Regional Innovation Scoreboard 2019

Methodology Report

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Table of Contents

1. Introduction

The Regional Innovation Scoreboard (RIS) is the regional extension of the European Innovation Scoreboard. The European Innovation Scoreboard (EIS) provides a comparative assessment of the innovation performance at the country level of the EU Member States and other European countries. The RIS 2019 uses as many indicators as possible from the EIS, including regional data from the Community Innovation Survey (CIS).

This Methodology Report describes the indicators included in the RIS 2019, data availability, and methods used for estimating missing data. Section 2 provides details on the indicators used in the RIS 2019. Section 3 explains the imputation techniques used for estimating missing data. Section 4 discusses the methodology used for calculating regional composite indicators and the methodology used for determining regional performance group membership. Regional innovation performance is measured using a composite indicator – the Regional Innovation Index – which summarises the performance of the indicators used in the RIS 2019. Section 5 presents the definitions for the structural indicators used in regional profiles.

2. Regional Innovation Scoreboard indicators

In the RIS, regional innovation performance should ideally be measured using the full measurement framework of the European Innovation Scoreboard (EIS), i.e. using regional data for the same indicators applied to measure innovation performance at the country level. However, for many indicators used in the EIS, regional data are not available.

The RIS is limited to using regional data for 17 of the 27 indicators used in the EIS (**Table 1**). For several indicators, slightly different definitions have been applied, as regional data would not be available if the definitions were the same as in the EIS:

- For the Population with completed tertiary education, the RIS uses data for the age group 30-34. The indicator in the EIS covers the broader age group 25-34. Tabulated regional data for this age group are not available from Eurostat, instead the same age group has been used as in the RIS 2017;
- For two indicators using data from the Community Innovation Survey (CIS) – Non-R&D innovation expenditures and Sales of new-to-market and new-to-firm innovations – the data refer only to SMEs and not to all companies;[1]
- For PCT patent applications, regional data have been extracted from the OECD's REGPAT database;
- For Trademark applications, only EU trademark applications have been used, for which the data have been calculated by Science Metrix. The EIS uses the aggregate of both EUIPO and WIPO (Madrid Protocol) applications, but regional data for the latter are not available;
- For Design applications, the EIS uses data on individual design applications, for which regional data are not available. The RIS uses data on design applications,

[1] Regional Community Innovation Survey (CIS) data are not publicly available and have been made available explicitly for the Regional Innovation Scoreboard by national statistical offices. The CIS assigns the innovation activities of multi-establishment enterprises to the region where the head office is located. There is a risk that regions without head offices score lower on the CIS indicators, as some of the activities in these regions are assigned to other regions with head offices. To minimize this risk, the regional CIS data excludes large firms - which are more likely to have multiple establishments in different regions - and focuses on SMEs only. More details are provided in the RIS 2019 Methodology Report.

where a design application can include more than one individual design application. Data for regional design applications have been calculated by Science Metrix;

- For Employment in knowledge-intensive activities, regional data are also not available, and instead Employment in medium-high and high-tech manufacturing and knowledge-intensive services is used.

Table 1: A comparison of the indicators included in the European Innovation Scoreboard and the Regional Innovation Scoreboard

	EIS 2019	RIS 2019
FRAMEWORK CONDITIONS		
Human resources	*Doctorate graduates per 1000 population aged 25-34*	*No regional data*
	Percentage of population aged 25-34 having completed tertiary education	Smaller age group 30-34
	Lifelong learning, the share of population aged 25-64 enrolled in education or training aimed at improving knowledge, skills and competences	Identical
Attractive research systems	International scientific co-publications per million population	Identical
	Scientific publications among the top-10% most cited publications worldwide as percentage of total scientific publications of the country	Identical
	Foreign doctorate students as percentage of all doctorate students	*No regional data*
Innovation-friendly environment	*Broadband penetration (Share of enterprises with a maximum contracted download speed of the fastest fixed internet connection of at least 100 Mb/s)*	*No regional data*
	Opportunity-driven entrepreneurship	*No regional data*
INVESTMENTS		
Finance and support	R&D expenditure in the public sector as percentage of GDP	Identical
	Venture capital expenditure as percentage of GDP	*No regional data*
Firm invest-ments	R&D expenditure in the business sector as percentage of GDP	Identical
	Non-R&D innovation expenditures as percentage of total turnover	For SMEs only
	Enterprises providing training to develop or upgrade ICT skills of their personnel	*No regional data*
INNOVATION ACTIVITIES		
Innovators	SMEs introducing product or process innovations as percentage of SMEs	Identical
	SMEs introducing marketing or organisational innovations as percentage of SMEs	Identical
	SMEs innovating in-house as percentage of SMEs	Identical
Linkages	Innovative SMEs collaborating with others as percentage of SMEs	Identical
	Public-private co-publications per million population	Identical
	Share of private co-funding of public R&D expenditures	*No regional data*
Intellectual assets	PCT patent applications per billion GDP (in Purchasing Power standards (PPS))	Identical
	Trademark applications per billion GDP (in PPS)	European trademark applications
	Individual design applications per billion GDP (in PPS)	Design applications

