European Innovation Scoreboard 2016

Methodology report

This report was prepared by:

Hugo Hollanders, Nordine Es-Sadki, and Minna Kanerva

Maastricht University (Maastricht Economic and Social Research Institute on Innovation and Technology – MERIT)

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Coordinated and guided by:

Mark Nicklas, Acting Head of Unit, Daniel Bloemers,
Alberto Licciardello, and Marshall Hsia

Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs

Directorate F – Innovation and Advanced Manufacturing

Unit F1 – Innovation Policy and Investment for Growth

in close co-operation with

Román Arjona, Chief Economist, Marnix Surgeon, Deputy Head of Unit,
and Richard Deiss

Directorate-General for Research and Innovation

Unit A4 – Analysis and monitoring of national research policies

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1. Introduction

The annual European Innovation Scoreboard (EIS) provides a comparative assessment of the research and innovation performance of the EU Member States and the relative strengths and weaknesses of their research and innovation systems. It helps Member States assess areas in which they need to concentrate their efforts in order to boost their innovation performance.

This Methodology report will discuss the definitions and rationale for the indicators included in the EIS 2016. The report will also provide a detailed discussion of the methodology used for calculating the composite innovation index. Finally, the report will discuss the impact of several changes in the methodology on countries' performance scores.

2. European Innovation Scoreboard indicators

2.1 The innovation indicators

The EIS 2016 largely follows the methodology of previous editions in distinguishing between three main types of indicators and eight innovation dimensions, capturing in total 25 different indicators (cf. Table 1).

The **Enablers** capture the main drivers of innovation performance external to the firm and differentiate between three innovation dimensions. The Human resources dimension includes three indicators and measures the availability of a high-skilled and educated workforce. The Open, excellent and attractive research systems dimension includes three indicators and measures the international competitiveness of the science base. The Finance and support dimension includes two indicators and measures the availability of finance for innovation projects and the support of governments for research and innovation activities.

Firm activities capture the innovation efforts at the level of the firm and differentiate between three innovation dimensions. The Firm investments dimension includes two indicators of both R&D and non-R&D investments that enterprises make in order to generate innovations. The Linkages & entrepreneurship dimension includes three indicators and measures entrepreneurial efforts and collaboration efforts among innovating enterprises and also with the public sector. The Intellectual assets dimension captures different forms of Intellectual Property Rights (IPR) generated as a throughput in the innovation process.

Outputs capture the effects of enterprises' innovation activities and differentiate between two innovation dimensions. The Innovators dimension includes three indicators and measures the number of enterprises that have introduced innovations onto the market or within their organisations, covering both technological and non-technological innovations and the presence of high-growth enterprises. The Economic effects dimension includes five indicators and captures the economic success of innovation in employment, exports, and sales due to innovation activities.

Table 1: European Innovation Scoreboard indicators

MAIN TYPE / Innovation dimension / Indicator	**Data source**
ENABLERS	
Human resources	
1.1.1 New doctorate graduates per 1000 population aged 25-34	Eurostat
1.1.2 Percentage population aged 30-34 having completed tertiary education	Eurostat
1.1.3 Percentage youth aged 20-24 having attained at least upper secondary level education	Eurostat
Open, excellent and attractive research systems	
1.2.1 International scientific co-publications per million population	Web of Science
1.2.2 Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country	Web of Science
1.2.3 Non-EU doctorate students as percentage of all doctorate students	Eurostat
Finance and support	
1.3.1 R&D expenditure in the public sector as percentage of GDP	Eurostat
1.3.2 Venture capital investment as percentage of GDP	Venture capital: Invest Europe GDP: Eurostat
FIRM ACTIVITIES	
Firm investments	
2.1.1 R&D expenditure in the business sector as percentage of GDP	Eurostat
2.1.2 Non-R&D innovation expenditures as percentage of turnover	Eurostat
Linkages & entrepreneurship	
2.2.1 SMEs innovating in-house as percentage of SMEs	Eurostat
2.2.2 Innovative SMEs collaborating with others as percentage of SMEs	Eurostat
2.2.3 Public-private co-publications per million population	Web of Science
Intellectual assets	
2.3.1 PCT patents applications per billion GDP (Purchasing Power Standard €)	Patents: OECD GDP: Eurostat
2.3.2 PCT patent applications in societal challenges (environment-related technologies; health) per billion GDP (Purchasing Power Standard €)	Patents: OECD GDP: Eurostat
2.3.3 Community trademarks per billion GDP (Purchasing Power Standard €)	Trademarks: EUIPO GDP: Eurostat
2.3.4 Community designs per billion GDP (Purchasing Power Standard €)	Designs: EUIPO GDP: Eurostat
OUTPUTS	
Innovators	
3.1.1 SMEs introducing product or process innovations as percentage of SMEs	Eurostat
3.1.2 SMEs introducing marketing or organisational innovations as percentage of SMEs	Eurostat
3.1.3 Employment in fast-growing enterprises (average innovativeness scores)	Joint Research Centre
Economic effects	
3.2.1 Employment in knowledge-intensive activities (manufacturing and services) as percentage of total employment	Eurostat
3.2.2 Medium and high technology product exports as percentage of total product exports	Eurostat
3.2.3 Knowledge-intensive services exports as percentage of total service exports	Joint Research Centre
3.2.4 Sales of new-to-market and new-to-firm innovations as percentage of turnover	Eurostat
3.2.5 License and patent revenues from abroad as percentage of GDP	Eurostat

2.2 Innovation indicators definitions

This section presents the definitions of the indicators.

Indicator 1.1.1 New doctorate graduates per 1000 population aged 25-34

Numerator: Number of doctorate graduates (ISCED 8)

Denominator: The reference population is all age classes between 25 and 34 years inclusive.

Rationale: The indicator is a measure of the supply of new second-stage tertiary graduates in all fields of training. For most countries, ISCED 8 captures PhD graduates only, with the exception of Finland, Portugal, and Sweden, where also non-PhD degrees leading to an award of an advanced research qualification are included.

Data source: Eurostat

Indicator 1.1.2 Percentage population aged 30-34 having completed tertiary education

Numerator: Number of persons in age class with some form of post-secondary education (ISCED 5-8)

Denominator: The reference population is all age classes between 30 and 34 years inclusive.

Rationale: This is a general indicator of the supply of advanced skills. It is not limited to science and technical fields because the adoption of innovations in many areas, in particular in the service sectors, depends on a wide range of skills. International comparisons of educational levels, however, are difficult due to large discrepancies in educational systems, including access to tertiary education, and the level of attainment that is required to receive a tertiary degree. The indicator focuses on a narrow share of the population aged 30 to 34, and it will more easily and quickly reflect changes in educational policies leading to more tertiary graduates.

Data source: Eurostat

Indicator 1.1.3 Percentage youth aged 20-24 having attained at least upper secondary level education

Numerator: Number of young people aged 20-24 having attained at least upper secondary education

Denominator: The reference population is all age classes between 20 and 24 years inclusive.

Rationale: The indicator measures the qualification level of the population aged 20-24 years in terms of formal educational degrees. It provides a measure for the "supply" of human capital of that age group and for the output of education systems in terms of graduates. Completed upper secondary education is generally considered to be the minimum level required for successful participation in a knowledge-based society and is positively linked with economic growth.

Data source: Eurostat

Indicator 1.2.1 International scientific co-publications per million population

Numerator: Number of scientific publications with at least one co-author based abroad (where abroad is non-EU for the EU28)

Denominator: Total population

Rationale: International scientific co-publications are a proxy for the quality of scientific research as collaboration increases scientific productivity.

Data sources: Publications: Web of Science (calculations by CWTS); population: Eurostat

Indicator 1.2.2 Scientific publications among the top-10% most cited publications worldwide as % of total scientific publications of the country

Numerator: Number of scientific publications among the top-10% most cited publications worldwide

Denominator: Total number of scientific publications.

