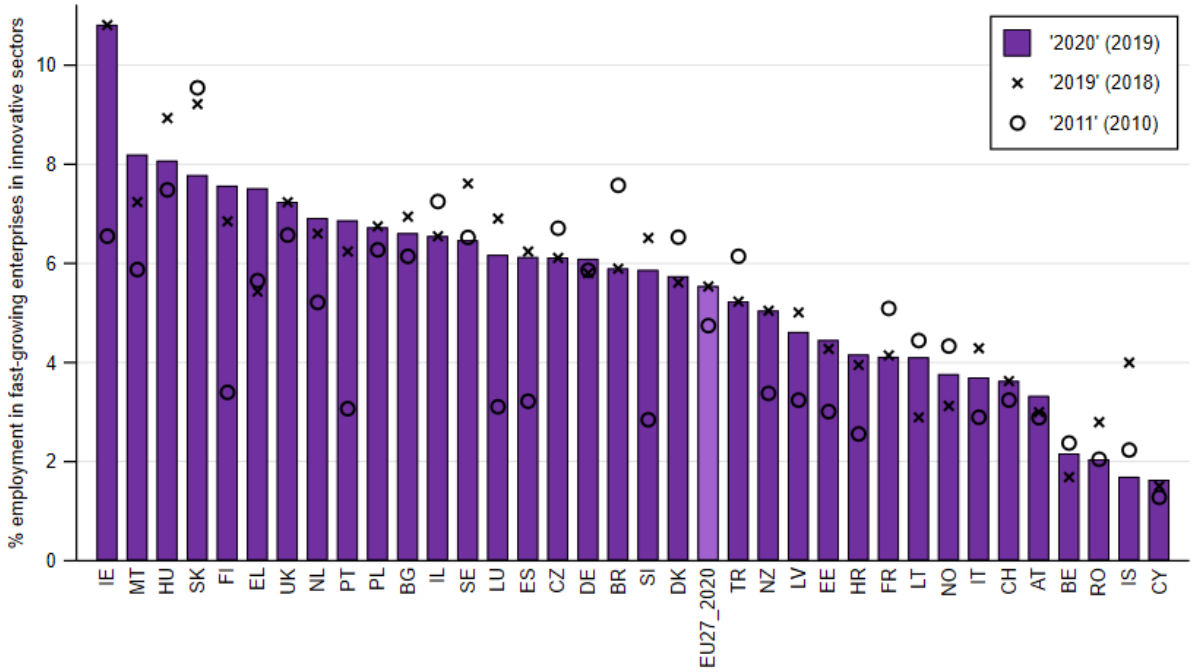
Table 9 Key parameters of the DYN component

	Numerator	**Denominator**
Definition	Number of employees in high growth enterprises measured in employment (growth by 10% or more) in the top 50% most innovative sectors, defined according to CIS*KIA scores	Number of employees in the population of active enterprises in t (in the Business economy except activities of holding companies, with 10 employees or more)
Source	Eurostat, bd_9pm_r2 [indic_sb: V16961, selected NACE sectors: B06, B09, C11, C12, C19, C20, C21, C26, C27, C28, C29, C30, C32, D35, E39, G46, H51, J, K, L, M, N79]	Eurostat bd_9bd_sz_cl_r2 [indic_sb: V16911; sizeclass: GE10: nace_r2: B-N_X_K642]
Notes	EU27_2020 2012, 2013, 2019: numerator computed as sum of available countries. ME, MK, RS, TR, JP, US data not available.	EU27_2020: 2019, denominator computed using available countries.
Most recent year used [Nr.years lag vs.2020]	2019[1]	
Notes on time coverage	Data not available prior to 2012, except for BR and NZ.	
Corresponding EIS indicator	4.1.2 Employment in fast-growing enterprises (percentage of total employment)	

Note: See Table A1.3 for a description of the NACE sector codes.

The most recent country performance in DYN and its recent evolution across time are shown in **Figure 6**. The top performing countries in 2020 are Ireland, Malta, Hungary, Slovakia, Finland and Greece, while the strongest growth performance since 2011 was observed in Finland, Portugal, Slovenia, Luxembourg and Spain. The overall patterns suggest that the DYN component captures both the dynamism of the economy, with countries experiencing strong economic changes (e.g., Eastern Member States, Ireland, Spain) typically having the better levels and growth performance in this indicator, and a successful innovation environment (e.g., Finland).

Figure 6 Employment in fast-growing enterprises in the top 50% most innovative sectors as a percentage of total employment (in %)



Source: See table 9. *Notes:* This chart shows 2019 data for all countries, except for Brazil, Switzerland, Ireland, Israel, Turkey, United Kingdom and New Zealand, for which 2018 was the latest data available.

Table 10 DYN : Employment in fast-growing enterprises in the top 50% most innovative sectors as a percentage of total employment (in %)

Time Point (Actual year)	'2011' (2010)	'2013' (2012)	'2015' (2014)	'2017' (2016)	'2018' (2017)	'2019' (2018)	'2020' (2019)
IE	6.6	6.6	8.8	8.5	10.3	10.8	10.8
MT	5.9	5.9	7.3	7.2	7.2	7.2	8.2
HU	7.5	7.5	7.6	8.5	9.4	8.9	8.1
SK	9.6	9.6	7.4	7.3	8.6	9.2	7.8
FI	3.4	3.4	5.0	5.4	6.5	6.9	7.6
EL	5.7	5.7	5.7	5.7	5.7	5.4	7.5
UK	6.6	6.6	6.9	7.1	6.8	7.2	7.2
NL	5.2	5.2	5.5	5.1	5.6	6.6	6.9
PT	3.1	3.1	3.7	4.9	5.5	6.2	6.9
PL	6.3	6.3	5.5	6.2	6.3	6.8	6.7
BG	6.2	6.2	6.1	7.5	7.3	7.0	6.6
IL	7.3	7.9	6.5	6.0	6.1	6.6	6.6
SE	6.5	6.5	6.0	6.2	7.0	7.6	6.5
LU	3.1	3.1	4.2	4.7	6.2	6.9	6.2
ES	3.2	3.2	3.5	5.3	6.2	6.2	6.1
CZ	6.7	6.7	4.9	7.2	8.0	6.1	6.1
DE	5.9	5.9	4.5	4.8	5.1	5.8	6.1
BR	7.6	7.4	5.9	5.9	5.9	5.9	5.9
SI	2.9	2.9	2.9	3.9	4.9	6.5	5.9
DK	6.5	6.5	4.3	4.9	5.2	5.6	5.7
EU27_2020	4.8	4.8	4.2	4.8	5.2	5.5	5.5
TR	6.2	6.2	6.2	5.8	5.4	5.2	5.2
NZ	3.4	4.9	5.0	5.1	5.1	5.1	5.1
LV	3.2	3.2	4.8	5.6	5.7	5.0	4.6
EE	3.0	3.0	3.4	2.8	3.1	4.3	4.5
HR	2.6	2.6	2.6	3.3	3.9	4.0	4.2
FR	5.1	5.1	4.3	4.2	3.8	4.2	4.1
LT	4.5	4.5	4.0	2.5	3.6	2.9	4.1
NO	4.3	4.3	4.8	3.1	2.8	3.1	3.8
IT	2.9	2.9	2.6	3.3	3.7	4.3	3.7
CH	3.2	3.2	3.2	3.1	3.1	3.6	3.6
AT	2.9	2.9	2.4	2.2	2.5	3.0	3.3
BE	2.4	2.4	2.4	2.8	3.6	1.7	2.2
RO	2.1	2.1	2.8	3.6	3.4	2.8	2.0
IS	2.2	3.9	3.5	6.5	5.1	4.0	1.7
CY	1.3	1.3	0.8	1.8	1.8	1.5	1.6

Source: see Table 9. *Notes:* Data for time points up to "2013" and for "2020" were in some cases partly available from the OECD, but not from Eurostat. Thus, for subsequent calculations for the composite indicator, we followed the practice of the European Innovation Scoreboard to replicate the closest available data for years with missing data. Countries with no data for any of the years (ME, MK, RS, JP, US) are not listed in the table. Figures for all years are provided in Table A7 in the Annex.

3. Multi-variate analysis

3.1 The IOI 2021 dataset

The multi-variate analysis and aggregation of the IOI 2021 indicators were carried out on a dataset that consisted of 410 observations referring to 40 countries and the EU region for 10 consecutive years. The dataset includes five indicators, namely PCT, KIABI, GOOD, SERV and DYN. As explained above, two alternative sets of values were considered for GOOD and SERV, depending on whether the EU27 is compared in a global benchmark (INT) or with European Member States (EUR)[9].

Data availability: In a few cases, data were missing for some of the years in the time range considered. In these cases, in line with the established practice of the European Innovation Scoreboard, data from the nearest available year was used. In case where data was available for preceding as well as subsequent year, missing data was imputed by applying the average of those two neighbours. **Table A2** in the Annex illustrates the latest year available by country and component.

Imputation: Data for DYN was unavailable from official statistics for a range of countries, including Japan, North Macedonia, Montenegro, Serbia and the US for any of the time points[10]. In accordance with the established IOI methodology, missing data for these countries was imputed using the Expectation-Maximization method and the information on the remaining four components (PCT, KIABI, $GOOD_{INT}$ and $SERV_{INT}$).

Descriptive Statistics for the non-normalized IOI 2021 dataset are shown in the upper part of **Table 11.** In the table, for distinction purposes, the imputed DYN series are denoted as DYN_{imp}. When compared with previous editions of the IOI, the size of the dataset has increased due to the addition of the latest years. We note that none of the distributions shows excessive skewness or kurtosis, indicating that outliers are not an issue for the aggregation of the IOI variables[11].

We further observe that the pairwise Pearson correlation between the IOI 2021 variables (shown in the lower part of **Table 11**) is positive and significant in all cases with the exclusion of the DYN-PCT and GOOD-KIABI indicator pairs. The highest correlations are found between KIABI and PCT (0.585) and between KIABI and the SERV indicators (0.576 and 0.572 for $SERV_{EUR}$ and $SERV_{INT}$, respectively). By contrast, there is little if any association between GOOD and SERV and between DYN and most of the indicators. Positive correlation between the indicators implies that the indicators provide complementary information about the different aspects of countries' innovation output. The presence of low correlations, especially in the case of the DYN component, suggests the importance of using data for the individual components alongside aggregate IOI scores, when country performance is compared.

[9] The difference between the two sets of values is in the values of EU27.

[10] This is due to the fact that the publication of business demographic statistics on high-growth firms is a relatively recent development in European statistics. The issue is also on the agenda of the OECD Entrepreneurship Indicators Programme, however, its data for the US is published according to a 20%, rather than 10% growth threshold. As shown by Vertesy et al (2017) using CIS data, the two thresholds not only result in very different country rankings, but capture a significantly different share of firms.

[11] Following the literature on outliers' detection (Groeneveld and Meeden, 1984), excessive skewness and kurtosis indicate the presence of outliers in a distribution. Skewness, a measure of the asymmetry of a distribution, and kurtosis, a measure of the thickness of the tails of a distribution, are considered excessive when they simultaneously cross the threshold-values of 2 and 3.5.

Table 11 Descriptive statistics and pairwise correlation for the IOI indicators

	PCT	KIABI	$GOOD_{EUR}$	$GOOD_{INT}$	$SERV_{EUR}$	$SERV_{INT}$	DYN	DYN_{imp}
N	410	410	410	410	410	410	360	410
Min	0.0	4.7	7.9	7.9	9.0	9.0	0.1	0.1
Max	13.2	34.1	74.4	74.4	94.0	94.0	10.8	10.8
Mean	2.9	14.6	45.5	45.6	55.9	56.0	5.0	5.0
SD	3.0	5.3	16.0	16.1	20.3	20.4	1.9	1.8
Skewness	1.3	1.2	-0.6	-0.6	-0.1	-0.1	0.2	0.2
Kurtosis	4.0	5.4	2.9	2.9	2.0	2.0	2.7	3.0
Correlation								
PCT	1							
KIABI	0.585	1						
$GOOD_{EUR}$	0.314	(0.077)	1					
$GOOD_{INT}$	0.314	(0.074)	0.999	1				
$SERV_{EUR}$	0.534	0.576	0.217	0.219	1			
$SERV_{INT}$	0.534	0.572	0.221	0.226	0.999	1		
DYN	(0.023)	0.090	0.198	0.195	0.149	0.147	1	
DYN_{imp}	(0.051)	0.099	0.216	0.214	0.171	0.170	1.000	1

Note: Pearson correlation coefficients in brackets are not significant at 10%. Pooled data for all 10 years.

3.2 Normalisation and aggregation

In the z-score normalization procedure, each country-year score was transformed by subtracting the mean and dividing by the standard deviation for the pooled country-year combinations for the selected indicator. The z-scores thus obtained were re-scaled using the following formula: z*1.5+5 to obtain a positive score in the 0-10 range, in line with previous IOI methodology (see Vertesy and Tarantola, 2014). COMP (EUR and INT) scores were obtained as the average of the normalized GOOD and SERV scores. The descriptive statistics and the correlation between the normalized IOI indicators are shown in **Table 12**. The combination of GOOD and SERV into COMP[12] leads to stronger correlation coefficients with respect to PCT as well as KIABI (0.544 and 0.418, respectively), but still relatively lower with respect to DYN (0.248). As DYN remains the most "distinct" indicator in the normalized dataset from a statistical point of view, there is reason to expect that the information it contains is underrepresented unless weights (as scaling coefficients) are applied in its favour when data are aggregated into composite scores.