	EIS 2019	RIS 2019
IMPACTS		
Employment impacts	Employment in knowledge-intensive activities (manufacturing and services) as percentage of total employment	Employment in medium-high and high-tech manufacturing and knowledge-intensive services
	Employment in fast-growing firms of innovative sectors	*No regional data*
Sales impacts	*Medium and high-tech product exports as percentage of total product exports*	*No regional data*
	Knowledge-intensive services exports as percentage of total service exports	*No regional data*
	Sales of new-to-market and new-to-firm innovations as percentage of total turnover	For SMEs only

2.2 Indicator definitions

This section presents detailed definitions for each of the indicators used in the RIS 2019. For each indicator, the following information is provided: definitions of the numerator and denominator, a short rationale, the source of the data, and data availability. The numbering of the indicators follows that of the indicators in the EIS 2019, as shown in **Table 1** above.

Percentage population aged 30-34 having completed tertiary education	
Numerator	Number of persons in age class with some form of post-secondary education
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, including the service sectors, depends on a wide range of skills. The indicator focuses on a narrow share of the population aged 30 to 34 and will relatively quickly reflect changes in educational policies leading to more tertiary graduates
Included in EIS	No, proxy for EIS indicator measuring share of population aged 25-34 having completed tertiary education
Data source	Eurostat, regional statistics
Data availability	NUTS 2: 2009, 2011, 2013, 2015, 2017

Percentage population aged 25-64 participating in lifelong learning	
Numerator	Number of persons in private households aged between 25 and 64 years who have participated in the four weeks preceding the interview, in any education or training, whether or not relevant to the respondent's current or possible future job
Denominator	Total population aged between 25 and 64 years
Rationale	Lifelong learning encompasses all purposeful learning activity, whether formal, non-formal or informal, undertaken on an ongoing basis with the aim of improving knowledge, skills and competence. The intention or aim to learn is the critical point that distinguishes these activities from non-learning activities, such as cultural or sporting activities
Included in EIS	Yes
Data source	Eurostat, regional statistics
Data availability	NUTS 2: 2009, 2011, 2013, 2015, 2017

International scientific co-publications per million population	
Numerator	Number of scientific publications with at least one co-author based abroad
Denominator	Total population
Rationale	International scientific co-publications are a proxy for the quality of scientific research as collaboration increases scientific productivity
Included in EIS	Yes
Data source	Numerator: Web of Science. Data provided by CWTS (Leiden University) as part of a contract to DG Research and Innovation. Denominator: Eurostat
Data availability	NUTS 2: 2008, 2010, 2012, 2014, 2016

Scientific publications among the top-10% most cited publications worldwide	
Numerator	Number of scientific publications among the top-10% most cited publications worldwide
Denominator	Total number of scientific publications
Rationale	The indicator is a measure 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
Included in EIS	Yes
Data source	Web of Science. Data provided by CWTS (Leiden University) as part of a contract to DG Research and Innovation
Data availability	NUTS 2: 2007, 2009, 2011, 2013, 2015

R&D expenditures in the public sector as percentage of GDP	
	All R&D expenditures in the government sector (GOVERD) and the higher education sector (HERD)
Denominator	Regional Gross Domestic Product
Rationale	R&D expenditure represents one of the major drivers of economic growth in a knowledge-based economy. Trends in the R&D expenditure indicator provide key indications of the future competitiveness and wealth of a region. R&D spending is essential for making the transition to a knowledge-based economy as well as for improving production technologies and stimulating growth
Included in EIS	Yes
Data source	Eurostat, regional statistics
Data availability	NUTS 2: 2008, 2010, 2012, 2014, 2016