Rationale: The indicator is a proxy for the efficiency of the research system as highly cited publications are assumed to be of higher quality. There could be a bias towards small or English speaking countries given the coverage of Scopus' publication data. Countries like France and Germany, where researchers publish relatively more in their own language, are more likely to underperform on this indicator as compared to their real academic excellence.

Data source: Web of Science (calculations by CWTS)

Indicator 1.2.3 Non-EU doctorate students as % of total doctorate students

Numerator: Number of doctorate students coming from a non-EU country. For non-EU countries, the number of non-national doctorate students is used

Denominator: Total number of doctorate students

Rationale: The share of non-EU doctorate students reflects the mobility of students as an effective way of diffusing knowledge. Attracting high-skilled foreign doctorate students will add to creating a net brain gain and will secure a continuous supply of researchers.

Data source: Eurostat

Indicator 1.3.1 R&D expenditure in the public sector (% of GDP)

Numerator: All R&D expenditures in the government sector (GOVERD) and the higher education sector (HERD). Both GOVERD and HERD according to Frascati Manual definitions[1], in national currency and current prices

Denominator: Gross domestic product as defined in the European System of Accounts (ESA 2010), in national currency and current prices

Rationale: R&D expenditure represents one of the major drivers of economic growth in a knowledge-based economy. As such, trends in the R&D expenditure indicator provide key indications of the future competitiveness and wealth of the EU. Research and development spending is essential for making the transition to a knowledge-based economy as well as for improving production technologies and stimulating growth.

[1] The OECD's Frascati Manual is the internationally recognised methodology for collecting and using R&D statistics. It is an essential tool for statisticians and science and innovation policy makers worldwide. It includes definitions of basic concepts, data collection guidelines, and classifications for compiling R&D statistics. The 2015 edition is available at: http://www.oecd.org/publications/frascati-manual-2015-9789264239012-en.htm

Data source: Eurostat

Indicator 1.3.2 Venture capital (% of GDP)

Numerator: Venture capital investment is defined as private equity being raised for investment in companies. Management buyouts, management buy-ins, and venture purchase of quoted shares are excluded. Data include two investment stages: Early stage (seed + start-up) and Expansion and replacement. Seed capital is defined as financing provided to research, assess and develop an initial concept before a business has reached the start-up phase. Start-up capital is defined as financing provided for product development and initial marketing, manufacturing, and sales. Companies may be in the process of being set up or may have been in business for a short period of time, but have not sold their product commercially. Expansion capital is defined as financing provided for the growth and expansion of a company which is breaking even or trading profitably. Capital may be used to finance increased production capacity, market or product development, and/or provide additional working capital. It includes bridge financing for the transition from private to public quoted company, and rescue/turnaround financing. Replacement capital is defined as purchase of existing shares in a company from another private equity investment organisation or from another shareholder(s). It includes refinancing of bank debt.

Denominator: Gross domestic product as defined in the European System of Accounts (ESA 2010), in national currency and current prices

Rationale: The amount of venture capital is a proxy for the relative dynamism of new business creation. In particular for enterprises using or developing new (risky) technologies, venture capital is often the only available means of financing their (expanding) business.

Data sources: Venture capital expenditure: Invest Europe; GDP: Eurostat

Indicator 2.1.1 R&D expenditure in the business sector (% of GDP)

Numerator: All R&D expenditures in the business sector (BERD), according to Frascati Manual definitions[2], in national currency and current prices

Denominator: Gross domestic product as defined in the European System of Accounts (ESA 2010), in national currency and current prices

Rationale: The indicator captures the formal creation of new knowledge within enterprises. It is particularly important in the science-based sector (pharma-ceuticals, chemicals and some areas of electronics) where most new knowledge is created in or near R&D laboratories.

Data source: Eurostat

Indicator 2.1.2 Non-R&D innovation expenditures (% of total turnover)

Numerator: Sum of total innovation expenditure for enterprises, in national currency and current prices excluding intramural and extramural R&D expenditures

Denominator: Total turnover for all enterprises (both innovators and non-innovators), in national currency and current prices

Rationale: This indicator measures non-R&D innovation expenditure as percentage of total turnover. Several of the components of innovation expenditure, such as investment in equipment and machinery and the acquisition of patents and licenses, measure the diffusion of new production technology and ideas.

Data source: Eurostat (Community Innovation Survey)

[2] See previous footnote

Indicator 2.2.1 SMEs innovating in-house (% of all SMEs)

Numerator: Sum of SMEs with in-house innovation activities. Innovative enterprises are defined as enterprises which have introduced new products or processes, either in-house or in combination with other enterprises. This indicator does not include new products or processes developed by other enterprises.

Denominator: Total number of SMEs (both innovators and non-innovators)

Rationale: This indicator measures the degree to which SMEs, that have introduced any new or significantly improved products or production processes, have innovated in-house. The indicator is limited to SMEs because almost all large enterprises innovate and because countries with an industrial structure weighted towards larger enterprises tend to do better.

Data source: Eurostat (Community Innovation Survey)

Indicator 2.2.2 Innovative SMEs co-operating with others (% of all SMEs)

Numerator: Sum of SMEs with innovation co-operation activities. Enterprises with co-operation activities are those that had any co-operation agreements on innovation activities with other enterprises or institutions in the three years of the survey period.

Denominator: Total number of SMEs (both innovators and non-innovators)

Rationale: This indicator measures the degree to which SMEs are involved in innovation co-operation. Complex innovations, in particular in ICT, often depend on the ability to draw on diverse sources of information and knowledge, or to collaborate on the development of an innovation. This indicator measures the flow of knowledge between public research institutions and enterprises, and between enterprises and other enterprises. The indicator is limited to SMEs because almost all large enterprises are involved in innovation co-operation.

Data source: Eurostat (Community Innovation Survey)

Indicator 2.2.3 Public-private co-publications per million population

Numerator: Number of public-private co-authored publications. The "public-private co-publications" are defined as all research-related papers (document types: 'research articles', 'research reviews', notes' and 'letters') published in the Web of Science database. These co-publications have been allocated to one or more countries according to the geographical location of the business enterprise (or enterprises) that are listed in the authors affiliate address(es); as a result, the geographical location of the public sector research partner(s) in those addresses is not relevant. Each co-publication is counted as one publication for each country, irrespective of the number of co-authors and (parent) organisations listed in the author affiliate address(es). The definition of the "private" sector excludes the private medical and health sector.

Denominator: Total population

Rationale: This indicator captures public-private research linkages and active collaboration activities between business sector researchers and public sector researchers resulting in academic publications.

Data sources: Publications: Web of Science (calculations by CWTS); population: Eurostat

Indicator 2.3.1 PCT patent applications per billion GDP (in PPS€)

Numerator: Number of patents applications filed under the PCT, at international phase, designating the European Patent Office (EPO). Patent counts are based on the priority date, the inventor's country of residence and fractional counts.

Denominator: Gross Domestic Product in Purchasing Power Standard Euros

Rationale: The capacity of enterprises to develop new products will determine their competitive advantage. One indicator of the rate of new product innovation is the number of patents. This indicator measures the number of PCT patent applications.

Data source: Patents: OECD; GDP: Eurostat

Indicator 2.3.2 PCT patent applications in societal challenges per billion GDP (in PPS€)

Numerator: Number of PCT patent applications in Environment-related technologies and Health. Patents in Environment-related technologies include those in Climate change mitigation technologies related to buildings, Climate change mitigation technologies related to energy generation, transmission or distribution, Capture, storage, sequestration or disposal of greenhouse gases, Environmental management, Climate change mitigation technologies related to transportation, and Water-related adaptation technologies. Patents in health-related technologies include those in Medical technology and Pharmaceuticals.

Denominator: Gross Domestic Product in Purchasing Power Standard Euros

Rationale: This indicator measures PCT applications in health technology and environment-related technologies and is highly relevant as increased numbers of patent applications in health technology and environment-related technologies will be necessary to meet the societal needs of an ageing European society and sustainable growth.