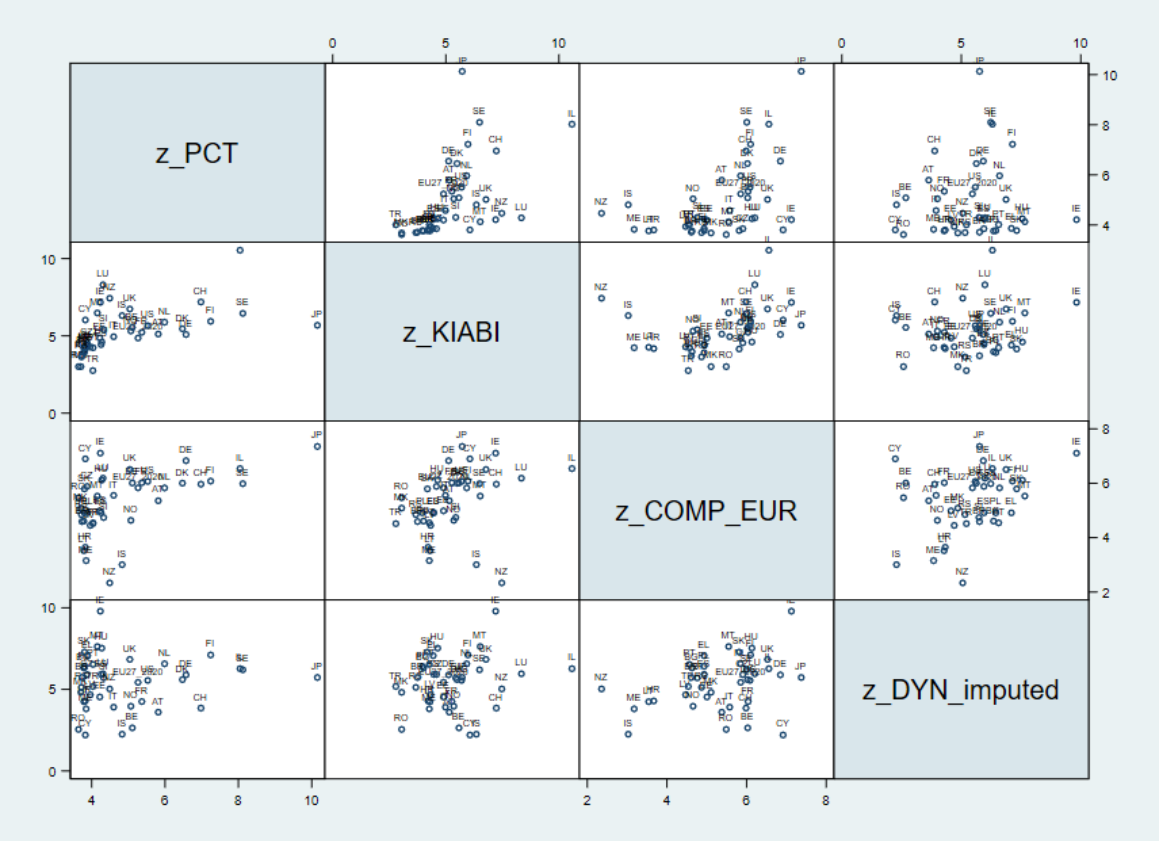
Figure 7 offers a visual representation of the relationship between indicator pairs for the latest time point. The matrix of scatterplots shows all possible two-way combinations of the IOI components, helping to understand how countries perform with relation to one another according to two selected dimensions. The matrix also helps understand visually the association between the components.

[12] To avoid redundancy, we only show here statistics for $COMP_{EUR}$.

Table 12 Descriptive statistics a and pairwise Pearson correlation for the normalized and re-scaled components

	PCT	KIABI	$COMP_{EUR}$	DYN_{imp}
N	410	410	410	410
Min	3.5	2.2	2.0	1.0
Max	10.1	10.6	7.4	9.8
Mean	5.0	5.0	5.0	5.0
SD	1.5	1.5	1.2	1.5
Skewness	1.3	1.2	-0.4	0.2
Kurtosis	4.0	5.4	2.6	3.0
Correlation				
PCT	1			
KIABI	0.585	1		
$COMP_{EUR}$	0.544	0.418	1	
DYN	(0.052)	0.100	0.248	1

Figure 7 Scatterplot matrix for normalized IOI component scores, most recent year



The IOI scores are obtained by aggregating the z-score normalized component scores in two steps. First, a weighted average of the normalized data is computed according to the formula $I = w_1 PCT + w_2 KIABI + w_3 COMP + w_4 DYN$, where w_1, w_2, w_3, w_4 are the weights (or rather, scaling coefficients) of the component indicators and are equal to .22, .22, .22, .34, respectively. The weights, which are equal to the ones used for the 2019 edition, were obtained in such a way that the IOI is statistically equally balanced in its underlying components. This procedure aims to correct the effect of the correlation structure on the importance of the single components. While, in theoretical terms, all elements are equally important, because of an arithmetical effect, composite indicators tend to depend more on the most

correlated elements (here, PCT, KIABI and COMP) and less on the others (here, DYN)[13]. Dependence or importance is measured in terms of squared Pearson correlation coefficient between the normalized components and the aggregate index. In an iterative process, components that are highly correlated with the index are assigned a lower scaling coefficient and, conversely, components with a lower correlation are assigned a higher scaling coefficient. Without rebalancing, users of the index would mistakenly expect that a high score of the index correspond to an equally strong performance in all dimensions. A re-balanced index can be read as a fairer summary of its components. Scaling factors, therefore, are defined by the correlation structure of the pooled country-year dataset. As this structure may change when data from additional years or countries are added, any update implies a potential need of re-adjusting the weights or scaling coefficients. In the case of the current update, however, the correlation structure after the addition of the most recent years remain stable enough to ensure stability in the weights, which are equal to those used in the previous edition (Vértesy and Damioli, 2019).

In a final step, the obtained scores are re-normalized to EU2011 = 100, for ease of communication. The aggregation is then carried out for two datasets. A dataset, which includes intra- plus extra-EU scores for the EU-27 (labelled 'EU27_2020'), is used to compare EU Member States with one another as well as with selected international benchmark countries. The aim of the second dataset is to compare the EU aggregate with selected international benchmark countries (in which only extra-EU scores are used, for a more valid comparison14). Given the difference in the level of EU scores and the second normalization step which relates scores to EU2011=10015, composite scores obtained from the two datasets are not directly comparable with one another.

[13] Paruolo et al (2013) and Becker et al (2017) show that the relative importance of variables are variance-based, hence they are ratios of quadratic forms of nominal weights, while the target relative importance is often deduced as ratio of nominal weights. A correction of the 'scaling coefficients' can be used to have component indicators with the desired relative target importance.

[14] Considering that export values for the US similarly exclude trade between the various States.

[15] Scores are rescaled using the following formula: 100*Score of country i in year t/EU Score in 2011.

4. Country performance in composite scores

IOI composite score results are presented in this section separately for the two aggregations described above. The first benchmark – referred to as the "European comparison" – shall be used to compare EU Member States with one another, with the EU average, as well as with non-EU (i.e., OECD, BRICS) countries. The second benchmark is offered for comparing the scores of the EU as a single entity (EUx) with those of non-EU countries (nevertheless, other comparisons are also possible, with the exception of those with EU MSs). Both aggregations use five components. While PCT, KIABI and DYN are the same in both cases, GOOD, SERV and COMP are specific to the European and international comparison. Country scores obtained from the two rankings will slightly differ due to the fact that EU27 and EU27x scores are different for GOOD, SERV and COMP (see tables in Section 2.3), and thus the distribution of the dataset used for European comparison will be slightly different from that of the dataset used for international comparison. The use of two different datasets and calculations was necessary due to the re-normalization step, as IOI scores are computed against the EU2011 = 100 benchmark. It follows that IOI scores obtained from the two computations will slightly differ because the EU 2011 = 100 benchmarks will be different. **Table 13** aims to help readers select the appropriate source for a given comparison.

Table 13 Which source to use for different comparisons?

Which ranking to use to compare…	European comparison	International comparison
an EU Member State (MS) with another EU MS (e.g., DE vs NL)?	Yes	Yes
an EU MS with the EU (e.g., DE vs EU27)?	Yes	No
an EU MS with a non-EU MS (i.e., DE vs. US)?	Yes	Yes
a non-EU MS with another non-EU Member State (e.g., US vs IL)?	Yes	Yes
a non-EU MS with the EU (e.g., US vs EU27)?	No	Yes

4.1 European comparison

This section reports the IOI 2020 scores obtained from the aggregation. The overall performance of countries is shown in **Figure 8** and in **Table 14** for the European comparison. To compare trends over time, users are advised to consider country performance in each of the years shown in the current edition, which has a time coverage of 10 years starting with 2011. Comparing results across different editions of the IOI would not be valid given the differences in the dataset (country and year range), definition changes (i.e., DYN), all of which affect normalization, weighting and aggregation procedure, and thus, final scores and ranking of countries.

Israel is a clear leader among the countries in the sample with KIABI and SERV being its strongest components. Among EU Member States, Ireland, Finland, and Sweden stand out as top performers. Among the IOI top-performers, the PCT component is particularly important for Japan, Israel and Finland, the KIABI one for Israel, the COMP GOOD and COMP SERV components for Japan, Finland, and Ireland. The DYN one is particularly important for Ireland and Finland.

Looking at the trends, we observe that the following countries have changed their performance more significantly in recent years: Greece's performance increased due to improvements in all components; Lithuania's performance increased due to improvements in PCT, GOOD, and SERV, which offset a decline in DYN. At the same time, Iceland's score declined more significantly than in other countries due to a fall in all components, with the exception of KIABI.

As stressed before, it is especially important to look at performance by component as the weaker association between DYN and the rest of the indicators implies a potential loss of information on country variation in the aggregation. A study of country performance by component is offered in Section 4.3. It is also important to keep in mind that, as shown in detail in the Section 5, the robustness of rankings should be always taken into account. As a matter of fact, the ranks of some countries may be particularly

sensitive to single modelling choices (e.g. outlier treatment, normalisation, weighting scheme, aggregation) undertaken in the development of the composite indicator. The IOI is a stable composite indicator with respect to the assumptions tested, but readers are advised to take into account the presence of a few countries with slightly larger variability. Their rank with respect to the closest countries may depend on fractional changes in the weights or on the aggregation formula. The range of possible alternative country ranks is shown in Section 5.1. Furthermore, it is important to keep in mind that DYN scores were not known for any time point for six countries (ME, MK, RS, JP and US), and had to be estimated. Their scores and ranks should therefore not be taken at face value.