R&D expenditures in the business sector as percentage of GDP	
Numerator	All R&D expenditures in the business sector (BERD)
Denominator	Regional Gross Domestic Product
Rationale	The indicator captures the formal creation of new knowledge within firms. It is particularly important in the science-based sector (pharmaceuticals, chemicals and some areas of electronics), where most new knowledge is created in or near R&D laboratories
Included in EIS	Yes
Data source	Eurostat, regional statistics
Data availability	NUTS 2: 2008, 2010, 2012, 2014, 2016

Non-R&D innovation expenditures in SMEs as percentage of turnover	
Numerator	Sum of total innovation expenditure for SMEs, excluding intramural and extramural R&D expenditures
Denominator	Total turnover for SMEs
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
Included in EIS	No, proxy for EIS indicator including all enterprises
Data source	Community Innovation Survey: Eurostat and National Statistical Offices
Data availability	NUTS 1 and 2 for different countries for CIS 2008, CIS 2010, CIS 2012, CIS 2014, CIS 2016

SMEs introducing product or process innovations as percentage of SMEs	
Numerator	Number of SMEs that 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 key to innovation in manufacturing activities. Higher shares of technological innovators should reflect a higher level of innovation activities
Included in EIS	Yes
Data source	Community Innovation Survey: Eurostat and National Statistical Offices
Data availability	NUTS 1 and 2 for different countries for CIS 2008, CIS 2010, CIS 2012, CIS 2014, CIS 2016

SMEs introducing marketing or organisational innovations as percentage of SMEs	
Numerator	Number of SMEs that introduced a new marketing innovation and/or organisational innovation to one of their markets
Denominator	Total number of SMEs
Rationale	Many firms, in particular in the service sectors, innovate through non-technological forms of innovation. Examples of these are organisational innovations. This indicator tries to capture the extent to which SMEs innovate through non-technological innovation
Included in EIS	Yes
Data source	Community Innovation Survey: Eurostat and National Statistical Offices
Data availability	NUTS 1 and 2 for different countries for CIS 2008, CIS 2010, CIS 2012, CIS 2014, CIS 2016

SMEs innovating in-house as percentage of SMEs	
Numerator	Number of SMEs with in-house innovation activities. Innovative firms with in-house innovation activities have introduced a new product or new process either in-house or in combination with other firms. The indicator does not include new products or processes developed by other firms
Denominator	Total number of SMEs
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 firms innovate
Included in EIS	Yes
Data source	Community Innovation Survey: Eurostat and National Statistical Offices
Data availability	NUTS 1 and 2 for different countries for CIS 2008, CIS 2010, CIS 2012, CIS 2014, CIS 2016

Innovative SMEs collaborating with others as percentage of SMEs	
Numerator	Number of SMEs with innovation co-operation activities. Firms with co-operation activities are those that have had any co-operation agreements on innovation activities with other enterprises or institutions
Denominator	Total number of SMEs
Rationale	This indicator measures the degree to which SMEs are involved in innovation co-operation. Complex innovations often depend on companies' ability to draw on diverse sources of information and knowledge, or to collaborate on the development of an innovation. The indicator measures the flow of knowledge between public research institutions and firms, and between firms and other firms. The indicator is limited to SMEs, because almost all large firms are involved in innovation co-operation
Included in EIS	Yes
Data source	Community Innovation Survey: Eurostat and National Statistical Offices
Data availability	NUTS 1 and 2 for different countries for CIS 2008, CIS 2010, CIS 2012, CIS 2014, CIS 2016

Public-private co-publications per million population	
Numerator	Number of public-private co-authored research publications. The definition of the "private sector" excludes the private medical and health sector. Publications are assigned to the country/countries in which the business companies or other private sector organisations are located
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
Included in EIS	Yes
Data source	Numerator: Web of Science. Data provided by CWTS (Leiden University) as part of a contract to DG Research and Innovation Denominator: Eurostat
Data availability	NUTS 2, 2009, 2011, 2013, 2015, 2017

PCT patent applications per billion regional GDP	
Numerator	Number of patents applied for at the European Patent Office (EPO), by year of filing. The regional distribution of the patent applications is assigned according to the address of the inventor
Denominator	Gross Domestic Product in Purchasing Power Standard
Rationale	The capacity of firms to develop new products determines their competitive advantage. One indicator of the rate of new product innovation is the number of patent applications
Included in EIS	Yes
Data source	Numerator: OECD, REGPAT. Denominator: Eurostat
Data availability	NUTS 2: 2008, 2010, 2012, 2014, 2016