Data source: Patents: OECD; GDP: Eurostat

Indicator 2.3.3 Community trademarks per billion GDP (in PPS€)

Numerator: Number of new community trademarks. A trademark is a distinctive sign, identifying certain goods or services as those produced or provided by a specific person or enterprise. The Community trademark offers the advantage of uniform protection in all countries of the European Union through a single registration procedure with the Office for Harmonization.

Denominator: Gross Domestic Product in Purchasing Power Standard Euros

Rationale: Trademarks are an important innovation indicator, especially for the service sector. The Community trademark gives its proprietor a uniform right applicable in all Member States of the European Union through a single procedure which simplifies trademark policies at European level. It fulfils the three essential functions of a trademark: it identifies the origin of goods and services, guarantees consistent quality through evidence of the company's commitment vis-à-vis the consumer, and is a form of communication, a basis for publicity and advertising.

Data source: Trademarks: European Union Intellectual Property Office (EUIPO); GDP: Eurostat

Indicator 2.3.4 Community designs per billion GDP (in PPS€)

Numerator: Number of new community designs. A registered Community design is an exclusive right for the outward appearance of a product or part of it, resulting from the features of, in particular, the lines, contours, colours, shape, texture and/or materials of the product itself and/or its ornamentation.

Denominator: Gross Domestic Product in Purchasing Power Standard Euros

Rationale: A design is the outward appearance of a product or part of it resulting from the lines, contours, colours, shape, texture, materials and/or its ornamentation. A product can be any industrial or handicraft item including packaging, graphic symbols and typographic typefaces but excluding computer programs. It also includes products that are composed of multiple components, which may be disassembled and reassembled. Community design protection is directly enforceable in each Member State and it provides both the option of an unregistered and a registered Community design right for one area encompassing all Member States.

Data source: Designs: European Union Intellectual Property Office (EUIPO); GDP: Eurostat

Indicator 3.1.1 SMEs introducing product or process innovation (% of SMEs)

Numerator: Number of SMEs who introduced a new product or a new process to one of their markets

Denominator: Total number of SMEs

Rationale: Technological innovation, as measured by the introduction of new products (goods or services) and processes, is a key ingredient to innovation in manufacturing activities. Higher shares of technological innovators should reflect a higher level of innovation activities.

Data source: Eurostat (Community Innovation Survey)

Indicator 3.1.2 SMEs introducing marketing or organisational innovations (% of SMEs)

Numerator: Number of SMEs who introduced a new marketing innovation or organisational innovation to one of their markets

Denominator: Total number of SMEs

Rationale: The Community Innovation Survey mainly asks enterprises about their technological innovation. Many enterprises, in particular in the services sectors, innovate through other non-technological forms of innovation. Examples of these are marketing and organisational innovations. This indicator captures the extent that SMEs innovate through non-technological innovation.

Data source: Eurostat (Community Innovation Survey)

Indicator 3.1.3 Employment in fast-growing enterprises (average innovativeness scores) (% of total employment)

Numerator: Employment in fast-growing enterprises in innovative sectors is calculated through sector-specific innovation coefficients, reflecting the level of innovativeness of each sector, serving as a proxy for distinguishing innovative enterprises. These coefficients are weighted with sectoral shares of employment in fast-growing enterprises, providing an indication of the dynamism of fast-growing enterprises in innovative sectors. Fast-growing enterprises are defined as enterprises with average annualised growth in number of employees of more than

10 % a year, over a three-year period, and with 10 or more employees at the beginning of the observation period (period of growth).

The economic sectors included are the three-digit NACE business economy sectors as identified by the national statistical office based on national business register data and based on the number of employees in these enterprises. More details are provided in section 3.4 of the Staff Working Document SWD(2013) 325 on "Developing an indicator of innovation output"[3]

Denominator: Total employment in high-growth enterprises in the business economy

Rationale: This indicator provides an indication of the dynamism of fast-growing enterprises in innovative sectors as compared to all fast-growing business activities. It captures the capacity of a country to transform rapidly its economy to respond to new needs and to take advantage of emerging demand.

Data source: Indicator calculated by Joint Research Centre using Eurostat data

Indicator 3.2.1 Employment in knowledge-intensive activities (% of total employment)

Numerator: Number of employed persons in knowledge-intensive activities in business industries. Knowledge-intensive activities are defined, based on EU Labour Force Survey data, as all NACE Rev.2 industries at 2-digit level where at least 33% of employment has a higher education degree (ISCED 5-8).

Denominator: Total employment

Rationale: Knowledge-intensive activities provide services directly to consumers, such as telecommunications, or provide knowledge inputs to the innovative activities of other enterprises in all sectors of the economy.

Data source: Eurostat

Indicator 3.2.2 Exports of medium and high technology products (% share of total product exports)

Numerator: Value of medium and high technology exports, in national currency and current prices. Medium and high tech exports include exports of the following SITC Rev.3 products: 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.

Denominator: Value of total product exports, in national currency and current prices

Rationale: The indicator measures the technological competitiveness of the EU, i.e. the ability to commercialise the results of research and development (R&D) and innovation in the international markets. It also reflects product specialisation by country. Creating, exploiting and commercialising new technologies are vital for the competitiveness of a country in the modern economy. This is because medium and high technology products are key drivers for economic growth, productivity and welfare, and are generally a source of high value added and well-paid employment.

Data source: Eurostat (ComExt) (UN ComTrade for non-EU countries)

[3] http://ec.europa.eu/research/press/2013/pdf/staff_working_document_indicator_of_innovation_output.pdf

Indicator 3.2.3 Knowledge-intensive services exports (% share of total services exports)

Numerator: Exports of knowledge-intensive services is defined as the sum of credits in EBOPS 2010 (Extended Balance of Payments Services Classification) items SC1, SC2, SC3A, SF, SG, SI, SJ and SK1.

Denominator: Total value of services exports (S).

Rationale: The indicator measures the competitiveness of the knowledge-intensive services sector. Competitiveness-enhancing measures and innovation strategies can be mutually reinforcing for the growth of employment, export shares and turnover at the firm level. It reflects the ability of an economy, notably resulting from innovation, to export services with high levels of value added, and successfully take part in knowledge-intensive global value chains.

Data source: Indicator calculated by Joint Research Centre using Eurostat data

Indicator 3.2.4 Sales of new-to-market and new-to-firm innovations (% of turnover)

Numerator: Sum of total turnover of new or significantly improved products either new to the firm or new to the market for all enterprises

Denominator: Total turnover for all enterprises (both innovators and non-innovators), in national currency and current prices

Rationale: This indicator measures the turnover of new or significantly improved products and includes both products which are only new to the firm and products which are also new to the market. The indicator thus captures both the creation of state-of-the-art technologies (new to market products) and the diffusion of these technologies (new to firm products).

Data source: Eurostat (Community Innovation Survey)

Indicator 3.2.5 License and patent revenues from abroad (% of GDP)

Numerator: Export part of the international transactions in royalties and license fees

Denominator: Gross Domestic Product

Rationale: Trade in technology comprises four main categories: Transfer of techniques (through patents and licences, disclosure of know-how); Transfer (sale, licensing, franchising) of designs, trademarks and patterns; Services with a technical content, including technical and engineering studies, as well as technical assistance; and Industrial R&D. License and patent revenues capture disembodied technology exports.

Data source: Eurostat

3. Methodology for calculating composite scores

The overall innovation performance of each country has been summarized in a composite indicator, the Summary Innovation Index (SII). Section 3.1 provides details on data availability per country and per indicator. Section 3.2 explains the methodology used for calculating the SII.

3.1 Data availability

The European Innovation Scoreboard uses the most recent statistics from Eurostat and other internationally recognised sources as available at the time of analysis. International sources have been used wherever possible in order to improve comparability between countries. Note that the most recent year for which data are available varies across indicators (cf. Table 1). The calculations are made by labelling with *2015* the most recent year available, although the data relate to actual performance in 2012 (seven indicators), 2013 (four indicators), 2014 (seven indicators) and 2015 (seven indicators).