Figure 8 IOI composite scores (EUR) by country and across time

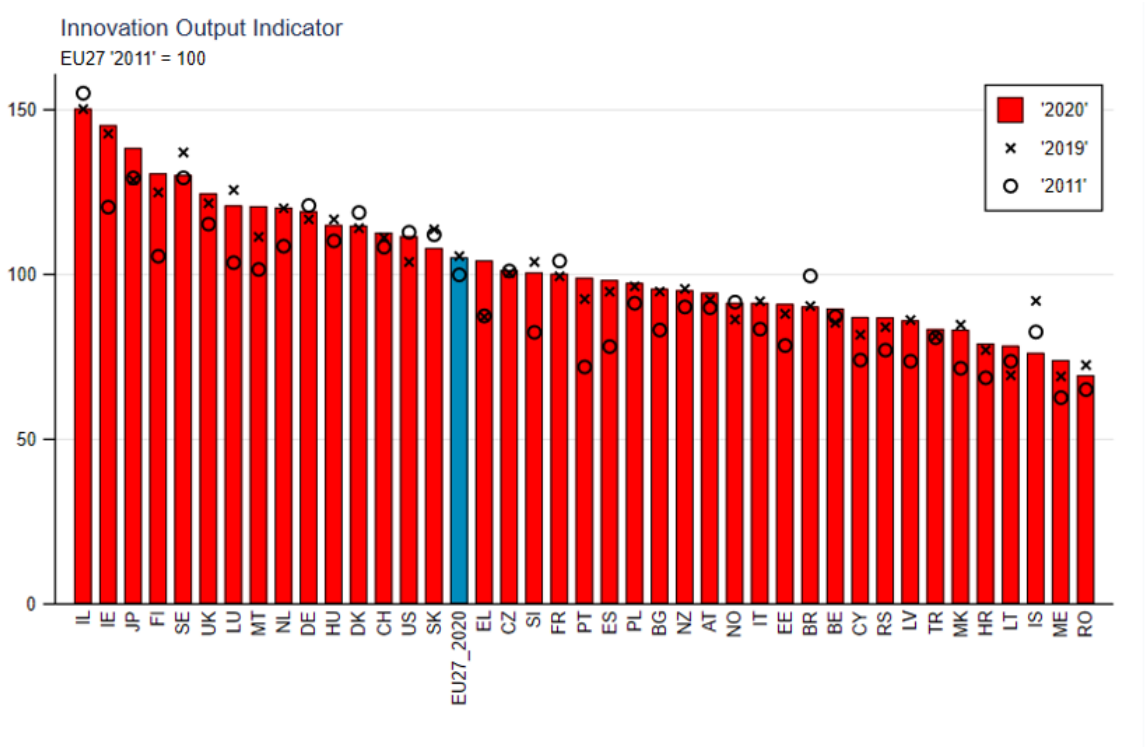


Table 14 Innovation Output Indicator scores: European countries' comparison

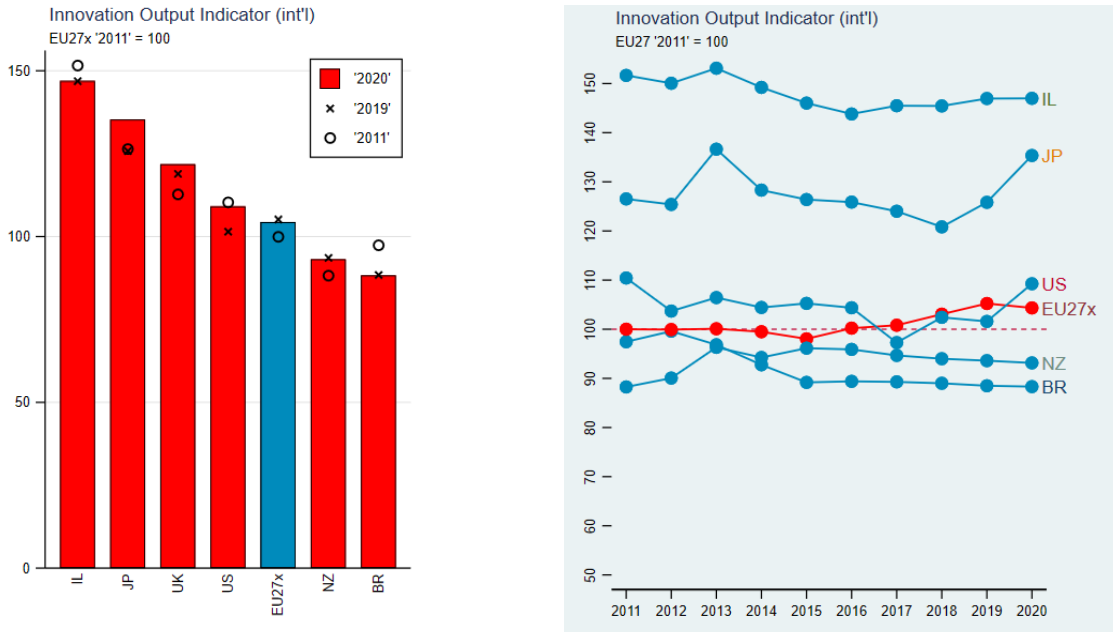
Country	'2011'	'2013'	'2015'	'2017'	'2018'	'2019'	'2020'
IL	155.1	156.6	149.4	148.8	148.8	150.3	150.4
IE	120.6	120.8	133.6	130.6	139.9	142.8	145.3
JP	129.4	139.8	129.3	126.9	123.7	128.8	138.5
FI	105.6	106.0	116.7	114.7	121.4	125.0	130.7
SE	129.4	127.8	126.7	126.5	133.4	137.1	130.2
UK	115.4	115.1	119.9	121.1	119.1	121.7	124.7
LU	103.7	105.5	108.0	108.5	120.0	125.8	121.0
MT	101.6	103.9	114.9	112.8	113.2	111.5	120.8
NL	108.7	111.6	114.5	112.2	115.2	120.2	120.4
DE	121.1	119.4	110.9	111.8	113.8	116.9	119.2
HU	110.3	109.6	109.3	114.2	118.8	116.8	115.1
DK	118.9	118.8	106.6	107.8	109.7	114.2	114.9
CH	108.4	105.4	106.8	106.3	107.5	111.3	112.8
US	112.9	108.9	107.7	99.5	104.7	103.9	111.7
SK	112.2	112.2	100.9	102.3	109.6	113.8	108.1
EU27_2020	100.0	100.2	98.2	101.0	103.4	105.7	105.2
EL	87.6	87.5	88.0	88.0	88.3	87.3	104.3
CZ	101.2	102.4	92.5	105.6	110.8	100.5	101.3
SI	82.6	82.5	84.8	86.4	92.2	103.9	100.6
FR	104.2	104.1	100.1	99.1	97.0	99.5	100.2
PT	72.1	72.2	77.7	84.2	87.7	92.7	99.0
ES	78.3	78.7	81.0	90.6	94.4	94.9	98.4
PL	91.4	91.5	88.5	92.8	93.6	96.5	97.5
BG	83.3	84.7	88.7	96.3	95.6	94.9	95.7
NZ	90.3	98.5	98.3	96.8	96.1	95.7	95.3
AT	90.0	91.7	88.7	87.5	89.5	92.5	94.5
NO	91.7	93.1	96.3	85.4	86.2	86.4	91.4
IT	83.5	83.5	82.8	86.6	88.7	91.9	91.4
EE	78.6	78.7	80.7	78.7	81.5	88.2	91.1
BR	99.7	99.1	91.2	91.3	91.0	90.5	90.3
BE	87.3	88.1	89.0	90.4	95.6	85.4	89.7
CY	74.2	77.2	79.2	83.0	84.9	81.8	87.2
RS	77.2	86.7	82.1	81.1	82.6	84.1	87.0
LV	73.8	75.3	85.7	90.9	90.1	86.3	86.1
TR	80.9	83.1	84.4	84.6	82.3	81.3	83.5
MK	71.6	74.9	78.1	79.5	81.1	84.8	83.3
HR	68.8	67.2	68.2	72.7	77.5	77.2	79.1
LT	73.8	73.9	73.4	65.3	71.9	69.5	78.4
IS	82.7	89.4	88.1	104.9	95.8	92.1	76.3
ME	62.7	69.3	75.8	76.0	69.7	69.2	74.1
RO	65.2	65.4	70.4	76.3	76.0	72.6	69.5

Note: Figures for all years are provided in Table A8 in the Annex.

4.2 International comparison

The EU aggregate performance can be benchmarked against non-EU countries with the use of a slightly modified index, which – as explained earlier – uses GOOD and SERV figures that characterize the external trade of the EU as a block. The scores and ranks of the EU27 to be used for international comparison, following the practice of previous editions of the IOI, are denoted with EU27x. It is important to keep in mind that performance scores for non-EU countries should be read with caution. Differences in industrial classification and coverage may imply that KIABI scores are not fully comparable. As for DYN, in some cases, scores may lack comparability due to differences in the industrial breakdown (as in the case of Israel, New Zealand and Brazil) and imputation procedures (as, for instance, in the case of Japan, and the US)[16].

Figure 9 The Innovation Output Indicator: EU in a global comparison and trends



The global benchmark scores of the latest time point and trends over time are presented above in two figures, followed by a table of scores. **Figure 9** aims to offer an instantaneous comparison of current and past EU [EU27x in the charts] performance with the United States and Japan, as well as selected countries from different continents for which sufficient data were available: Brazil, Israel, New Zealand, and the UK. Actual composite scores are reported in **Table 15**. Country performance in the component indicators is provided further below, which helps understand the source of differences in IOI performance.

The overall IOI international ranking remained broadly unchanged since 2011 with Brazil being the only country reporting the largest decrease. The EU clearly improved its performance with respect to 2011, reducing its gap with some better performing countries (e.g., Israel and the United States). Looking at the shorter term changes between 2019 and 2020, Japan and the United States experienced marked improvements, while the performance of other countries (including the EU) remained substantially unchanged.

[16] Also Montenegro, North Macedonia and Serbia were imputed. See data source tables in Section 2 for specific details and notes on data for non-EU MSs.

Table 15 Innovation Output Indicator scores: International Comparison

Country	'2011'	'2013'	'2015'	'2017'	'2018'	'2019'	'2020'
IL	151.7	153.1	146.0	145.5	145.4	146.9	147.0
IE	117.8	118.1	130.5	127.7	136.7	139.6	142.0
JP	126.5	136.6	126.4	124.0	120.9	125.9	135.3
FI	103.3	103.7	114.1	112.1	118.6	122.2	127.8
SE	126.5	124.9	123.8	123.6	130.4	134.0	127.3
UK	112.8	112.5	117.2	118.3	116.4	119.0	121.8
LU	101.3	103.1	105.6	106.0	117.3	122.9	118.3
MT	99.3	101.6	112.3	110.3	110.7	109.0	118.1
NL	106.2	109.1	111.9	109.6	112.6	117.5	117.6
DE	118.3	116.7	108.3	109.3	111.2	114.2	116.5
HU	107.8	107.1	106.8	111.7	116.2	114.2	112.5
DK	116.2	116.1	104.2	105.4	107.2	111.6	112.3
CH	106.0	103.0	104.3	103.9	105.1	108.8	110.2
US	110.4	106.4	105.2	97.2	102.4	101.6	109.1
SK	109.7	109.7	98.6	100.0	107.2	111.2	105.6
EU27x	100.0	100.1	98.0	100.8	103.1	105.2	104.3
EL	85.6	85.6	86.0	86.0	86.3	85.3	101.9
CZ	98.9	100.1	90.4	103.2	108.3	98.2	99.0
SI	80.7	80.6	82.9	84.5	90.2	101.6	98.4
FR	101.8	101.7	97.9	96.9	94.8	97.3	98.0
PT	70.4	70.6	75.9	82.3	85.8	90.6	96.8
ES	76.5	77.0	79.2	88.6	92.3	92.8	96.1
PL	89.3	89.4	86.5	90.7	91.5	94.3	95.3
BG	81.4	82.9	86.7	94.2	93.5	92.8	93.5
NZ	88.3	96.4	96.2	94.7	94.0	93.6	93.2
AT	88.0	89.6	86.7	85.5	87.4	90.4	92.4
NO	89.7	91.1	94.1	83.5	84.2	84.5	89.4
IT	81.7	81.6	81.0	84.6	86.7	89.9	89.4
EE	76.8	77.0	78.9	76.9	79.7	86.2	89.1
BR	97.5	96.8	89.2	89.3	89.0	88.5	88.3
BE	85.4	86.1	86.9	88.4	93.4	83.5	87.7
CY	72.5	75.4	77.3	81.1	83.0	80.0	85.2
RS	75.4	84.8	80.2	79.3	80.7	82.3	85.1
LV	72.1	73.6	83.8	88.8	88.1	84.4	84.2
TR	79.1	81.3	82.5	82.7	80.5	79.5	81.6
MK	70.1	73.2	76.3	77.7	79.3	82.9	81.4
HR	67.2	65.7	66.7	71.0	75.8	75.5	77.3
LT	72.2	72.2	71.7	63.9	70.4	68.0	76.7
IS	80.9	87.5	86.2	102.6	93.7	90.1	74.6
ME	61.4	67.8	74.2	74.3	68.2	67.7	72.4
RO	63.7	64.0	68.8	74.6	74.2	71.0	67.9

Note: Figures for all years are provided in Table A9 in the Annex.

4.3 Analysis by component

The IOI scores serve as an entry point to examine the performance and trends at the level of indicators. In the following, we provide an overview table of the component-by-component performance of all the countries in our sample, assessing the latest results and ranks, as well as the change over the 2011 to 2020 period, between the first and last available data points. In addition, we highlight the strengths and weaknesses of each country in each of the five components, measured in terms of their performance relative to others.

Table 16 Country performance in the IOI components and change over time

Group	Geo	Indicator	IOI	PCT	KIABI	GOOD	SERV	DYN
EU	EU27_2020	Value '2020'	105.2	3.4	14.2	57.7	63.2	5.5
		Rank	16	12	24	12	19	21
		% Change 2020/2011	↑ 5.2	↓ -13.3	↑ 8.4	↑ 7.2	↓ -1.0	↑ 16.6
	EU27_2020x	Value '2020'	104	3	14	62	67	6
		Rank	16	12	24	8	19	21
		% Change 2020/2011	↑ 4	↓ -13	↑ 8	↑ 5	↓ -6	↑ 17
	AT	Value '2020'	94	5	15	58	50	3
		Rank	26	9	20	13	30	32
		% Change 2020/2011	↑ 5	↓ -8	↑ 8	↑ 7	↑ 12	↑ 15
	BE	Value '2020'	90	3	17	53	74	2
		Rank	31	13	15	19	14	33
		% Change 2020/2011	↑ 3	↓ -16	↑ 12	↑ 14	↑ 12	↓ -9
	BG	Value '2020'	96	0	11	37	57	7
		Rank	24	37	35	34	23	11
		% Change 2020/2011	↑ 15	↑ 39	↑ 31	↑ 42	↑ 88	↑ 8
	CY	Value '2020'	87	1	18	58	92	2
		Rank	32	32	10	14	2	36
		% Change 2020/2011	↑ 18	↓ -5	↑ 21	↑ 51	↑ 29	↑ 27
	CZ	Value '2020'	101	1	13	68	52	6
		Rank	18	30	26	4	29	16
		% Change 2020/2011	0	↓ -20	↑ 7	↑ 8	↑ 29	↓ -9
	DE	Value '2020'	119	6	15	67	78	6
		Rank	10	6	21	5	11	17
		% Change 2020/2011	↓ -2	↓ -20	↓ -3	↑ 3	↑ 2	↑ 4
	DK	Value '2020'	115	6	16	53	74	6
		Rank	12	7	16	20	13	20
		% Change 2020/2011	↓ -3	↓ -12	↑ 3	↑ 24	-5	-12
	EE	Value '2020'	91	1	14	41	61	4
		Rank	29	24	24	29	21	25
		% Change 2020/2011	↑ 16	↓ -44	↑ 31	↑ 5	↑ 32	↑ 48
	EL	Value '2020'	104	1	13	29	75	8
		Rank	17	29	28	36	12	6
		% Change 2020/2011	↑ 19	↑ 61	↑ 11	↑ 38	↑ 31	↑ 33
	ES	Value '2020'	98	1	13	46	53	6
		Rank	22	22	27	26	26	15
		% Change 2020/2011	↑ 26	↓ -10	↑ 8	↓ -2	↑ 73	↑ 90
	FI	Value '2020'	131	7	18	47	83	8