Trademark applications per billion regional GDP	
Numerator	Number of trademark applications applied for at EUIPO
Denominator	Gross Domestic Product in Purchasing Power Standard
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
Included in EIS	No, proxy for EIS indicator covering both EUIPO and WIPO (Madrid Protocol) applications
Data source	Numerator: European Union Intellectual Property Office (EUIPO). Data provided by Science Metrix as part of a contract to DG Research and Innovation Denominator: Eurostat
Data availability	NUTS 2: 2009, 2011, 2013, 2015, 2017

Design applications per billion regional GDP	
Numerator	Number of designs applied for at EUIPO
Denominator	Gross Domestic Product in Purchasing Power Standard
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
Included in EIS	No, proxy for EIS indicator covering individual design applications
Data source	Numerator: European Union Intellectual Property Office (EUIPO). Data provided by Science Metrix as part of a contract to DG Research and Innovation. Denominator: Eurostat
Data availability	NUTS 2: 2009, 2011, 2013, 2015, 2017

Employment in medium-high/high tech manufacturing and knowledge-intensive services as percentage of total workforce	
Numerator	Number of employed persons in the medium-high and high tech manufacturing sectors include Chemicals (NACE 24), Machinery (NACE 29), Office equipment (NACE 30), Electrical equipment (NACE 31), Telecommunications and related equipment (NACE 32), Precision instruments (NACE 33), Automobiles (NACE 34) and Aerospace and other transport (NACE 35). Number of employed persons in the knowledge-intensive services sectors include Water transport (NACE 61), Air transport (NACE 62), Post and telecommunications (NACE 64), Financial intermediation (NACE 65), Insurance and pension funding (NACE 66), Activities auxiliary to financial intermediation (NACE 67), Real estate activities (NACE 70), Renting of machinery and equipment (NACE 71), Computer and related activities (NACE 72), Research and development (NACE73), and Other business activities (NACE 74)
Denominator	Total workforce including all manufacturing and service sectors
Rationale	The share of employment in high technology manufacturing sectors is an indicator of the manufacturing economy that is based on continual innovation through creative, inventive activity. The use of total employment gives a better indicator than using the share of manufacturing employment alone, since the latter will be affected by the relative decline of manufacturing in some countries. Knowledge-intensive services can be provided directly to consumers, such as telecommunications, and provide inputs to the innovative activities of other firms in all sectors of the economy. The latter can increase productivity throughout the economy and support the diffusion of a range of innovations, in particular those based on ICT
Included in EIS	No, proxy for EIS indicator on employment in knowledge-intensive activities
Data source	Eurostat
Data availability	NUTS 2: 2009, 2011, 2013, 2015, 2017

Sales of new-to-market and new-to-firm innovations in SMEs as percentage of turnover	
Numerator	Sum of total turnover of new or significantly improved products for SMEs
Denominator	Total turnover for SMEs
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)
Included in EIS	No, proxy for EIS indicator including all enterprises
Data source	Community Innovation Survey: Eurostat and National Statistical Offices
Data availability	NUTS 1 and 2 for different countries for CIS 2008, CIS 2010, CIS 2012, CIS 2014, CIS 2016

2.3 Regional coverage

The Regional Innovation Scoreboard covers 238 regions in 23 EU Member States, Norway, Serbia and Switzerland at different NUTS levels.[2] The NUTS classification (Nomenclature of territorial units for statistics) is a hierarchical system for dividing the economic territory of the EU, which distinguishes between three levels: NUTS 1 captures major socio-economic regions, NUTS 2 captures basic regions for the application of regional policies, and NUTS 3 captures small regions for specific diagnoses.

Depending on differences in regional data availability, the RIS covers 32 NUTS 1 level regions and 216 NUTS 2 level regions (**Table 2**, NUTS 1 regions in countries covered at the NUTS 2 level are also counted as NUTS 2 regions). In addition, the EU Member States Cyprus, Estonia, Latvia, Lithuania, Luxembourg, and Malta are included at the country level, as in these countries NUTS 1 and NUTS 2 levels are identical to the country territory. For the countries included at the country level, their performance levels relative to the EU28 scores from the EIS 2019 have been used.