The availability of data by country for the eight-year period covered in the EIS 2016 is stated in Table 2. For almost all Member States, data availability is above 90%. For Greece, data availability is below 90%, as the Community Innovation Surveys 2008 and 2010 were not conducted in this country. For non-EU countries, data availability is, on average, much lower, mostly due to lacking innovation survey data.

Data availability for the 28 Member States is 100% for 12 indicators (Table 3), between 90% and 100% for nine indicators, between 80% and 90% for three indicators, and below 80% for one indicator (SMEs innovating in-house). Data availability is below 100% for almost all indicators for the total sample of 36 countries including eight non-EU countries.

Missing data have been imputed as explained in step 3 in Section 3.2.

Table 2: Data availability by country

BE Belgium	99.4%	CY Cyprus	98.8%	SK Slovakia	99.4%
BG Bulgaria	99.4%	LV Latvia	94.7%	FI Finland	97.7%
CZ Czech Republic	100%	LT Lithuania	100%	SE Sweden	97.1%
DK Denmark	97.7%	LU Luxembourg	91.8%	UK United Kingdom	94.7%
DE Germany	96.5%	HU Hungary	99.4%	IS Iceland	72.5%
EE Estonia	100%	MT Malta	97.1%	IL Israel	74.9%
IE Ireland	94.2%	NL Netherlands	96.5%	MK Former Yugoslav Republic of Macedonia	66.7%
EL Greece	81.9%	AT Austria	98.2%	NO Norway	95.9%
ES Spain	98.2%	PL Poland	98.8%	RS Serbia	67.3%
FR France	94.2%	PT Portugal	98.2%	CH Switzerland	80.1%
HR Croatia	95.3%	RO Romania	93.6%	TR Turkey	82.5%
IT Italy	97.1%	SI Slovenia	89.5%	UA Ukraine	52.0%

Table 3: Data availability by indicator

Innovation dimension / Indicator	**EU Member States**	**All countries**
Human resources		
1.1.1 New doctorate graduates per 1000 population aged 25-34	94.0%	90.9%
1.1.2 Percentage population aged 30-34 having completed tertiary education	100%	94.6%
1.1.3 Percentage youth aged 20-24 having attained at least upper secondary level education	100%	96.6%
Open, excellent and attractive research systems		
1.2.1 International scientific co-publications per million population	100%	100%
1.2.2 Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country	100%	97.3%
1.2.3 Non-EU doctorate students as percentage of all doctorate students	89.2%	82.4%
Finance and support		
1.3.1 R&D expenditure in the public sector as percentage of GDP	92.2%	87.8%
1.3.2 Venture capital investment as percentage of GDP	100%	91.1%
Firm investments		
2.1.1 R&D expenditure in the business sector as percentage of GDP	94.4%	89.2%
2.1.2 Non-R&D innovation expenditures as percentage of turnover	86.9%	76.8%
Linkages & entrepreneurship		
2.2.1 SMEs innovating in-house as percentage of SMEs	74.5%	68.6%
2.2.2 Innovative SMEs collaborating with others as percentage of SMEs	96.6%	86.5%
2.2.3 Public-private co-publications per million population	99.0%	99.2%
Intellectual assets		
2.3.1 PCT patents applications per billion GDP (Purchasing Power Standard €)	100%	94.6%
2.3.2 PCT patent applications in societal challenges (environment-related technologies; health) per billion GDP (Purchasing Power Standard €)	100%	94.6%
2.3.3 Community trademarks per billion GDP (Purchasing Power Standard €)	100%	97.6%
2.3.4 Community designs per billion GDP (Purchasing Power Standard €)	100%	100%
Innovators		
3.1.1 SMEs introducing product or process innovations as percentage of SMEs	94.5%	84.9%
3.1.2 SMEs introducing marketing or organisational innovations as percentage of SMEs	89.7%	78.9%
3.1.3 Employment in fast-growing enterprises (average innovativeness scores)	100%	91.9%
Economic effects		
3.2.1 Employment in knowledge-intensive activities (manufacturing and services) as percentage of total employment	95.1%	91.1%
3.2.2 Medium and high technology product exports as percentage of total product exports	100%	97.0%
3.2.3 Knowledge-intensive services exports as percentage of total service exports	100%	91.9%
3.2.4 Sales of new-to-market and new-to-firm innovations as percentage of turnover	95.9%	87.0%
3.2.5 License and patent revenues from abroad as percentage of GDP	99.1%	95.9%

3.2 Methodology for calculating the Summary Innovation Index

Step 1: Identifying and replacing outliers

Positive outliers are identified as those country scores which are higher than the mean across all countries plus twice the standard deviation[4]. Negative outliers are identified as those country scores which are smaller than the mean across all countries minus twice the standard deviation. These outliers are replaced by the respective maximum and minimum values observed over all the years and all countries. Table 4 summarizes the outliers per indicator and year (negative outliers are shown in italics).

Table 4: Overview of positive and negative outliers

Innovation dimension / Indicator	**Positive / *Negative* outlier**
Human resources	
1.1.1 New doctorate graduates per 1000 population aged 25-34	RO: 2007 SI: 2013, 2014 SE: 2007 CH: 2007-2014
1.1.2 Percentage population aged 30-34 having completed tertiary education	*MK: 2008, 2009* *TR: 2008, 2009*
1.1.3 Percentage youth aged 20-24 having attained at least upper secondary level education	*ES: 2008, 2009* *TR: 2008-2015* *UA: 2008-2012*
Open, excellent and attractive research systems	
1.2.1 International scientific co-publications per million population	DK: 2014, 2015 IS: 2010-2015 CH: 2010-2015
1.2.2 Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country	CH: 2011-2013
1.2.3 Non-EU doctorate students as percentage of all doctorate students	FR: 2010-2012 CH: 2007-2014
Finance and support	
1.3.1 R&D expenditure in the public sector as percentage of GDP	DK: 2013, 2014 FI: 2009-2012, 2014 SE: 2012, 2014 *MK: 2007*
1.3.2 Venture capital investment as percentage of GDP	IE: 2010, 2011 LU: 2009-2011
Firm investments	
2.1.1 R&D expenditure in the business sector as percentage of GDP	FI: 2008-2010 SE: 2008 IL: 2007-2014
2.1.2 Non-R&D innovation expenditures as percentage of turnover	EE: 2006 CY: 2006 RS: 2012 CH: 2010 TR: 2012
Linkages & entrepreneurship	
2.2.1 SMEs innovating in-house as percentage of SMEs	*RO: 2012*

[4] This approach follows the well-adopted Chauvenet's Criterion in statistical theory.

Innovation dimension / Indicator	**Positive / *Negative* outlier**
2.2.2 Innovative SMEs collaborating with others as percentage of SMEs	CY: 2006 FI: 2006 UK: 2008, 2010
2.2.3 Public-private co-publications per million population	DK: 2010,2011 NO: 2008-2014 CH: 2008-2014
Intellectual assets	
2.3.1 PCT patents applications per billion GDP (Purchasing Power Standard €)	FI: 2006, 2007, 2009-2012 SE: 2006-2010, 2012 IL: 2006-2013
2.3.2 PCT patent applications in societal challenges (environment-related technologies; health) per billion GDP (Purchasing Power Standard €)	DK: 2005-2009, 2011 CH: 2007 IL: 2005-2012
2.3.3 Community trademarks per billion GDP (Purchasing Power Standard €)	CY: 2012-2015 LU: 2008-2015 MT: 2012-2015
2.3.4 Community designs per billion GDP (Purchasing Power Standard €)	BG: 2013 LU: 2007, 2011-2014 MT: 2012-2014
Innovators	
3.1.1 SMEs introducing product or process innovations as percentage of SMEs	*RO: 2012* CH: 2008
3.1.2 SMEs introducing marketing or organisational innovations as percentage of SMEs	DE: 2006, 2008 IL: 2008, 2012 *UA: 2010, 2012*
3.1.3 Employment in fast-growing enterprises (average innovativeness scores)	IE: 2013 CY: 2013 *LV: 2011, 2012* LU: 2010
Economic effects	
3.2.1 Employment in knowledge-intensive activities (manufacturing and services) as percentage of total employment	LU: 2008-2014 IL: 2008-2014
3.2.2 Medium and high tech product exports as percentage of total product exports	*IS: 2009-2015* *NO: 2008-2015* *MK: 2009*
3.2.3 Knowledge-intensive services exports as percentage of total service exports	No outliers
3.2.4 Sales of new-to-market and new-to-firm innovations as percentage of turnover	EL: 2006 MT: 2006 SK: 2010 CH: 2008 TR: 2012
3.2.5 License and patent revenues from abroad as percentage of GDP	IE: 2014 MT: 2007-2014 NL: 2010-2013 CH: 2009-2014