Group	Geo	Indicator	IOI	PCT	KIABI	GOOD	SERV	DYN
		Rank	4	4	11	24	7	5
		% Change 2020/2011	↑ 24	↓ -24	↑ 16	↑ 13	↑ 30	↑ 122
	FR	Value '2020'	100	4	16	57	69	4
		Rank	20	11	19	15	17	27
		% Change 2020/2011	↓ -4	↓ -12	↑ 8	↑ 2	↑ 9	↓ -19
	HR	Value '2020'	79	1	12	39	27	4
		Rank	37	33	33	33	39	26
		% Change 2020/2011	↑ 15	↓ -18	↑ 11	↓ -9	↑ 35	↑ 62
	HU	Value '2020'	115	1	13	70	55	8
		Rank	11	21	25	3	25	3
		% Change 2020/2011	↑ 4	↓ -2	↑ 2	↑ 3	↑ 11	↑ 8
	IE	Value '2020'	145	1	22	61	93	11
		Rank	2	23	5	8	1	1
		% Change 2020/2011	↑ 21	↓ -49	↑ 8	↑ 20	0	↑ 65
	IT	Value '2020'	91	2	15	52	63	4
		Rank	28	17	22	22	20	30
		% Change 2020/2011	↑ 9	↑ 4	↑ 7	↑ 4	↑ 21	↑ 28
	LT	Value '2020'	78	0	12	40	23	4
		Rank	38	36	30	30	41	28
		% Change 2020/2011	↑ 6	↑ 43	↑ 36	↑ 24	↑ 26	↓ -8
	LU	Value '2020'	121	2	26	43	91	6
		Rank	7	20	2	27	3	14
		% Change 2020/2011	↑ 17	↓ -9	↑ 4	↓ -13	↑ 5	↑ 98
	LV	Value '2020'	86	1	12	34	55	5
		Rank	34	28	29	35	24	24
		% Change 2020/2011	↑ 17	↓ -28	↑ 36	↑ 13	↑ 9	↑ 42
	MT	Value '2020'	121	1	20	60	52	8
		Rank	8	25	7	10	27	2
		% Change 2020/2011	↑ 19	↑ 350	↑ 23	↑ 21	↓ -21	↑ 39
	NL	Value '2020'	120	5	18	54	68	7
		Rank	9	8	12	17	18	8
		% Change 2020/2011	↑ 11	↓ -16	↑ 19	↑ 25	↓ -12	↑ 33
	PL	Value '2020'	97	0	11	49	49	7
		Rank	23	35	36	23	33	10
		% Change 2020/2011	↑ 7	↑ 8	↑ 18	↓ -1	↑ 24	↑ 7
	PT	Value '2020'	99	1	12	43	48	7
		Rank	21	26	32	28	34	9
		% Change 2020/2011	↑ 37	↑ 48	↑ 32	↑ 16	↑ 10	↑ 123
	RO	Value '2020'	69	0	8	59	52	2
		Rank	41	41	40	11	28	34
		% Change 2020/2011	↑ 7	↑ 6	↑ 18	↑ 17	↑ 16	0
	SE	Value '2020'	130	9	20	56	69	6
		Rank	5	2	8	16	16	13
		% Change 2020/2011	↑ 1	↓ -9	↑ 15	↑ 5	↓ -6	↓ -1
	SI	Value '2020'	101	2	16	63	27	6

Group	Geo	Indicator	IOI	PCT	KIABI	GOOD	SERV	DYN
		Rank	19	19	17	6	40	19
		% Change 2020/2011	↑22	↓-49	↑18	↑16	↑1	↑106
	SK	Value '2020'	108	1	12	71	46	8
		Rank	15	34	34	2	35	4
		% Change 2020/2011	↓-4	↑31	↑13	↑17	↑29	↓-19
EFTA	CH	Value '2020'	113	7	22	53	72	4
		Rank	13	5	4	18	15	31
		% Change 2020/2011	↑4	↓-4	↑15	↓-15	↑9	↑12
	IS	Value '2020'	76	3	19	8	50	2
		Rank	39	16	9	41	32	35
		% Change 2020/2011	↓-8	↓-27	↓4	↓-33	↓-16	↓-24
	NO	Value '2020'	91	3	16	16	84	4
		Rank	27	14	18	39	6	29
		% Change 2020/2011	0	↓-18	↑8	↑36	↑17	↓-13
OECD	IL	Value '2020'	150	9	34	60	79	7
		Rank	1	3	1	9	10	12
		% Change 2020/2011	↓-3	↓-17	↑2	↑17	↑4	↓-10
	JP	Value '2020'	138	13	17	73	84	
		Rank	3	1	13	1	5	
		% Change 2020/2011	↑7	↑38	↓-2	0	↑3	
	NZ	Value '2020'	95	2	23	8	31	5
		Rank	25	18	3	40	38	23
		% Change 2020/2011	↑6	↓-42	0	↓-14	↓-15	↑49
	UK	Value '2020'	125	3	21	52	89	7
		Rank	6	15	6	21	4	7
		% Change 2020/2011	↑8	↓-13	↑21	↑14	↑6	↑10
	US	Value '2020'	112	4	17	47	83	
		Rank	14	10	14	25	8	
		% Change 2020/2011	↓-1	↑1	↑1	↓-1	↑17	
Candidates	ME	Value '2020'	74	1	12	20	39	
		Rank	40	31	32	37	36	
		% Change 2020/2011	↑18		↑14	↑120	↑98	
	MK	Value '2020'	83	0	8	63	37	
		Rank	36	40	40	7	37	
		% Change 2020/2011	↑16	↑77	↑7	↑61	↑43	
	RS	Value '2020'	87	0	10	40	60	
		Rank	33	39	38	32	22	
		% Change 2020/2011	↑13	↑1	↑16	↑49	↑43	
	TR	Value '2020'	83	1	7	40	50	5
		Rank	35	27	41	31	31	22
		% Change 2020/2011	↑3	↑75	↑45	↑5	↑86	↓-15
BRICS	BR	Value '2020'	90	0	10	17	81	6
		Rank	30	38	37	38	9	18
		% Change 2020/2011	↓-9	↑29	↓-5	↓-26	↑15	↓-22

5. Robustness of ranks and validation of results

5.1 Robustness and sensitivity analysis

5.1.1 Robustness of country ranks to changing modelling assumptions

An important modelling choice in the development of the IOI was selecting weights as scaling coefficients to ensure that each component has an equal contribution to the variance of the final scores. Choices with regards to weights is one among a set of modelling choices that are made amidst uncertainty which, in theory, influences the robustness of actual country rank outcomes. We performed a robustness analysis to quantify the impact of the uncertainty in a) selecting the weights and b) selecting a fully compensatory vs. a non-fully-compensatory aggregation method on country rankings. More specifically, we run 1000 Monte-Carlo simulations that re-computed the IOI by using the scaling coefficients of each component randomly perturbed by +/-35% with respect to those used to obtain effective equal contribution, and an aggregation procedure randomly chosen between the geometric average and the fully compensatory arithmetic average. As a result, we obtained a distribution of possible country rankings with which we could contrast the baseline IOI rankings (see **Figure 10**)[17].

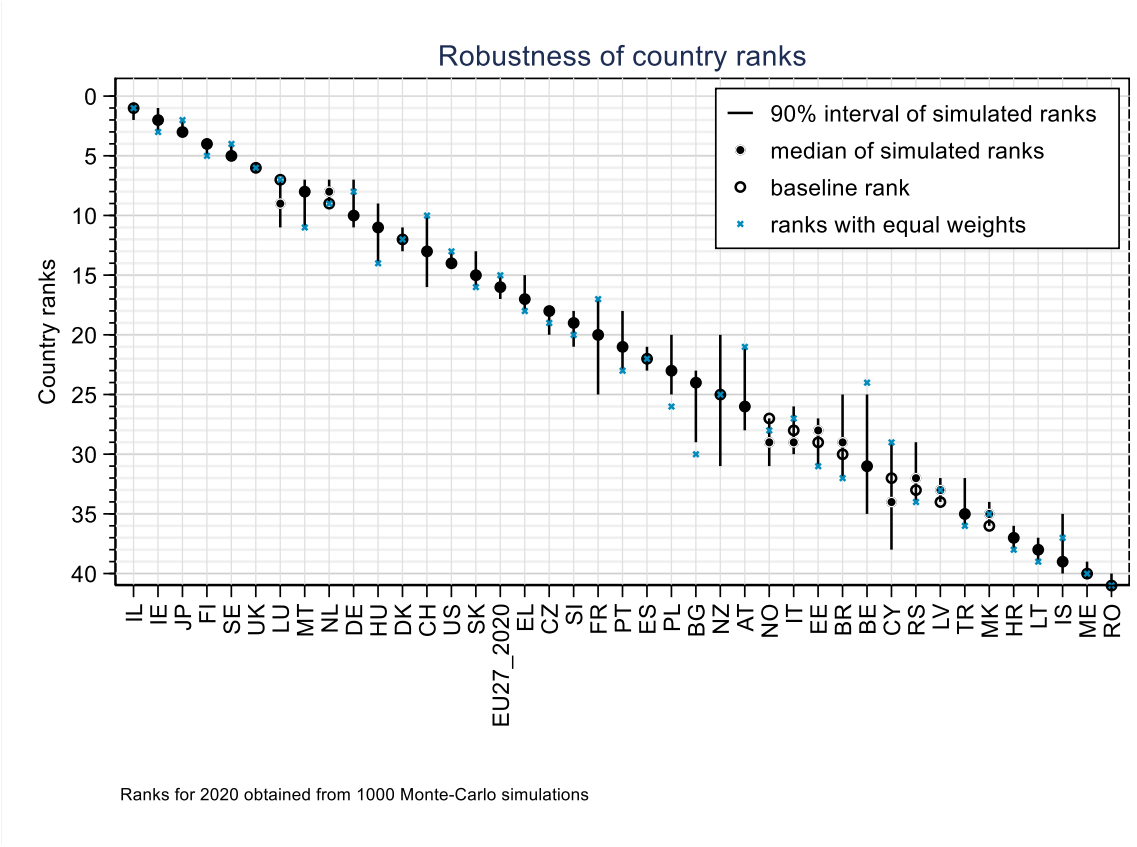
Based on the outcomes of the uncertainty analysis, we can conclude the following. First, that the median rank obtained from the simulations is identical to the baseline ranking for 31 of the 40 countries, and deviates only 1 or 2 positions for the rest of the countries. The IOI ranks fall in all cases within the interquartile range (IQR) of possible ranks. In other words, this means that even if weights were adjusted by as much as 35% in favour of the components in which a given country is performing best, it is unlikely that its rank position would significantly improve.

Second, while the results show a rather robust picture for the IOI, one should (as in the case of other aggregate indicators) not take ranks at face value, given that many neighbouring country pairs show considerable overlap in their possible ranks (e.g., it is difficult to distinguish with certainty the performance of Luxemburg and Malta, or those of Hungary and Switzerland). Countries showing the highest variation of their simulated ranks (namely New Zealand, Austria, Brazil, Belgium, France and Cyprus with 90% of simulated ranks ranging 5 or more positions) are typically positioned in the middle or middle-low part of the distribution, while the ranks of the countries in the tails of the IOI distribution (namely Israel, Ireland, Japan, and Finland in the upper tail, and Montenegro and Romania in the bottom one) appear rather solid.

Third, we also plotted a hypothetical rank obtained by applying equal weights (0.25) for all coefficients (thus, in effect, reducing the contribution of the DYN component). The results suggest that the choice of using nominally unbalanced weights to achieve broadly balanced importance of the different components adversely affect the performance of France, Austria, Belgium and Cyprus (and Germany, Switzerland and Iceland to a lower degree), and positively affect the performance of Malta, Poland, Hungary and Bulgaria (and Slovakia, Greece, Portugal, and Brazil to a lower extent).

[17] We discuss ranks obtained from European comparison as the results obtained from the international comparison are highly similar.

Figure 10 Robustness of IOI country ranks due to uncertainty in weights, "2020" Eur. Comparison



Note: Baseline IOI ranks are shown by hollow circle. Box plots show the distribution of simulated IOI country ranks at the latest time point, obtained from 1000 Monte-Carlo simulations in which the scaling coefficients were perturbed by +/-35% with respect to those used for effective equal contribution of components, and alternative averages (the non-fully compensatory geometric vs arithmetic) were applied. Vertical lines show the distribution of 90% of the simulated ranks. Black dot shows the median rank across all the simulations. Blue cross shows hypothetical ranks obtained when using equal weight (0.25) for all components.

5.1.2 Sensitivity of results to changes in components

In a "confirmatory" analysis, we computed sensitivity indices to reveal the contribution of each component to the total variance in IOI composite scores, which can be roughly interpreted as a means of measuring the amount of information contained in the underlying indicators that is captured by the composite index. This is a validation exercise, since by construction, the weights or scaling coefficients for each component were calibrated to achieve equal contribution – using a linear method based on Pearson correlation coefficients (r2). However, there is a possibility that the relationship between indicators and composites are non-linear. To better understand the association between the components and the composites also in case of non-linearity, we also followed a polynomial spline-fitting method[18] (Becker et al., 2017). The results reported in **Table 17** show roughly similar Si sensitivity indices for both methods, and highlight a relatively weaker contribution of DYN compared to the other three components. This is not surprising in light of the correlation tables in Section 3 that showed how DYN differs from the rest of the indicators. Overall, it suggests that the composite index captures the latent phenomenon of innovation output synthetizing well the information of individual components.

[18] The aim of this method is to compute a polynomial function (which may include quadratic or cubic term) in such a way that it best fits the distribution of the data (plotted in terms of the selected component and the composite scores).