Step 2: Setting reference years

For each indicator, a reference year is identified for all countries based on data availability for all countries for which data availability is at least 75%. For most indicators, this reference year will be lagging one or two years behind the year to which the EIS refers. For the EIS 2016, the reference year will be 2014 or 2015 for most indicators.

Step 3: Imputing for missing values

Reference year data are then used for "2015", etc. If data for the latest year are missing, they are imputed with the data of the latest available year. If data for a year-in-between are missing, they are imputed with the value of the previous year. If data are not available at the beginning of the time series, they are imputed with the next available year.

The examples in Table 5 clarify this step and show how 'missing' data are imputed. If data are missing for all years, no data will be imputed (the indicator will not contribute to the Summary Innovation Index).

In case the data for an indicator are not available for a given country at any time point, the composite score is evaluated without that indicator by re-calculating the weights for the other indicators such that their sum is one.

Table 5: Examples of imputation techniques

Latest year missing	"2015"	"2014"	"2013"	"2012"	"2011"
Available data	N/A	45	40	35	30
Use most recent year	**45**	45	40	35	30
Year-in-between missing	"2015"	"2014"	"2013"	"2012"	"2011"
Available data	50	N/A	40	35	30
Substitute with previous year	50	**40**	40	35	30
Beginning-of-period missing	"2015"	"2014"	"2013"	"2012"	"2011"
Available data	50	45	40	35	N/A
Substitute with next available year	50	45	40	35	**35**

Step 4: Determining Maximum and Minimum scores

The Maximum score is the highest score found for the whole time period within all countries excluding positive outliers. Similarly, the Minimum score is the lowest score found for the whole time period within all countries excluding negative outliers.

Step 5: Transforming data that have highly skewed distributions across Countries

Most of the indicators are fractional indicators with values between 0% and 100%. Some indicators are unbound indicators, where values are not limited to an upper threshold. These indicators can be highly volatile and can have skewed data distributions (where most countries show low performance levels and a few countries show exceptionally high performance levels). For the following indicators, data have been transformed using a square root transformation (cf. Table 6): Public-private co-publications, PCT patent applications, PCT patent applications in societal challenges, Community trademarks, and License and patent revenues from abroad. A square root transformation means using the square root of the indicator value instead of the original value.

Table 6: Degree of skewness and data transformations

Innovation dimension / Indicator	**Skewness**	**Skewness after data trans-formation**
Human resources		
1.1.1 New doctorate graduates per 1000 population aged 25-34	0.53*	--
1.1.2 Percentage population aged 30-34 having completed tertiary education	-0.31*	--
1.1.3 Percentage youth aged 20-24 having attained at least upper secondary level education	-0.81*	--
Open, excellent and attractive research systems		
1.2.1 International scientific co-publications per million population	0.75*	--
1.2.2 Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country	0.07*	--
1.2.3 Non-EU doctorate students as percentage of all doctorate students	0.92*	--
Finance and support		
1.3.1 R&D expenditure in the public sector as percentage of GDP	0.07*	--
1.3.2 Venture capital investment as percentage of GDP	0.78*	--
Firm investments		
2.1.1 R&D expenditure in the business sector as percentage of GDP	0.73*	--
2.1.2 Non-R&D innovation expenditures as percentage of turnover	0.81*	--
Linkages & entrepreneurship		
2.2.1 SMEs innovating in-house as percentage of SMEs	-0.05*	--
2.2.2 Innovative SMEs collaborating with others as percentage of SMEs	0.32*	--
2.2.3 Public-private co-publications per million population	1.24	0.47
Intellectual assets		
2.3.1 PCT patents applications per billion GDP (Purchasing Power Standard €)	1.08	0.53
2.3.2 PCT patent applications in societal challenges (environment-related technologies; health) per billion GDP (Purchasing Power Standard €)	1.24	0.49
2.3.3 Community trademarks per billion GDP (Purchasing Power Standard €)	1.34	0.29
2.3.4 Community designs per billion GDP (Purchasing Power Standard €)	0.81*	--
Innovators		
3.1.1 SMEs introducing product or process innovations as percentage of SMEs	0.00*	--
3.1.2 SMEs introducing marketing or organisational innovations as percentage of SMEs	0.03*	--
3.1.3 Employment in fast-growing enterprises (average innovativeness scores)	0.03*	--
Economic effects		
3.2.1 Employment in knowledge-intensive activities (manufacturing and services) as percentage of total employment	0.07*	--
3.2.2 Medium and high technology product exports as percentage of total product exports	-0.39*	--
3.2.3 Knowledge-intensive services exports as percentage of total service exports	0.17*	--
3.2.4 Sales of new-to-market and new-to-firm innovations as percentage of turnover	0.37*	--
3.2.5 License and patent revenues from abroad as percentage of GDP	1.53	0.91

* No transformation as skewness is below 1.

Step 6: Calculating re-scaled scores

Re-scaled scores of the country scores (after correcting for outliers and a possible transformation of the data) for all years are calculated by first subtracting the Minimum score and then dividing by the difference between the Maximum and Minimum score. The maximum re-scaled score is thus equal to 1 and the minimum re-scaled score is equal to 0. For positive and negative outliers, the re-scaled score is equal to 1 or 0, respectively.

Step 7: Calculating composite innovation indexes

For each year, a composite Summary Innovation Index is calculated as the unweighted average of the re-scaled scores for all indicators where all indicators receive the same weight (1/25 if data are available for all 25 indicators).

3.3 Methodology for calculating growth rates

Average annual growth rates – usually referred to as compound annual growth rates – of the Summary Innovation Index, the innovation dimensions, and the individual indicators are calculated using the following formula, where the number of years equals 7 (i.e. the number of yearly changes between 2008 and 2015):

$$\text{Growth rate} = \left(\frac{\text{value end of period}}{\text{value beginning of period}} \right)^{\left(\frac{1}{\text{numberof years}} \right)} - 1$$

3.4 Methodology used for international benchmarking

The methodology for calculating average innovation performance for the EU and its major global competitors is similar to that used for calculating average innovation performance for the EU Member States:

1. Calculate normalised scores for all indicators as follows: Y_i = ((X_i - smallest X for all countries) / (largest X for all countries – smallest X for all countries)) such that all normalised scores are between 0 and 1
2. Calculate the arithmetic average over these index scores (CI_i)
3. Calculate performance relative to that of the EU: $CI_i^* = 100*CI_i/CI_{EU}$

Note that the results for country *i* depend on the data from the other countries, as the smallest and largest scores used in the normalisation procedure are calculated over all countries.

4. Changes in methodology and the impact on performance scores

Although the general methodology of the EIS 2016 remained unchanged, there have been several changes in indicator definitions, data sources or data revisions as compared to the Innovation Union Scoreboard 2015 report. Due to these changes, results in this year's report are not comparable to those in last year's report. In the sections below, these changes will be explained in more detail, and the impact on the SII scores for the Member States will be discussed (cf. Table 7 for a statistical summary of the impact of these changes on Member States' innovation performance). This section will not discuss the impact on the individual indicator values. For some indicators, this is briefly discussed in the introduction in the EIS 2016 report.

Of these changes, several had to be introduced because of changes in the primary data sources. These include changes in the values for the three indicators using bibliometric data (sub-sections 1, 2, and 4 below), in the values for the two indicators using Balance of Payment statistics (sub-sections 8 and 9 below), and the value for PCT patent applications in societal challenges, as OECD data for the definition used up until last year are no longer available (sub-section 5 below). Changes to the indicators on Venture capital investments (sub-section 3 below) and Community designs (sub-section 7 below) were introduced, as these are perceived to improve the measurement framework.

4.1 International scientific co-publications: change in data source

Data on International scientific co-publications are calculated by the Centre for Science and Technology Studies (CWTS) using data from Web of Science[5]. For the IUS 2015 report, the indicator was calculated by Science-Metrix using data from Scopus[6]. Web of Science is an online subscription-based scientific citation indexing service maintained by Thomson Reuters. Scopus is a bibliographic database containing abstracts and citations for academic journal articles maintained by Elsevier.

The impact on the SII, however, is only small as the relative change in indicator values is not too different between the Member States. For all Member States the impact is between -0.7% and +0.5%. For 18 Member States performance has improved as a result of this change, for nine Member States it has worsened. The largest positive impact is observed for Slovenia (+0.5%), the Netherlands, and Sweden (both +0.4%), the largest negative impact is observed for Cyprus and Luxembourg (both -0.7%) and Malta (-0.6%). The impact on rank performance is positive for Belgium and Lithuania, and negative for Latvia and Luxembourg.

4.2 Most-cited scientific publications: change in data source

Data on Most-cited scientific publications are calculated by CWTS using data from Web of Science. For the IUS 2015 and earlier reports, the indicator was calculated by Science-Metrix using data from Scopus.

The impact on the SII is small for most Member States with changes between -0.6% and +0.8%, but for five Member States the impact is at or above +1.0%. For 19 Member States performance has improved as a result of this change, for nine Member States it has worsened. The overall strongest positive impact is observed for Romania (+3.0%) and Hungary (+2.4%). The impact on rank performance is positive for Cyprus, Czech Republic and Germany, and negative for Estonia, Italy and the Netherlands.

[5] http://ipscience.thomsonreuters.com/product/web-of-science/
[6] https://www.elsevier.com/solutions/scopus

4.3 Venture capital investments: change in definition, calculation method and data availability

First, the definition of Venture capital investments has changed, using market instead of industry statistics. Industry statistics measure how much venture capital funding originates from a particular country, whereas market statistics measure how much venture capital is invested in a particular country. Market statistics provide more relevant information about the importance of venture capital for the domestic market.

The impact on the SII is mixed with performance improving for 12 Member States and declining for 15 Member States. For all Member States, the impact is between -4.3% and +1.0%. The largest positive impact is observed for Ireland and Spain (both +1.0%), the largest negative impact is observed for Luxembourg (-4.3%), Denmark (-2.0%) and the UK (-1.3%). The impact on rank performance is positive for Belgium, Ireland and Sweden, and negative for Denmark, Luxembourg, and the UK.

A *second change* is that for Venture capital investments three-year averages have been used, whereas in the IUS 2015 and earlier reports two-year averages were used.

The impact on the SII is mixed with performance improving for 15 Member States and declining for 12 Member States. For all Member States, the impact is between -2.6% and +0.6%. The largest positive impact is observed for Finland and Poland (both +0.6%), the largest negative impact is observed for Latvia (-2.6%) and Cyprus (-1.4%). The impact on rank performance is positive for Belgium, Germany and Lithuania, and negative for Latvia, the Netherlands, and the UK.

A *third change* is that Venture capital statistics are obtained directly from Invest Europe, which has provided data for all Member States, including data for those countries for which data had not been available in any of the previous EIS/IUS reports: Croatia, Cyprus, Estonia, Latvia, Lithuania, Malta, Slovakia, and Slovenia.

Only for the Member States for which Venture capital were not available in previous EIS/IUS reports there is an impact on the SII. The impact on the SII is mixed with performance improving for four Member States and declining for four Member States. For these eight Member States, the impact is between -4.0% (Malta) and +3.5% (Latvia). The impact on rank performance is positive for Cyprus, Estonia, Hungary, Latvia, Lithuania, and Spain, and negative for Croatia, Malta, and Slovakia.

4.4 Public-private co-publications: data revision

Data on Public-private co-publications are calculated by CWTS using data from Web of Science. Data are not comparable to those used in the 2015 report due to a revised calculation method by CWTS.

The impact on the SII, however, is only small as the relative change in indicator values is not too different between the Member States. For all Member States the impact is between -0.1% and +1.0%. For 26 Member States performance has improved as a result of this change, for two Member States it has worsened (Belgium, -0.1%, and Denmark, -0.01%). The largest positive impact is observed for Romania (+1.0%) and Poland (+0.9%). The impact on rank performance is positive for Germany and Latvia, and negative for Croatia and the Netherlands.

4.5 PCT patent applications in societal challenges: change in definition

For the IUS 2015, the indicator was calculated using data from the OECD aggregating PCT patent applications in Environment-related technologies and Health. Patents in Environment-related technologies include applications in the following technology domains: 1) General Environmental Management (air, water, waste), 2) Energy generation from renewable and non-fossil sources, 3) Combustion technologies with mitigation potential (e.g. using fossil fuels, biomass, waste, etc.), 4) Technologies

specific to climate change mitigation, 5) Technologies with potential or indirect contribution to emissions mitigation, 6) Emissions abatement and fuel efficiency in transportation, and 7) Energy efficiency in buildings and lighting. Patents in Health-related technologies include applications in the following technology domains: Medical technology and Pharmaceuticals.

For the EIS 2016, similar data for Environment-related technologies are no longer available from the OECD. Environment-related technologies for the EIS 2016 include applications in the following technology domains: 1) Climate change mitigation technologies related to buildings, 2) Climate change mitigation technologies related to energy generation, transmission or distribution, 3) Capture, storage, sequestration or disposal of greenhouse gases, 4) Environmental management, 5) Climate change mitigation technologies related to transportation, and 6) Water-related adaptation technologies.

The impact on the SII, however, is only small as the relative change in indicator values is not too different between the Member States. For all Member States, the impact is between -1.2% and +1.0%. For 19 Member States performance has improved as a result of this change, for nine Member States it has worsened. The largest positive impact is observed for Bulgaria (+1.0%) and Croatia (+0.9%), the largest negative impact is observed for Cyprus (-1.2%) and Hungary (-0.4%). The impact on rank performance is positive for Germany, and negative for the Netherlands.

4.6 Community trademarks: change in data source

Data are obtained directly from the European Union Intellectual Property Office (EUIPO). Previously, data were extracted from Eurostat who also use EUIPO as their source. The advantage of receiving the data directly from EUIPO is that more timely 2015 data could be used. For all Member States, the impact on the SII is very small and is between -0.2% and no change. The impact on rank performance is positive for Germany, and negative for the Netherlands.

4.7 Community designs: change in definition and data source

For the indicator measuring Community designs, following a recommendation from EUIPO, data on individual designs have been used instead of using the number of applications, as one application can include multiple individual designs. Data are obtained directly from EUIPO[7]. Previously, data were extracted from Eurostat who also use EUIPO as their source, but Eurostat data are for number of applications only. The advantage of receiving the data directly from EUIPO is also that more timely 2015 data could be used.

The impact on the SII is significant being between -6.9% and +8.5%. For five Member States performance has improved as a result of this change, for 21 Member States it has worsened. The largest positive impact is observed for Bulgaria (+8.5%) and Germany (+1.1%), the largest negative impact is observed for Latvia (-6.9%), Poland (-4.9%), Slovenia (-4.3%) and Croatia (-3.3%). The impact on rank performance is positive for Germany, Lithuania, and Malta, and negative for Croatia, Czech Republic, Latvia, and the Netherlands.