Table 17 Sensitivity indices for IOI components

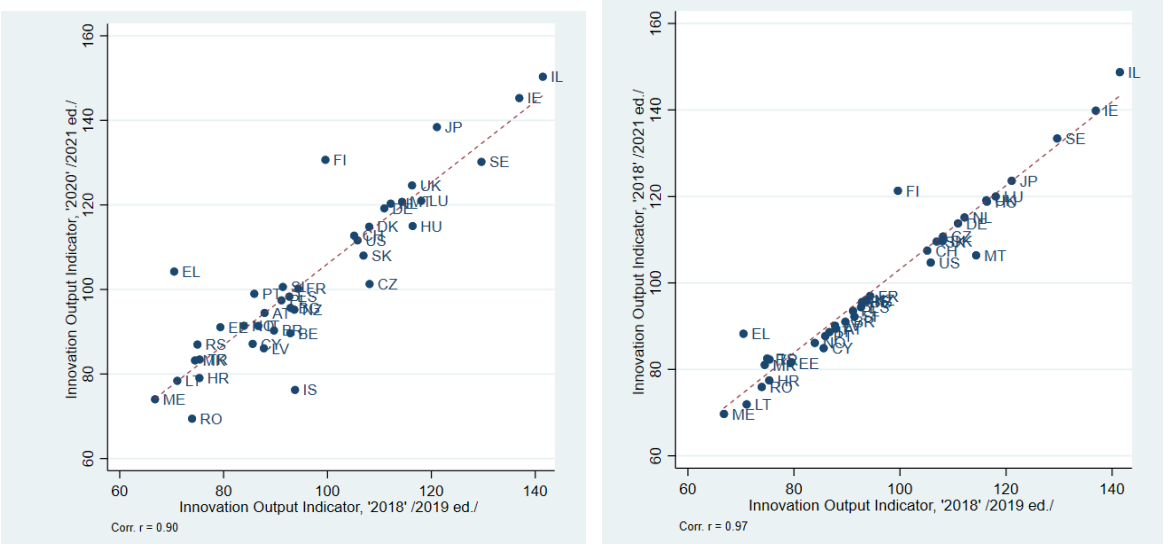
	Si Corr r2	Si Spline r2
PCT	0.50	0.50
KIABI	0.49	0.49
COMP	0.52	0.58
DYN	0.41	0.41

5.2 Validation of results

IOI scores reported in this edition (IOI 2021) are benchmarked against the IOI scores obtained from the previous edition of the IOI (IOI 2019) as well as the Summary Innovation Index 2021, to validate results and better understand the impact of methodological changes on country scores.

There is no reason to expect IOI 2021 scores to be fully aligned with IOI 2019 scores, given the data updates retroactively affecting all components. At the same time, striking differences may indicate calculation errors as well as trend breaks in the underlying data. **Figure 11** shows the relation between IOI 2019 and IOI 2021 scores. The left panel contrasts the latest scores obtained in 2019 (Vertesy and Damioli 2019) with this year's most recent scores. The right panel contrasts the latest scores obtained in 2019 (time point '2018') with those that are obtained for the same year (time point '2018') using this year's pooled dataset. While the left panel indicates how the most recent country performance changed over time and editions, the right panel aims to measure the effect of changing only the edition and fixing the time. We interpret the relatively largest deviations from the 45-degree line on the right panel as effects of retroactive data updates; it is reassuring to find that most of these remain limited as both panels indicate a strong, positive correlation between IOI scores across time. The countries that score higher according to IOI 2021 than according to IOI 2019 - which are in the top left part of the scatterplots – are Japan, Finland and Greece, while those with important drops are Romania, the Iceland and Czech Republic. The right panel shows that part of these changes are due to retroactive data updates in Finland and Greece.

Figure 11 Comparison of IOI scores between the 2021 and 2019 editions



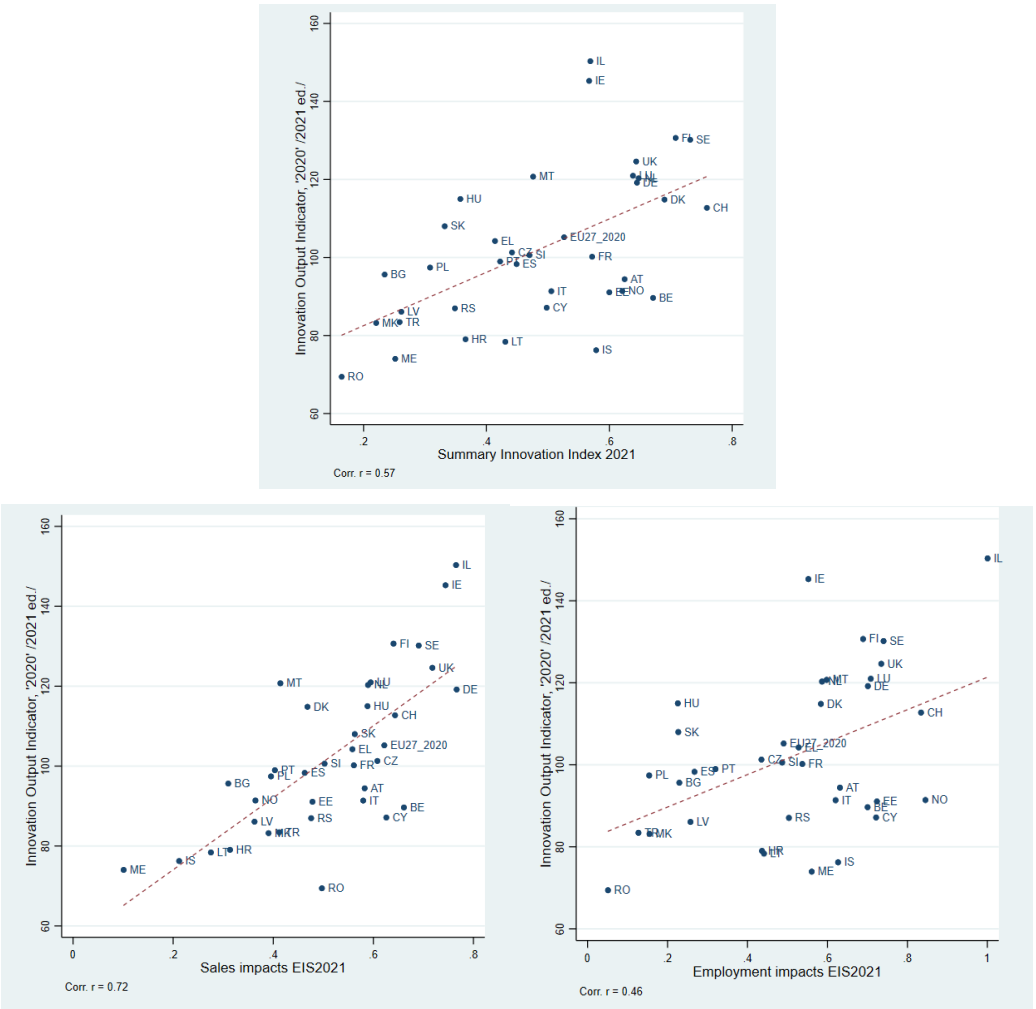
Note: Left panel shows latest time points (i.e., 2020 for 2021 edition and 2018 for 2019 edition). Right panel shows 2018 time point from both 2021 and 2019 editions. IOI scores are shown in Table A10 in the Annex.

It is also interesting to compare the IOI with widely used tool of the European Commission measuring innovation performance of countries, which is the Summary Innovation Index (SII)[19], and other aggregate indices of the European Innovation Scoreboard (EIS) to understand similarities and differences across the rankings. We observe that the IOI and overall SII offer a rather different picture of innovation performance of countries (top-left panel of **Figure 12**). While the two indices are positively correlated (Pearson r=0.57), we see that some countries (take, for instance, France and Ireland), which have very similar scores according to the SII, are set widely apart by their IOI scores. The observed differences are not surprising, as the SII is an unweighted average of 32 indicators representing 12 innovation dimensions, whereas the IOI is a weighted average of only 4 components (and five indicators). The Scoreboard takes a more comprehensive view on innovation system performance, capturing framework conditions (such as human resources, attractive research systems, innovation-friendly environment), a wide range of investments (public and private R&D, venture capital, etc.), the innovation activities of SMEs, linkages, etc. as well as impacts (employment and sales). It is therefore also informative to consider for comparison an aggregate of a smaller set of EIS indicators as well, which are more associated with impacts and outputs. The bottom-left panel of **Figure 12**, thus for validation purposes, focuses on the Sales impacts dimension of the EIS, which also includes the COMP indicators in addition to a third indicator and with which the IOI shows a positive and high correlation (Pearson correlation r=0.72. The two scores are rather aligned, although Romania is a notable outlier performing much better in the Sales impacts dimension of the EIS than in the IOI. Finally, the bottom-right panel of **Figure 12** reports the comparison with the Employment impacts dimension of the EIS, which is based on the KIABI indicator and a second component. In this case, the Pearson correlation with the IOI is still positive but below 0.5.

IOI scores are also benchmarked against figures on gross R&D expenditure per GDP, which has long been considered as a key input to innovation. The correlation in this case is positive and equal to 0.56 (**Figure 13**). Nevertheless, it is important to highlight the high variation in IOI scores across countries with similar level of R&D spending and vice versa. While understanding the source of these differences would require an in-depth study of national innovation systems, which goes beyond the scope of this report, this comparative exercise can provide a useful entry point. Israel and Ireland, which are the IOI leaders, report strikingly different R&D spending, with Israel outperforming Ireland more than four-fold. Also, many countries with an R&D expenditure of about 2-2.2% have very different innovation output scores: see e.g. France, Norway, and Iceland. Compared to the previous year, the correlation between IOI and R&D expenditure is stable at nearly 0.6.

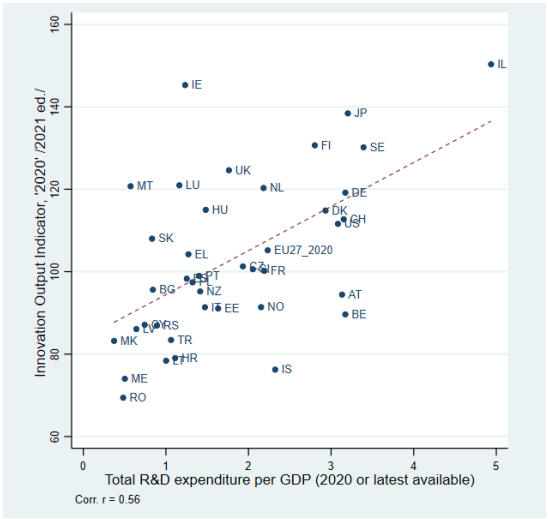
[19] The European Innovation Scoreboard provides a comparative analysis of innovation performance in EU countries, other European countries, and regional neighbours. It assesses relative strengths and weaknesses of national innovation systems and helps countries identify areas they need to address. See European Commission (2021)].

Figure 12 Comparison of country scores according to IOI, and the Summary Innovation Index as well as the EIS Sales (4.1) and Employment (4.2) pillars



Note: IOI2019, the SII and selected EIS 2019 composite scores and ranks are shown in Table A11 in the Annex.

Figure 13 Innovation Output and R&D expenditure of countries



6. Conclusions

The report presents the latest figures for the composite index and its underlying indicators for 40 countries, including European Union (EU) Member States (MSs) and selected EFTA, OECD and emerging economies. The four components of the IOI provide a benchmark for countries and the European Union as an aggregate in terms of patent-based technological innovation, skilled labour force feeding into the economic structure of a country, competitiveness of knowledge-intensive goods and services, and employment in fast-growing enterprises in innovative sectors. The methodology is unchanged with respect to the refinements introduced in the 2017 edition and adopted in the 2019 version.

Results show that the overall IOI international ranking remained broadly unchanged since 2011. The EU continues to be outperformed by Israel, Japan, the UK and the US, but there is some evidence of convergence, as the gap between the leader (Israel) and some top-performers countries (Japan, the UK and the EU) has somewhat declined since 2011. As compared to 2019, EU performance in innovation output remained broadly unchanged. Within EU MSs, Ireland, Finland, and Sweden are the top-performers in terms of innovation output, and Croatia, Lithuania and Romania those with the lowest IOI. As compared to 2019, the largest relative increases in IOI scores are observed in Greece, Lithuania and Malta, and the strongest relative falls in Romania, Slovakia and Sweden.

The analysis also documents the importance of benchmarking a country's performance not only according to its composite scores, but also according to the various components. Most notably, the multivariate analysis on the relationship between the component indicators shows that the component measuring employment in fast-growing enterprises in innovative sectors (DYN) has a weak, positive association with the rest of the components and, as a consequence, with the IOI aggregate index. This may suggest that innovation performance of countries is constituted by two rather distinct underlying dimensions: one referring to the performance of the technology- and knowledge-based economy and the second one concerning entrepreneurship and business dynamism in innovative sectors. Strong performance in one of these two dimensions does not automatically imply strong performance in the other, suggesting that innovation policy should carefully monitor and foster the development of both in their own merits.

IOI scores reported in this edition (IOI 2021) were benchmarked against the IOI scores obtained from the previous edition of the IOI (IOI 2019) as well as the Summary Innovation Index 2021 and figures on gross R&D expenditure per GDP, to validate the results. Overall, there is evidence of a strong, positive correlation between IOI scores across time, pointing to a low impact of methodological changes on country scores.

The IOI scores also correlate positively with both the SII and R&D expenditures, although the correlation is below 0.6 in both cases. This result confirms the specificity of the IOI, which – by construction – encompasses various dimensions of the innovation output landscape, namely technological development, employment, trade and entrepreneurship.

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List of country abbreviations

Code	Country
AT	Austria
BE	Belgium
BG	Bulgaria
BR	Brazil
CH	Switzerland
CY	Cyprus
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
EL	Greece
ES	Spain
EU27	EU27 aggregate
EU27x	Extra- EU27
FI	Finland
FR	France
HR	Croatia
HU	Hungary
IE	Ireland
IL	Israel
IS	Iceland
IT	Italy
JP	Japan
LT	Lithuania
LU	Luxembourg
LV	Latvia
ME	Montenegro
MK	North Macedonia
MT	Malta
NL	Netherlands
NO	Norway
NZ	New Zealand
PL	Poland
PT	Portugal
RO	Romania
RS	Serbia
SE	Sweden
SI	Slovenia
SK	Slovakia
TR	Turkey
UK	United Kingdom
US	United States

List of figures

List of tables

Annexes

Annex 1. Additional tables

Table A1.1 Description of medium-high-tech product classes

SITC Code	Description
266	synthetic fibres suitable for spinning
267	other man-made fibres suitable for spinning; waste of man-made fibres
512	alcohols, phenols, phenol-alcohols, and their halogenated, sulphonated, nitrated or nitrosated derivatives
513	carboxylic acids and their anhydrides, halides, peroxides and peroxyacids; their halogenated, sulphonated, nitrated or nitrosated derivatives
525	radioactive and associated materials
533	pigments, paints, varnishes and related materials
54	medicinal and pharmaceutical products
553	perfumery, cosmetic or toilet preparations (excluding soaps)
554	soap, cleansing and polishing preparations
562	fertilizers (other than those of group 272)
57	plastics in primary forms
58	plastics in non-primary forms
591	insecticides, rodenticides, fungicides, herbicides, anti-sprouting products, etc.
593	explosives and pyrotechnic products
597	prepared additives for mineral oils and the like; prepared liquids for hydraulic transmission; anti-freezing preparations and prepared de-icing fluids; lubricating preparations
598	miscellaneous chemical products, n.e.s.
629	articles of rubber, n.e.s.
653	fabrics, woven, of man-made textile materials (not including narrow or special fabrics)
671	pig-iron, spiegeleisen, sponge iron, iron or steel granules and powders and ferro-alloys
672	ingots and other primary forms, of iron or steel; semi-finished products of iron or steel
679	tubes, pipes and hollow profiles, and tube or pipe fittings, of iron or steel
71	tubes, pipes and hollow profiles, and tube or pipe fittings, of iron or steel
72	machinery specialized for particular industries
731	machine tools working by removing metal or other material
733	machine tools for working metal, sintered metal carbides or cermets, without removing material
737	metalworking machinery (other than machine tools) and parts thereof, n.e.s.
74	general industrial machinery and equipment, n.e.s., and machine parts, n.e.s.
751	office machines
752	automatic data-processing machines and units thereof; magnetic or optical readers, machines for transcribing data onto data media in coded form and machines for processing such data, n.e.s.

SITC Code	Description
759	parts and accessories (other than covers, carrying cases and the like) suitable for use solely or principally with machines falling withing groups 751 and 752
76	telecommunications and sound-recording and reproducing apparatus and equipment
77	electrical machinery, apparatus and appliances, n.e.s., and electrical parts thereof (including non-electrical counterparts, n.e.s., of electrical household-type equipment)
78	road vehicles (including air-cushion vehicles)
79	other transport equipment
812	sanitary, plumbing and heating fixtures and fittings, n.e.s.
87	professional, scientific and controlling instruments and apparatus, n.e.s.
88	photographic apparatus, equipment and supplies and optical goods, n.e.s.; watches and clocks
891	arms and ammunition

Table A1.2 Description of knowledge-intensive services

EBOPS 2010 code	Description
SC1	Sea transport
SC2	Air transport
SC3A	Space transport
SF	Insurance and pension services
SG	Financial services
SH	Charges for the use of intellectual property n.i.e.
SI	Telecommunications, computer, and information services
SJ	Other business services
SK1	Audio-visual and related services

Table A1.3 Description of innovative sectors

NACE code	Description
B06	Extraction of crude petroleum and natural gas
B09	Mining support service activities
C11	Manufacture of beverages
C12	Manufacture of tobacco products
C19	Manufacture of coke and refined petroleum products
C20	Manufacture of chemicals and chemical products
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
C26	Manufacture of computer, electronic and optical products
C27	Manufacture of electrical equipment
C28	Manufacture of machinery and equipment n.e.c.
C29	Manufacture of motor vehicles, trailers and semi-trailers
C30	Manufacture of other transport equipment
C32	Other manufacturing
D35	Electricity, gas, steam and air conditioning supply
H39	Remediation activities and other waste management services
G46	Wholesale trade, except of motor vehicles and motorcycles
H51	Air transport
J	Information and communication
K	Financial and insurance activities
L	Real estate activities
M	Professional, scientific and technical activities
N79	Travel agency, tour operator and other reservation service and related activities

Table A2 Latest year available (before data imputation) by country and IOI component

Country	PCT	KIABI	GOOD	SERV	DYN
AT	2018	2020	2020	2020	2019
BE	2018	2020	2020	2020	2019
BR	2018	2014	2020	2020	2014
BG	2018	2020	2020	2020	2019
CH	2018	2020	2020	2020	2018
CY	2018	2020	2020	2020	2019
CZ	2018	2020	2020	2020	2019
DE	2018	2020	2020	2020	2019
DK	2018	2020	2020	2019	2019
EE	2018	2020	2020	2020	2019
EL	2018	2020	2020	2020	2019
ES	2018	2020	2020	2020	2019
EU27_2020	2018	2020	2020	2020	2018
FI	2018	2020	2020	2020	2019
FR	2018	2020	2020	2020	2019
HR	2018	2020	2020	2020	2019
HU	2018	2020	2020	2020	2019
IE	2018	2020	2020	2019	2018
IL	2018	2018	2020	2019	2018
IS	2018	2020	2020	2019	2019
IT	2018	2020	2020	2020	2019
JP	2018	2020	2020	2020	2019
LT	2018	2020	2020	2020	2019
LU	2018	2020	2020	2019	2019
LV	2018	2020	2020	2020	2019
ME	2018	2020	2020	2020	2019
MK	2018	2020	2020	2020	2019
MT	2018	2020	2020	2020	2019
NL	2018	2020	2020	2019	2019
NO	2018	2020	2020	2020	2019
NZ	2018	2016	2020	2020	2016
PL	2018	2020	2020	2020	2019
PT	2018	2020	2020	2020	2019
RO	2018	2020	2020	2020	2019
RS	2018	2020	2020	2020	2019
SE	2018	2020	2020	2020	2019
SI	2018	2020	2020	2019	2019
SK	2018	2020	2020	2020	2019
TR	2018	2020	2020	2020	2019
UK	2018	2020	2020	2020	2018
US	2018	2020	2020	2020	2019

Table A3 PCT Applications per billion GDP (PPS), all years

Time Point (Actual year)	'2011' (2009)	'2012' (2010)	'2013' (2011)	'2014' (2012)	'2015' (2013)	'2016' (2014)	'2017' (2015)	'2018' (2016)	'2019' (2017)	'2020' (2018)
JP	9.5	10.9	12.0	12.3	11.4	11.0	11.0	12.2	12.7	13.2
SE	10.0	9.4	8.9	9.6	9.3	9.4	8.9	9.5	9.3	9.1
IL	10.9	10.2	10.1	10.8	10.0	10.2	10.5	9.8	9.4	9.0
FI	9.7	9.8	9.3	9.9	9.1	8.2	7.4	7.7	7.8	7.4
CH	7.1	7.2	7.2	7.3	6.6	6.3	6.3	6.5	6.8	6.9
DE	7.5	7.6	7.2	6.8	6.6	6.4	6.2	6.3	6.3	6.0
DK	6.6	6.3	6.7	6.1	6.3	6.0	6.0	6.1	6.1	5.8
NL	5.8	5.1	6.0	5.9	5.8	5.9	5.8	5.5	5.0	4.9
AT	4.9	5.3	5.1	4.7	5.0	4.9	4.8	4.7	4.8	4.5
US	3.9	4.0	4.2	4.4	4.9	4.3	4.1	4.2	4.1	4.0
FR	4.1	4.0	4.2	4.1	4.2	4.2	4.0	3.7	3.8	3.6
EU27_2020	3.9	3.9	4.0	3.8	3.8	3.8	3.6	3.6	3.5	3.4
BE	3.7	3.8	3.7	3.4	3.5	3.3	3.1	3.5	3.1	3.1
NO	3.7	3.4	3.0	2.9	3.0	2.8	2.8	3.6	3.2	3.0
UK	3.4	3.3	3.3	3.1	3.4	3.2	3.0	3.0	3.0	3.0
IS	3.5	2.8	3.3	3.3	3.3	3.3	3.2	2.4	3.4	2.6
IT	2.0	2.0	2.0	2.0	2.2	2.2	2.2	2.1	2.1	2.1
NZ	3.3	3.3	3.1	3.1	3.1	3.0	2.5	2.1	1.9	1.9
SI	3.1	3.1	3.0	2.8	3.4	3.0	1.7	1.9	2.6	1.5
LU	1.7	1.6	1.9	1.8	1.6	1.9	1.7	2.0	1.7	1.5
HU	1.5	1.5	1.5	1.4	1.4	1.3	1.4	1.3	1.2	1.4
ES	1.6	1.7	1.6	1.6	1.6	1.6	1.5	1.4	1.3	1.4
IE	2.7	2.3	2.7	2.3	2.5	2.4	1.8	2.0	1.7	1.4
EE	2.4	2.3	1.6	0.7	1.2	1.3	0.9	1.3	1.5	1.3
MT	0.3	0.7	0.2	0.8	0.9	1.4	1.0	1.6	1.2	1.2
PT	0.7	0.6	0.7	0.7	0.8	0.7	1.0	0.9	0.9	1.0
TR	0.5	0.6	0.5	0.6	0.6	0.7	0.7	0.8	0.8	1.0
LV	1.1	0.5	0.8	1.0	1.0	0.4	0.8	0.6	0.8	0.8
EL	0.4	0.4	0.4	0.6	0.6	0.6	0.5	0.6	0.6	0.7
CZ	0.8	0.7	0.8	0.9	1.1	1.1	1.0	0.8	0.8	0.6
ME	0.0	0.6	0.0	0.2	0.4	0.1	0.4	0.2	0.8	0.6
CY	0.6	0.3	0.5	0.4	0.7	0.8	0.5	0.5	0.5	0.6
HR	0.7	0.7	0.6	0.7	0.6	0.6	0.4	0.7	0.5	0.5
SK	0.4	0.5	0.5	0.4	0.6	0.4	0.5	0.7	0.6	0.5
PL	0.5	0.5	0.4	0.5	0.6	0.6	0.7	0.5	0.5	0.5
LT	0.3	0.4	0.4	0.8	0.8	0.8	0.4	0.6	0.5	0.5
BG	0.3	0.3	0.5	0.6	0.5	0.7	0.6	0.5	0.5	0.5
BR	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4
RS	0.3	0.3	0.2	0.4	0.3	0.4	0.4	0.4	0.3	0.3
MK	0.2	0.0	0.1	0.0	0.3	0.1	0.1	0.0	0.3	0.3
RO	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.2

Table A4 KIABI: Share of employment in knowledge-intensive activities in business industries (%), all years

Time Point (Actual year)	'2011' (2011)	'2012' (2012)	'2013' (2013)	'2014' (2014)	'2015' (2015)	'2016' (2016)	'2017' (2017)	'2018' (2018)	'2019' (2019)	'2020' (2020)
IL	33.4	33.3	33.0	33.2	33.2	33.2	33.6	34.1	34.1	34.1
LU	25.2	25.5	26.2	27.5	22.9	22.7	22.0	24.5	25.7	26.3
NZ	23.3	23.4	23.5	23.3	23.3	23.3	23.3	23.3	23.3	23.3
CH	19.4	20.1	20.2	20.8	20.7	21.3	21.4	21.7	21.9	22.4
IE	20.7	21.1	21.3	21.6	21.5	21.4	20.8	20.2	20.3	22.3
UK	17.2	17.6	17.8	18.0	18.3	18.4	18.4	18.8	19.2	20.8
MT	16.2	16.7	17.2	18.6	19.3	19.2	19.0	18.6	18.3	19.9
SE	17.2	17.6	17.7	17.9	18.2	18.4	18.5	18.8	19.0	19.8
IS	18.5	17.5	17.2	18.2	18.6	19.8	19.3	20.0	19.7	19.3
CY	15.1	16.9	17.2	17.2	16.2	16.4	17.0	17.7	17.2	18.3
FI	15.5	15.5	15.7	15.8	16.1	15.7	16.2	16.4	16.8	18.0
NL	14.9	15.3	17.1	17.3	17.4	17.5	17.1	17.7	17.8	17.8
JP	17.4	17.2	16.1	16.1	16.0	16.1	16.3	16.4	16.9	17.1
US	16.8	17.1	17.2	17.1	17.0	17.1	17.3	17.3	17.4	17.0
BE	14.8	15.2	15.3	15.4	15.5	15.2	15.6	15.7	16.0	16.6
DK	15.8	15.7	15.4	15.7	15.9	16.1	15.2	15.4	15.9	16.3
SI	13.7	14.1	14.0	14.0	14.1	13.7	13.7	13.9	14.6	16.1
NO	14.6	15.3	15.9	16.3	15.8	15.2	15.4	15.8	15.5	15.8
FR	14.4	14.3	14.0	14.0	14.3	14.3	14.5	14.7	15.1	15.5
AT	14.0	14.2	14.6	14.7	14.5	14.6	15.0	15.0	14.9	15.1
DE	15.4	15.3	14.7	14.6	14.6	14.8	14.8	14.8	15.0	15.0
IT	13.5	13.3	13.5	13.6	13.7	13.9	13.7	14.0	14.3	14.5
EU27_2020	13.1	13.2	13.2	13.3	13.4	13.5	13.6	13.7	13.9	14.2
EE	10.8	11.0	11.9	11.4	12.4	12.7	13.5	14.1	14.2	14.2
HU	13.0	12.5	12.9	12.3	12.0	12.2	11.6	11.8	12.2	13.3
CZ	12.3	12.7	13.0	12.7	12.4	12.8	12.9	13.2	13.1	13.1
ES	11.8	12.2	12.4	12.3	12.4	12.3	12.5	12.2	12.3	12.7
EL	11.4	12.4	12.5	12.2	12.0	12.2	12.1	12.1	12.2	12.6
LV	9.0	10.3	10.8	10.9	11.2	11.1	12.1	11.1	11.0	12.2
LT	8.9	9.1	9.0	8.8	9.3	9.7	9.7	10.4	11.0	12.1
PT	9.1	9.0	9.4	10.3	10.7	10.9	10.6	10.9	11.1	12.0
ME	10.5	10.2	11.0	10.7	11.7	11.4	11.2	10.8	11.9	12.0
HR	10.6	10.5	10.6	10.7	11.0	11.7	11.6	12.5	11.8	11.8
SK	10.4	10.1	9.6	9.9	9.6	10.0	10.6	10.2	11.0	11.7
BG	8.5	8.6	9.0	9.4	10.1	10.4	10.2	10.2	10.6	11.1
PL	9.2	9.7	9.6	9.9	10.0	10.0	10.3	10.4	10.6	10.9
BR	10.7	10.5	10.7	10.2	10.2	10.2	10.2	10.2	10.2	10.2
RS	8.5	7.7	8.7	9.1	9.3	9.1	9.4	9.7	9.7	9.9
RO	6.5	6.5	6.6	6.9	7.0	7.2	7.7	7.7	7.6	7.7
MK	7.2	7.0	6.2	6.3	6.3	6.5	6.3	6.3	7.0	7.7
TR	4.7	5.0	5.3	5.7	6.2	6.6	6.7	6.3	6.5	6.8