[7] The European Union Intellectual Property Office, or EUIPO, is the trademark and designs registry for the internal market of the European Union. Until 23 March 2016, it was named Office for Harmonization in the Internal Market (Trade Marks and Designs), or OHIM: https://euipo.europa.eu/ohimportal/en/

4.8 Exports of knowledge-intensive services: change in the methodology for calculating Balance of Payments statistics

The production of statistics on international trade in services uses as reference the International Monetary Fund (IMF)'s Balance Of Payments and International Investment Position Manual (BPM) and the United Nations' Manual on Statistics of International Trade in Services (MSITS). The indicator measuring Exports of knowledge-intensive services was first introduced in the EIS 2008. It followed the fifth edition of the BPM and matched NACE industries to EBOPS (Extended Balance of Payments Services Classification) using the correspondence table in the 2002 MSITS[8]. BMP5 and MSITS 2002 have meanwhile been replaced by newer editions, BMP6 (the sixth edition) and MSITS 2010.

As a result of these revisions, the EBOPS classification has been revised, requiring an update of the definition of knowledge-intensive services exports. As work is still ongoing at the United Nations Statistics Division on the concordance tables that would allow for an 'automatic' selection of knowledge-intensive services, a task force involving experts from various European Commission services decided to select a list of services that – given the details in BPM6 – are potentially associated with knowledge-intensive business activities[9]. Full details are reported in the Methodology report for the 2016 Innovation Output Indicator[10]. Data using the new definition have been estimated by the European Commission's Joint Research Centre.

The impact on the SII is significant being between -5.5% and +2.4%. For 13 Member States performance has improved as a result of this change, for 15 Member States it has worsened. The largest positive impact is observed for the Netherlands (+2.4%) and Cyprus (+2.2%), the largest negative impact is observed for Romania (-5.5%) and Bulgaria and Greece (both -2.0%). The impact on rank performance is positive for Belgium, Cyprus, Latvia, Malta, and Sweden, and negative for Croatia, Czech Republic, Denmark, Estonia, Luxembourg, and the UK.

4.9 License and patent revenues from abroad: change in the methodology for calculating Balance of Payments statistics

Similar as for the indicator measuring Exports of knowledge-intensive services, the indicator on License and patent revenues from abroad is also affected by the introduction of new international standards for compiling Balance of Payments statistics under the BPM6 methodology.

The impact on the SII is significant being between -1.2% and +7.0%. For 16 Member States performance has improved as a result of this change, for 12 Member States it has worsened. The largest positive impact is observed for Malta (+7.0%) and Hungary (+2.3%), the largest negative impact is observed for Germany (-1.2%). The impact on rank performance is positive for Hungary, Malta, and Sweden, and negative for Denmark, Italy, Portugal, and Slovakia.

[8] Table A.IV.1 in United Nations, Manual on Statistics of International Trade in Services, Statistical Papers Series M. No. 86, 2002

[9] The revised list of Knowledge-intensive services includes the following items: SC1 Sea transport, SC2 Air transport, SC3A Space transport, SF Insurance and pension services, SG Financial services, SI Telecommunications, computer and information services, SJ Other business services and SK1 Audio-visual and related services.

[10] Vertesy, D., (2016), The Innovation Output Indicator 2016: Methodology update, European Commission, DG JRC, COIN.

4.10 Overall impact

The overall impact is shown in the last two columns of Table 7. For 13 Member States performance has improved, for 15 Member States performance has declined as a result of the various smaller and larger changes in the measurement framework of the EIS 2016. The impact on the SII is between -6.5% and +11.3%. The largest positive impact is observed for Bulgaria (+11.3%) and Hungary (+5.5%), the largest negative impact is observed for Slovenia (-6.5%) and Latvia (-5.4%).

The impact on rank performance is small for most Member States. For 16 Member States there is no impact on rank performance, for 10 Member States rank performance changes by one position (for Belgium, Hungary, Lithuania, Malta, and Sweden, rank performance has improved by one position, for Czech Republic, Denmark, Latvia, Slovakia, and the UK, rank performance has worsened by one position), and for two Member States, rank performance has changed by three positions (with improved rank performance for Ireland and worsened rank performance for Luxembourg).

Table 7: Impact on SII of changes in EIS 2016 measurement framework

For each indicator, the first column shows the SII if the indicator had not been changed, the second column shows the percentage increase or decrease between the 'real' SII and that in the first column, and the third column shows the change in rank position as a result of the change in the respective indicator.

	SII		International scientific co-publications: change in data source			Most-cited scientific publications: change in data source			Venture capital: using market instead of industry statistics			Venture capital: using 3-year instead of 2-year average			Venture capital: improved data availability for 8 Member States			Public-private co-publications: revised data		
EU	0.521		0.521	0.0%		0.521	0.0%		0.523	-0.3%		0.522	0.0%		0.521	0.0%		0.521	0.1%	
BE	0.602	7	0.600	0.3%	2	0.603	-0.1%	0	0.605	-0.4%	1	0.599	0.5%	1	--	--	0	0.603	-0.1%	0
BG	0.242	27	0.242	-0.1%	0	0.238	1.5%	0	0.240	0.6%	0	0.240	0.5%	0	--	--	0	0.240	0.8%	0
CZ	0.434	16	0.433	0.2%	0	0.430	0.8%	1	0.432	0.4%	0	0.434	-0.1%	0	--	--	0	0.432	0.3%	0
DK	0.700	2	0.700	0.0%	0	0.700	0.1%	0	0.715	-2.0%	-1	0.702	-0.3%	0	--	--	0	0.700	0.0%	0
DE	0.632	4	0.631	0.1%	0	0.631	0.1%	1	0.631	0.1%	0	0.632	-0.1%	1	--	--	0	0.631	0.1%	1
EE	0.448	14	0.447	0.3%	0	0.451	-0.6%	-1	0.451	-0.7%	0	0.446	0.4%	0	0.437	2.5%	1	0.447	0.3%	0
IE	0.609	6	0.609	0.0%	0	0.607	0.2%	0	0.602	1.0%	3	0.609	0.0%	0	--	--	0	0.605	0.6%	0
EL	0.364	19	0.364	-0.1%	0	0.364	0.0%	0	0.364	0.0%	0	0.364	0.1%	0	--	--	0	0.363	0.3%	0
ES	0.361	20	0.361	0.2%	0	0.363	-0.5%	0	0.358	1.0%	0	0.361	0.1%	0	--	--	1	0.360	0.3%	0
FR	0.568	11	0.568	0.0%	0	0.565	0.5%	0	0.574	-0.9%	0	0.569	-0.2%	0	--	--	0	0.567	0.2%	0
HR	0.280	26	0.280	0.1%	0	0.278	1.0%	0	0.282	-0.6%	0	0.281	-0.2%	0	0.280	0.0%	-2	0.280	0.2%	-1
IT	0.432	17	0.432	0.1%	0	0.433	0.0%	-1	0.431	0.3%	0	0.432	0.0%	0	--	--	0	0.431	0.3%	0
CY	0.451	13	0.455	-0.7%	0	0.449	0.5%	1	0.454	-0.5%	0	0.458	-1.4%	0	0.455	-0.8%	1	0.449	0.4%	0
LV	0.281	25	0.282	-0.3%	-1	0.280	0.7%	0	0.284	-0.8%	0	0.289	-2.6%	-1	0.272	3.5%	1	0.279	0.8%	1
LT	0.282	24	0.282	0.1%	1	0.283	-0.2%	0	0.285	-0.9%	0	0.285	-1.0%	1	0.276	2.1%	1	0.282	0.1%	0
LU	0.598	9	0.602	-0.7%	-2	0.597	0.3%	0	0.625	-4.3%	-3	0.597	0.2%	0	--	--	0	0.595	0.5%	0
HU	0.355	21	0.354	0.2%	0	0.346	2.4%	0	0.352	0.8%	0	0.354	0.0%	0	--	--	1	0.353	0.5%	0
MT	0.437	15	0.440	-0.6%	0	0.434	0.8%	0	0.437	0.0%	0	0.437	0.0%	0	0.455	-4.0%	-2	0.436	0.3%	0
NL	0.631	5	0.629	0.4%	0	0.633	-0.2%	-1	0.630	0.2%	0	0.633	-0.2%	-1	--	--	0	0.631	0.0%	-1
AT	0.591	10	0.590	0.1%	0	0.590	0.1%	0	0.590	0.2%	0	0.593	-0.2%	0	--	--	0	0.590	0.3%	0
PL	0.292	23	0.292	0.1%	0	0.290	0.6%	0	0.292	-0.1%	0	0.290	0.6%	0	--	--	0	0.289	0.9%	0
PT	0.419	18	0.419	0.0%	0	0.419	0.0%	0	0.419	-0.2%	0	0.417	0.3%	0	--	--	0	0.418	0.1%	0
RO	0.180	28	0.180	-0.2%	0	0.174	3.0%	0	0.179	0.5%	0	0.179	0.2%	0	--	--	0	0.178	1.0%	0
SI	0.485	12	0.482	0.5%	0	0.482	0.5%	0	0.485	0.0%	0	0.484	0.1%	0	0.503	-3.7%	0	0.484	0.2%	0
SK	0.350	22	0.350	0.1%	0	0.345	1.6%	0	0.350	-0.1%	0	0.351	-0.1%	0	0.363	-3.5%	-2	0.348	0.5%	0
FI	0.649	3	0.648	0.2%	0	0.650	0.0%	0	0.647	0.3%	0	0.645	0.6%	0	--	--	0	0.647	0.3%	0
SE	0.704	1	0.701	0.4%	0	0.705	-0.1%	0	0.705	-0.1%	1	0.704	0.1%	0	--	--	0	0.703	0.1%	0
UK	0.602	8	0.601	0.2%	0	0.598	0.7%	0	0.610	-1.3%	-1	0.601	0.2%	-1	--	--	0	0.601	0.1%	0

Table 7: Impact on SII of changes in EIS 2016 measurement framework - continued

For each indicator, the first column shows the SII if the indicator had not been changed, the second column shows the percentage increase or decrease between the 'real' SII and that in the first column, and the third column shows the change in rank position as a result of the change in the respective indicator.

	SII		Patent applications in societal challenges: change in definition			Community trademarks: change in data source			Community designs: change in definition and data source			Exports of knowledge-intensive services: change in calculation of Balance of Payments statistics			License patent revenues: change in calculation of Balance of Payments statistics			Overall impact	
EU	0.521		0.521	0.1%		0.522	0.0%		0.522	-0.2%		0.522	0.0%		0.524	-0.5%		-0.9%	
BE	0.602	7	0.603	-0.1%	0	0.602	0.0%	0	0.608	-1.0%	0	0.598	0.7%	2	0.602	0.0%	0	-0.3%	1
BG	0.242	27	0.239	1.0%	0	0.241	0.0%	0	0.223	8.5%	0	0.246	-2.0%	0	0.242	-0.1%	0	11.3%	0
CZ	0.434	16	0.433	0.2%	0	0.434	-0.1%	0	0.440	-1.4%	-1	0.437	-0.8%	-1	0.432	0.4%	0	0.0%	-1
DK	0.700	2	0.699	0.1%	0	0.701	-0.1%	0	0.708	-1.1%	0	0.707	-1.0%	-1	0.701	-0.1%	-1	-4.2%	-1
DE	0.632	4	0.631	0.1%	1	0.632	0.0%	1	0.625	1.1%	1	0.633	-0.2%	0	0.639	-1.2%	0	0.1%	0
EE	0.448	14	0.447	0.1%	0	0.449	-0.2%	0	0.454	-1.3%	0	0.453	-1.0%	-1	0.448	-0.1%	0	-0.6%	0
IE	0.609	6	0.608	0.0%	0	0.609	0.0%	0	0.612	-0.5%	0	0.609	0.0%	0	0.608	0.1%	0	1.2%	3
EL	0.364	19	0.363	0.2%	0	0.364	-0.1%	0	0.366	-0.5%	0	0.372	-2.0%	0	0.364	0.0%	0	-2.0%	0
ES	0.361	20	0.361	0.0%	0	0.361	0.0%	0	0.363	-0.6%	0	0.359	0.6%	0	0.360	0.2%	0	1.2%	0
FR	0.568	11	0.567	0.2%	0	0.569	0.0%	0	0.570	-0.2%	0	0.565	0.6%	0	0.568	0.1%	0	0.3%	0
HR	0.280	26	0.278	0.9%	0	0.281	0.0%	0	0.290	-3.3%	-1	0.282	-0.4%	-1	0.280	0.0%	0	-2.3%	0
IT	0.432	17	0.432	0.1%	0	0.433	0.0%	0	0.431	0.3%	0	0.429	0.9%	0	0.433	-0.1%	-2	1.8%	0
CY	0.451	13	0.457	-1.2%	0	0.451	0.0%	0	0.456	-1.0%	0	0.442	2.2%	1	0.451	0.2%	0	-2.3%	0
LV	0.281	25	0.282	-0.2%	0	0.281	0.0%	0	0.302	-6.9%	-1	0.279	0.8%	1	0.282	-0.1%	0	-5.4%	-1
LT	0.282	24	0.283	-0.1%	0	0.282	-0.1%	0	0.288	-2.1%	2	0.282	-0.1%	0	0.282	0.0%	0	-2.2%	1
LU	0.598	9	0.599	-0.2%	0	0.598	0.0%	0	0.598	0.0%	0	0.599	0.0%	-1	0.595	0.5%	0	-3.8%	-3
HU	0.355	21	0.356	-0.4%	0	0.355	0.0%	0	0.358	-0.8%	0	0.353	0.3%	0	0.347	2.3%	1	5.5%	1
MT	0.437	15	0.438	-0.1%	0	0.437	0.0%	0	0.437	0.0%	1	0.436	0.2%	1	0.409	7.0%	3	2.9%	1
NL	0.631	5	0.632	-0.1%	-1	0.632	-0.1%	-1	0.639	-1.2%	-1	0.617	2.4%	0	0.633	-0.3%	0	1.0%	0
AT	0.591	10	0.591	0.0%	0	0.592	-0.1%	0	0.587	0.7%	0	0.586	0.9%	0	0.591	0.0%	0	2.1%	0
PL	0.292	23	0.292	0.1%	0	0.292	-0.1%	0	0.307	-4.9%	0	0.294	-0.9%	0	0.292	0.0%	0	-3.9%	0
PT	0.419	18	0.419	0.0%	0	0.419	-0.1%	0	0.416	0.6%	0	0.419	0.0%	0	0.418	0.1%	-1	0.9%	0
RO	0.180	28	0.179	0.1%	0	0.180	-0.2%	0	0.181	-0.7%	0	0.190	-5.5%	0	0.180	0.0%	0	-2.1%	0
SI	0.485	12	0.484	0.1%	0	0.485	-0.1%	0	0.507	-4.3%	0	0.484	0.1%	0	0.485	0.0%	0	-6.5%	0
SK	0.350	22	0.350	0.1%	0	0.350	0.0%	0	0.351	-0.2%	0	0.353	-0.7%	0	0.348	0.7%	-1	-1.8%	-1
FI	0.649	3	0.648	0.2%	0	0.650	-0.1%	0	0.658	-1.2%	0	0.653	-0.5%	0	0.650	0.0%	0	-0.2%	0
SE	0.704	1	0.704	0.0%	0	0.704	0.0%	0	0.711	-1.0%	0	0.699	0.7%	1	0.701	0.4%	1	0.4%	1
UK	0.602	8	0.601	0.1%	0	0.602	0.0%	0	0.605	-0.6%	0	0.606	-0.6%	-1	0.599	0.5%	0	-0.9%	-1


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