Table A5 GOOD: The share of medium- and high-tech products in total exports, all years

Time Point (Actual year)	'2011' (2011)	'2012' (2012)	'2013' (2013)	'2014' (2014)	'2015' (2015)	'2016' (2016)	'2017' (2017)	'2018' (2018)	'2019' (2019)	'2020' (2020)
JP	73.1	74.4	72.6	72.9	73.2	74.0	73.4	73.5	73.4	73.4
SK	60.3	61.7	63.6	65.0	66.6	68.0	67.2	67.8	69.0	70.8
HU	68.5	66.2	66.3	67.6	69.6	70.3	68.5	67.4	69.5	70.4
CZ	63.2	62.5	62.5	63.9	64.1	64.9	65.8	67.1	68.0	68.0
DE	65.5	66.0	66.2	66.5	67.6	68.2	68.6	68.5	68.1	67.4
SI	54.4	53.3	54.6	55.4	56.0	56.0	57.1	57.3	59.6	62.8
MK	38.8	41.1	45.6	52.1	56.0	57.0	57.4	60.6	61.9	62.5
EU27_2020x	59.2	58.7	59.1	59.7	61.5	61.8	61.7	61.5	61.9	62.3
IE	50.9	48.8	48.1	48.7	52.6	53.3	56.3	56.3	57.0	61.1
IL	51.4	51.8	52.3	51.5	54.9	53.6	57.3	56.8	55.3	60.4
MT	49.4	51.3	55.4	62.5	57.7	68.6	55.7	52.2	52.1	60.0
RO	50.4	50.2	50.7	50.9	52.8	54.9	55.8	57.2	57.4	58.9
EU27_2020	53.8	53.5	53.6	54.5	56.3	57.0	56.7	56.6	57.1	57.7
AT	53.9	55.1	56.6	57.0	57.6	57.8	58.0	57.4	58.3	57.6
CY	38.1	36.0	43.2	65.7	67.9	59.7	54.8	59.5	55.6	57.6
FR	56.2	57.1	57.2	57.4	58.6	59.3	58.6	58.3	58.8	57.3
SE	53.6	51.3	52.4	52.2	54.7	55.1	54.5	54.4	55.9	56.2
NL	43.4	42.8	42.1	44.3	48.6	49.7	49.7	49.9	50.9	54.2
CH	62.5	45.5	41.3	49.8	49.7	48.6	51.6	52.7	54.0	53.4
BE	46.8	46.7	45.9	46.6	48.3	48.9	48.0	48.0	50.7	53.1
DK	42.3	42.9	43.5	46.0	47.8	48.5	47.9	48.8	51.7	52.5
UK	45.6	48.5	43.5	51.9	53.3	57.9	56.3	52.3	53.3	52.1
IT	50.1	49.3	50.4	51.4	52.1	52.6	52.4	52.3	51.3	52.0
PL	49.6	48.2	48.7	48.9	49.4	49.6	48.8	48.6	49.4	49.3
FI	42.0	40.4	38.7	40.6	44.6	43.4	44.8	44.1	46.6	47.3
US	47.5	47.7	46.9	47.3	49.2	48.9	47.2	45.3	45.8	47.2
ES	47.2	44.3	46.0	45.5	47.8	48.8	46.8	45.8	46.0	46.1
LU	49.4	51.5	49.4	48.7	52.5	50.7	45.4	43.9	48.3	43.1
PT	36.8	36.5	35.2	35.9	36.8	37.9	38.5	40.1	42.5	42.6
EE	39.6	40.9	42.8	42.2	42.7	44.1	41.6	39.3	40.3	41.4
LT	32.4	31.9	31.1	34.7	34.5	35.3	36.9	36.8	38.0	40.2
TR	37.7	34.1	36.7	36.6	36.3	37.5	39.3	40.3	40.2	39.8
RS	26.6	33.2	41.1	40.0	39.1	39.6	38.6	38.4	38.7	39.5
HR	43.3	39.4	37.6	35.1	38.0	39.3	39.9	39.1	40.6	39.4
BG	25.9	25.7	26.8	29.1	31.0	32.5	33.0	34.7	35.7	36.8
LV	30.4	29.0	30.3	32.0	34.2	34.9	35.1	36.0	33.7	34.3
EL	21.1	18.4	18.0	19.4	22.5	22.5	21.2	21.4	23.2	29.1
ME	9.0	12.6	10.3	11.3	14.7	15.4	16.3	16.7	17.5	19.8
BR	23.3	24.1	25.7	23.0	24.9	26.7	25.1	25.1	21.3	17.3
NO	11.8	11.5	12.4	13.5	16.6	17.1	14.2	14.2	14.5	16.0
NZ	9.9	10.5	9.2	8.1	9.9	9.2	8.4	8.4	7.9	8.5
IS	11.9	11.8	10.0	11.5	9.6	10.6	10.3	8.7	12.0	8.0

Table A6 SERV: Knowledge-intensive services exports as percentage of total services exports (in %), all years

Time Point (Actual year)	'2011' (2011)	'2012' (2012)	'2013' (2013)	'2014' (2014)	'2015' (2015)	'2016' (2016)	'2017' (2017)	'2018' (2018)	'2019' (2019)	'2020' (2020)
IE	93.1	93.1	93.0	93.2	92.3	94.0	93.3	92.9	93.5	93.5
CY	71.5	69.3	68.7	71.9	73.5	74.1	73.2	73.6	74.3	92.2
LU	86.9	87.1	87.3	88.4	90.2	90.2	90.6	90.8	91.3	91.3
UK	83.3	82.7	81.7	80.9	80.5	81.1	81.8	82.7	80.9	88.6
JP	81.9	78.1	79.1	77.4	74.6	73.1	72.6	70.0	69.3	84.5
NO	71.5	78.8	78.8	79.8	78.8	78.3	76.9	77.2	76.7	83.7
FI	64.1	78.0	74.5	76.5	77.0	77.3	76.0	74.6	77.3	83.1
US	70.8	70.5	69.6	69.9	68.3	68.8	70.0	69.6	70.2	82.9
BR	70.6	70.8	70.6	77.2	77.7	77.0	78.1	75.5	77.1	80.9
IL	75.9	75.2	76.6	76.1	74.3	76.7	76.3	78.2	79.0	79.0
DE	76.3	76.9	74.9	73.5	74.8	75.2	75.4	74.6	68.0	77.9
EL	56.8	56.8	52.0	51.4	51.0	51.5	52.9	53.6	51.4	74.5
DK	78.1	79.3	78.2	78.0	74.7	70.9	71.6	69.6	74.4	74.4
BE	65.6	65.5	67.2	67.1	69.8	70.8	71.5	71.4	70.9	73.8
CH	66.3	67.4	66.3	66.8	68.7	70.4	68.9	68.1	67.4	72.3
SE	73.7	73.8	75.4	75.1	75.2	73.2	72.0	74.9	77.5	69.2
FR	62.9	63.0	63.1	63.9	63.1	64.1	61.8	62.9	62.8	68.8
NL	76.6	76.6	76.6	76.6	78.3	77.4	77.9	78.8	80.0	67.6
EU27_2020x	71.6	71.3	71.7	73.2	73.2	73.1	73.1	73.0	73.9	67.0
EU27_2020	63.9	64.5	64.4	65.5	66.3	66.3	66.1	66.3	67.3	63.2
IT	52.2	53.2	51.7	51.2	50.5	51.1	51.2	49.4	48.4	63.0
EE	46.3	46.1	45.0	45.3	44.4	47.9	49.7	50.3	47.3	61.0
RS	41.6	44.9	44.4	43.8	47.6	43.8	50.9	51.4	55.3	59.7
BG	30.2	32.5	31.9	37.6	43.3	42.5	41.0	41.4	44.9	56.6
LV	50.6	50.1	50.5	46.9	50.5	52.0	51.3	53.4	52.8	55.4
HU	49.5	48.7	47.9	48.5	47.3	48.2	49.4	49.5	49.1	54.8
ES	30.7	30.7	29.6	32.1	32.2	32.8	31.4	30.4	31.7	53.1
MT	66.4	66.6	66.3	57.9	57.9	57.9	50.3	52.0	49.6	52.2
RO	44.8	44.8	44.8	44.3	44.0	45.3	44.2	46.1	48.0	51.8
CZ	40.0	40.7	42.7	42.7	41.6	43.5	43.0	43.7	44.8	51.6
AT	45.1	45.1	44.8	44.6	44.1	43.3	43.9	44.8	45.7	50.5
TR	27.0	29.0	38.6	38.6	38.0	41.8	42.1	42.6	40.3	50.3
IS	59.4	59.4	59.4	59.5	57.1	51.7	51.7	50.3	49.8	49.8
PL	39.7	39.3	38.3	39.1	40.1	40.9	41.5	42.8	44.5	49.0
PT	43.4	42.4	43.7	43.4	41.9	39.6	37.7	36.9	36.4	47.5
SK	35.4	35.4	35.4	35.3	34.4	34.7	38.3	39.2	38.5	45.6
ME	19.6	20.0	20.0	19.1	19.6	18.9	18.6	19.3	18.8	38.8
MK	25.8	26.4	26.7	24.9	25.3	29.0	29.5	31.2	34.5	36.9
NZ	36.6	37.0	36.7	34.1	31.7	31.9	32.4	33.0	34.0	31.0
HR	20.3	20.0	17.9	20.3	20.3	20.0	20.1	20.9	21.6	27.3
SI	26.8	25.8	24.9	26.8	27.0	27.4	28.1	27.5	27.2	27.2
LT	18.1	18.0	19.0	18.7	18.8	23.2	20.1	14.3	19.0	22.8

Table A7 DYN: Employment in fast-growing enterprises in the top 50% most innovative sectors as a percentage of total employment (in %), all years

Time Point (Actual year)	'2011' (2010)	'2012' (2011)	'2013' (2012)	'2014' (2013)	'2015' (2014)	'2016' (2015)	'2017' (2016)	'2018' (2017)	'2019' (2018)	'2020' (2019)
IE	6.6	6.6	6.6	6.6	8.8	7.1	8.5	10.3	10.8	10.8
MT	5.9	5.9	5.9	5.8	7.3	7.3	7.2	7.2	7.2	8.2
HU	7.5	7.5	7.5	7.7	7.6	8.7	8.5	9.4	8.9	8.1
SK	9.6	9.6	9.6	9.3	7.4	7.7	7.3	8.6	9.2	7.8
FI	3.4	3.4	3.4	3.4	5.0	5.0	5.4	6.5	6.9	7.6
EL	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.4	7.5
UK	6.6	6.6	6.6	7.4	6.9	6.5	7.1	6.8	7.2	7.2
NL	5.2	5.2	5.2	5.7	5.5	4.8	5.1	5.6	6.6	6.9
PT	3.1	3.1	3.1	3.3	3.7	5.0	4.9	5.5	6.2	6.9
PL	6.3	6.3	6.3	5.2	5.5	5.8	6.2	6.3	6.8	6.7
BG	6.2	6.2	6.2	6.3	6.1	6.6	7.5	7.3	7.0	6.6
IL	7.3	7.3	7.9	6.9	6.5	6.0	6.0	6.1	6.6	6.6
SE	6.5	6.5	6.5	7.2	6.0	5.5	6.2	7.0	7.6	6.5
LU	3.1	3.1	3.1	3.9	4.2	4.6	4.7	6.2	6.9	6.2
ES	3.2	3.2	3.2	3.1	3.5	4.8	5.3	6.2	6.2	6.1
CZ	6.7	6.7	6.7	7.3	4.9	6.5	7.2	8.0	6.1	6.1
DE	5.9	5.9	5.9	5.7	4.5	4.6	4.8	5.1	5.8	6.1
BR	7.6	8.0	7.4	6.6	5.9	5.9	5.9	5.9	5.9	5.9
SI	2.9	2.9	2.9	2.7	2.9	3.2	3.9	4.9	6.5	5.9
DK	6.5	6.5	6.5	4.5	4.3	4.5	4.9	5.2	5.6	5.7
EU27_2020	4.8	4.8	4.8	4.6	4.2	4.6	4.8	5.2	5.5	5.5
TR	6.2	6.2	6.2	6.2	6.2	6.0	5.8	5.4	5.2	5.2
NZ	3.4	3.6	4.9	4.7	5.0	5.1	5.1	5.1	5.1	5.1
LV	3.2	3.2	3.2	4.4	4.8	5.2	5.6	5.7	5.0	4.6
EE	3.0	3.0	3.0	4.8	3.4	3.4	2.8	3.1	4.3	4.5
HR	2.6	2.6	2.6	2.8	2.6	3.3	3.3	3.9	4.0	4.2
FR	5.1	5.1	5.1	4.9	4.3	4.1	4.2	3.8	4.2	4.1
LT	4.5	4.5	4.5	4.5	4.0	2.1	2.5	3.6	2.9	4.1
NO	4.3	4.3	4.3	5.0	4.8	4.1	3.1	2.8	3.1	3.8
IT	2.9	2.9	2.9	3.2	2.6	3.1	3.3	3.7	4.3	3.7
CH	3.2	3.2	3.2	3.2	3.2	3.2	3.1	3.1	3.6	3.6
AT	2.9	2.9	2.9	3.1	2.4	1.9	2.2	2.5	3.0	3.3
BE	2.4	2.4	2.4	2.6	2.4	2.7	2.8	3.6	1.7	2.2
RO	2.1	2.1	2.1	2.2	2.8	2.6	3.6	3.4	2.8	2.0
IS	2.2	2.2	3.9	3.8	3.5	5.5	6.5	5.1	4.0	1.7
CY	1.3	1.3	1.3	0.6	0.8	0.1	1.8	1.8	1.5	1.6

Table A8 Innovation Output Indicator scores: European countries' comparison, all years

Country	'2011'	'2012'	'2013'	'2014'	'2015'	'2016'	'2017'	'2018'	'2019'	'2020'
IL	155.1	153.5	156.6	152.6	149.4	147.1	148.8	148.8	150.3	150.4
IE	120.6	119.8	120.8	120.5	133.6	124.7	130.6	139.9	142.8	145.3
JP	129.4	128.3	139.8	131.3	129.3	128.8	126.9	123.7	128.8	138.5
FI	105.6	107.7	106.0	108.0	116.7	113.5	114.7	121.4	125.0	130.7
SE	129.4	128.2	127.8	133.2	126.7	123.9	126.5	133.4	137.1	130.2
UK	115.4	116.1	115.1	121.0	119.9	118.0	121.1	119.1	121.7	124.7
LU	103.7	104.4	105.5	111.2	108.0	110.0	108.5	120.0	125.8	121.0
MT	101.6	103.6	103.9	106.3	114.9	118.0	112.8	113.2	111.5	120.8
NL	108.7	107.6	111.6	114.6	114.5	111.4	112.2	115.2	120.2	120.4
DE	121.1	121.2	119.4	117.5	110.9	111.3	111.8	113.8	116.9	119.2
HU	110.3	109.1	109.6	110.1	109.3	115.9	114.2	118.8	116.8	115.1
DK	118.9	118.3	118.8	106.9	106.6	106.6	107.8	109.7	114.2	114.9
CH	108.4	106.2	105.4	108.0	106.8	106.8	106.3	107.5	111.3	112.8
US	112.9	106.0	108.9	106.8	107.7	106.7	99.5	104.7	103.9	111.7
SK	112.2	112.3	112.2	111.2	100.9	103.1	102.3	109.6	113.8	108.1
EU27_2020	100.0	100.1	100.2	99.5	98.2	100.5	101.0	103.4	105.7	105.2
EL	87.6	88.2	87.5	87.6	88.0	88.3	88.0	88.3	87.3	104.3
CZ	101.2	101.4	102.4	105.7	92.5	102.1	105.6	110.8	100.5	101.3
SI	82.6	82.7	82.5	81.7	84.8	84.9	86.4	92.2	103.9	100.6
FR	104.2	104.1	104.1	102.8	100.1	99.7	99.1	97.0	99.5	100.2
PT	72.1	71.6	72.2	74.9	77.7	84.5	84.2	87.7	92.7	99.0
ES	78.3	78.4	78.7	78.0	81.0	88.3	90.6	94.4	94.9	98.4
PL	91.4	91.7	91.5	86.4	88.5	90.3	92.8	93.6	96.5	97.5
BG	83.3	83.7	84.7	87.4	88.7	92.3	96.3	95.6	94.9	95.7
NZ	90.3	92.1	98.5	96.4	98.3	98.1	96.8	96.1	95.7	95.3
AT	90.0	91.2	91.7	92.1	88.7	85.9	87.5	89.5	92.5	94.5
NO	91.7	93.1	93.1	97.6	96.3	91.2	85.4	86.2	86.4	91.4
IT	83.5	83.2	83.5	85.2	82.8	85.9	86.6	88.7	91.9	91.4
EE	78.6	79.0	78.7	85.8	80.7	81.7	78.7	81.5	88.2	91.1
BR	99.7	101.9	99.1	94.9	91.2	91.4	91.3	91.0	90.5	90.3
BE	87.3	88.0	88.1	88.8	89.0	89.8	90.4	95.6	85.4	89.7
CY	74.2	74.9	77.2	78.1	79.2	74.7	83.0	84.9	81.8	87.2
RS	77.2	84.0	86.7	79.8	82.1	81.7	81.1	82.6	84.1	87.0
LV	73.8	73.6	75.3	82.0	85.7	86.6	90.9	90.1	86.3	86.1
TR	80.9	81.0	83.1	83.8	84.4	85.2	84.6	82.3	81.3	83.5
MK	71.6	75.6	74.9	77.2	78.1	81.1	79.5	81.1	84.8	83.3
HR	68.8	67.9	67.2	68.5	68.2	73.0	72.7	77.5	77.2	79.1
LT	73.8	74.1	73.9	75.2	73.4	64.2	65.3	71.9	69.5	78.4
IS	82.7	79.8	89.4	90.4	88.1	100.4	104.9	95.8	92.1	76.3
ME	62.7	71.2	69.3	66.5	75.8	69.7	76.0	69.7	69.2	74.1
RO	65.2	65.1	65.4	66.6	70.4	70.0	76.3	76.0	72.6	69.5

Table A9 Innovation Output Indicator scores: International Comparison, all years

Country	'2011'	'2012'	'2013'	'2014'	'2015'	'2016'	'2017'	'2018'	'2019'	'2020'
IL	151.7	150.1	153.1	149.2	146.0	143.8	145.5	145.4	146.9	147.0
IE	117.8	117.1	118.1	117.7	130.5	121.9	127.7	136.7	139.6	142.0
JP	126.5	125.4	136.6	128.3	126.4	125.9	124.0	120.9	125.9	135.3
FI	103.3	105.3	103.7	105.6	114.1	111.0	112.1	118.6	122.2	127.8
SE	126.5	125.3	124.9	130.2	123.8	121.1	123.6	130.4	134.0	127.3
UK	112.8	113.5	112.5	118.3	117.2	115.3	118.3	116.4	119.0	121.8
LU	101.3	102.0	103.1	108.7	105.6	107.5	106.0	117.3	122.9	118.3
MT	99.3	101.2	101.6	103.9	112.3	115.4	110.3	110.7	109.0	118.1
NL	106.2	105.2	109.1	112.0	111.9	108.9	109.6	112.6	117.5	117.6
DE	118.3	118.5	116.7	114.8	108.3	108.8	109.3	111.2	114.2	116.5
HU	107.8	106.6	107.1	107.6	106.8	113.3	111.7	116.2	114.2	112.5
DK	116.2	115.6	116.1	104.5	104.2	104.2	105.4	107.2	111.6	112.3
CH	106.0	103.8	103.0	105.5	104.3	104.4	103.9	105.1	108.8	110.2
US	110.4	103.6	106.4	104.4	105.2	104.3	97.2	102.4	101.6	109.1
SK	109.7	109.8	109.7	108.7	98.6	100.8	100.0	107.2	111.2	105.6
EU27x	100.0	99.9	100.1	99.5	98.0	100.2	100.8	103.1	105.2	104.3
EL	85.6	86.2	85.6	85.7	86.0	86.4	86.0	86.3	85.3	101.9
CZ	98.9	99.1	100.1	103.3	90.4	99.8	103.2	108.3	98.2	99.0
SI	80.7	80.9	80.6	79.9	82.9	83.0	84.5	90.2	101.6	98.4
FR	101.8	101.7	101.7	100.5	97.9	97.4	96.9	94.8	97.3	98.0
PT	70.4	70.0	70.6	73.2	75.9	82.6	82.3	85.8	90.6	96.8
ES	76.5	76.7	77.0	76.3	79.2	86.3	88.6	92.3	92.8	96.1
PL	89.3	89.6	89.4	84.5	86.5	88.3	90.7	91.5	94.3	95.3
BG	81.4	81.9	82.9	85.5	86.7	90.3	94.2	93.5	92.8	93.5
NZ	88.3	90.1	96.4	94.3	96.2	95.9	94.7	94.0	93.6	93.2
AT	88.0	89.1	89.6	90.0	86.7	83.9	85.5	87.4	90.4	92.4
NO	89.7	91.0	91.1	95.5	94.1	89.2	83.5	84.2	84.5	89.4
IT	81.7	81.3	81.6	83.3	81.0	84.0	84.6	86.7	89.9	89.4
EE	76.8	77.2	77.0	83.9	78.9	79.8	76.9	79.7	86.2	89.1
BR	97.5	99.6	96.8	92.8	89.2	89.4	89.3	89.0	88.5	88.3
BE	85.4	86.0	86.1	86.8	86.9	87.8	88.4	93.4	83.5	87.7
CY	72.5	73.3	75.4	76.3	77.3	73.0	81.1	83.0	80.0	85.2
RS	75.4	82.1	84.8	78.1	80.2	79.8	79.3	80.7	82.3	85.1
LV	72.1	71.9	73.6	80.1	83.8	84.7	88.8	88.1	84.4	84.2
TR	79.1	79.2	81.3	82.0	82.5	83.3	82.7	80.5	79.5	81.6
MK	70.1	73.9	73.2	75.4	76.3	79.3	77.7	79.3	82.9	81.4
HR	67.2	66.4	65.7	67.0	66.7	71.4	71.0	75.8	75.5	77.3
LT	72.2	72.5	72.2	73.6	71.7	62.8	63.9	70.4	68.0	76.7
IS	80.9	78.1	87.5	88.4	86.2	98.2	102.6	93.7	90.1	74.6
ME	61.4	69.7	67.8	65.0	74.2	68.2	74.3	68.2	67.7	72.4
RO	63.7	63.6	64.0	65.0	68.8	68.5	74.6	74.2	71.0	67.9

Table A10 Comparison of IOI2021 and IOI2019 scores

	IOI2021		IOI2019
Country	**2018**	**2020**	**2018**
AT	89.5	94.5	87.8
BE	95.6	89.7	92.8
BG	95.6	95.7	92.8
BR	91.0	90.3	89.7
CH	107.5	112.8	105.1
CY	84.9	87.2	85.6
CZ	110.8	101.3	108.1
DE	113.8	119.2	110.9
DK	109.7	114.9	108.0
EE	81.5	91.1	79.3
EL	88.3	104.3	70.4
ES	94.4	98.4	92.6
EU27_2020	103.4	105.2	n.a.
FI	121.4	130.7	99.6
FR	97.0	100.2	94.3
HR	77.5	79.1	75.3
HU	118.8	115.1	116.4
IE	139.9	145.3	136.9
IL	148.8	150.4	141.4
IS	95.8	76.3	93.7
IT	88.7	91.4	86.6
JP	123.7	138.5	121.0
LT	71.9	78.4	71.0
LU	120.0	121.0	118.0
LV	90.1	86.1	87.7
ME	69.7	74.1	66.8
MK	81.1	83.3	74.5
MT	106.4	120.8	114.3
NL	115.2	120.4	112.1
NO	86.2	91.4	83.9
NZ	96.1	95.3	93.6
PL	93.6	97.5	91.1
PT	87.7	99.0	85.9
RO	76.0	69.5	73.9
RS	82.6	87.0	74.9
SE	133.4	130.2	129.6
SI	92.2	100.6	91.4
SK	109.6	108.1	106.9
TR	82.3	83.5	75.3
UK	119.1	124.7	116.2
US	104.7	111.7	105.7

Table A11 Comparison of the scores and ranks of the IOI2021, Summary Innovation Index and selected European Innovation Scoreboard pillars

	2020 Scores				2020 Rank			
Country	IOI2021	SII	EIS Employment pillar	EIS Sales pillar	IOI2021	SII	EIS Employment pillar	EIS Sales pillar
IL	150.4	0.6	1.0	0.8	1	15	1	2
IE	145.3	0.6	0.6	0.7	2	16	19	3
FI	130.7	0.7	0.7	0.6	4	3	11	8
SE	130.2	0.7	0.7	0.7	5	2	4	5
UK	124.7	0.6	0.7	0.7	6	8	5	4
LU	121.0	0.6	0.7	0.6	7	9	8	12
MT	120.8	0.5	0.6	0.4	8	20	15	26
NL	120.4	0.6	0.6	0.6	9	6	16	13
DE	119.2	0.6	0.7	0.8	10	7	9	1
HU	115.1	0.4	0.2	0.6	11	28	33	14
DK	114.9	0.7	0.6	0.5	12	4	17	24
CH	112.8	0.8	0.8	0.6	13	1	3	7
SK	108.1	0.3	0.2	0.6	15	30	32	17
EU27_2020	105.2	0.5	0.5	0.6	16	17	23	10
EL	104.3	0.4	0.5	0.6	17	26	21	19
CZ	101.3	0.4	0.4	0.6	18	23	27	11
SI	100.6	0.5	0.5	0.5	19	21	24	20
FR	100.2	0.6	0.5	0.6	20	14	20	18
PT	99.0	0.4	0.3	0.4	21	25	28	28
ES	98.4	0.4	0.3	0.5	22	22	29	25
PL	97.5	0.3	0.2	0.4	23	31	35	29
BG	95.7	0.2	0.2	0.3	24	35	31	34
AT	94.5	0.6	0.6	0.6	26	10	12	15
NO	91.4	0.6	0.8	0.4	27	11	2	31
IT	91.4	0.5	0.6	0.6	28	18	14	16
EE	91.1	0.6	0.7	0.5	29	12	6	22
BE	89.7	0.7	0.7	0.7	31	5	10	6
CY	87.2	0.5	0.7	0.6	32	19	7	9
RS	87.0	0.3	0.5	0.5	33	29	22	23
LV	86.1	0.3	0.3	0.4	34	32	30	32
TR	83.5	0.3	0.1	0.4	35	33	36	27
MK	83.3	0.2	0.2	0.4	36	36	34	30
HR	79.1	0.4	0.4	0.3	37	27	26	33
LT	78.4	0.4	0.4	0.3	38	24	25	35
IS	76.3	0.6	0.6	0.2	39	13	13	36
ME	74.1	0.3	0.6	0.1	40	34	18	37
RO	69.5	0.2	0.1	0.5	41	37	37	21

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