With some countries only being covered at the NUTS 1 level, there can be significant differences in the average size of regions. For instance, the average population of a NUTS 1 region in France (total population of almost 67 million) is 4.8 million, whereas it is 2.9 million for an average NUTS 2 region in Italy (total population of almost 60.5 million). The average unit of regional innovation performance analysis is 1.66 times larger in France than in Italy. These differences in unit size have implications for the variation of performance scores within countries. In general, a higher number of regions will lead to larger differences between regions in the same country.

Table 2: NUTS 1 and NUTS 2 regions included in RIS 2019 by country

Country	Number of regions at NUTS level		Average population size (2018)	Regions (NUTS code)	
	1	2			
BE Belgium	3		3,799,500	Région de Bruxelles-Capitale / Brussels Hoofdstedelijk Gewest (BE1)	Vlaams Gewest (BE2) Région Wallonne (BE3)
BG Bulgaria		6	1,175,000	Severozapaden (BG31) Severen tsentralen (BG32) Severoiztochen (BG33)	Yugoiztochen (BG34) Yugozapaden (BG41) Yuzhen tsentralen (BG42)
CZ Czechia		8	1,326,300	Praha (CZ01) Střední Cechy (CZ02) Jihozápad (CZ03) Severozápad (CZ04)	Severovýchod (CZ05) Jihovýchod (CZ06) Střední Morava (CZ07) Moravskoslezsko (CZ08)
DK Denmark		5	1,156,200	Hovedstaden (DK01) Sjælland (DK02) Syddanmark (DK03)	Midtjylland (DK04) Nordjylland (DK05)

[2] For Serbia, official NUTS codes are not available as Eurostat and Serbia have not yet agreed on statistical regions for the country. In this report, the following unofficial codes will be used: RS11 for Belgrade, RS12 for Vojvodina, RS21 for Šumadija and Western Serbia, and RS22 for Southern and Eastern Serbia.

Country	Number of regions at NUTS level		Average population size (2018)	Regions (NUTS code)	
	1	2			
DE Germany		38	2,178,700	Stuttgart (DE11) Karlsruhe (DE12) Freiburg (DE13) Tübingen (DE14) Oberbayern (DE21) Niederbayern (DE22) Oberpfalz (DE23) Oberfranken (DE24) Mittelfranken (DE25) Unterfranken (DE26) Schwaben (DE27) Berlin (DE30) Brandenburg (DE40) Bremen (DE50) Hamburg (DE60) Darmstadt (DE71) Gießen (DE72) Kassel (DE73) Mecklenburg-Vorpommern (DE80)	Braunschweig (DE91) Hannover (DE92) Lüneburg (DE93) Weser-Ems (DE94) Düsseldorf (DEA1) Köln (DEA2) Münster (DEA3) Detmold (DEA4) Arnsberg (DEA5) Koblenz (DEB1) Trier (DEB2) Rheinhessen-Pfalz (DEB3) Saarland (DEC0) Dresden (DED2) Chemnitz (DED4) Leipzig (DED5) Sachsen-Anhalt (DEE0) Schleswig-Holstein (DEF0) Thüringen (DEG0)
IE Ireland		3	1,610,100	Northern and Western (IE04) Southern (IE05)	Eastern and Midland (IE06)
EL Greece		13	826,200	Anatoliki Makedonia, Thraki (EL51) Kentriki Makedonia (EL52) Dytiki Makedonia (EL53) Ipeiros (EL54) Thessalia (EL61) Ionia Nisia (EL62)	Dytiki Ellada (EL63) Sterea Ellada (EL64) Peloponnisos (EL65) Attiki (EL30) Voreio Aigaio (EL41) Notio Aigaio (EL42) Kriti (EL43)
ES Spain		19	2,455,700	Galicia (ES11) Principado de Asturias (ES12) Cantabria (ES13) País Vasco (ES21) Comunidad Foral de Navarra (ES22) La Rioja (ES23) Aragón (ES24) Comunidad de Madrid (ES30) Castilla y León (ES41) Castilla-la Mancha (ES42)	Extremadura (ES43) Cataluña (ES51) Comunidad Valenciana (ES52) Illes Balears (ES53) Andalucía (ES61) Región de Murcia (ES62) Ciudad Autónoma de Ceuta (ES63) Ciudad Autónoma de Melilla (ES64) Canarias (ES70)
FR France	14		4,780,400	Île de France (FR1) Centre - Val de Loire (FRB) Bourgogne - Franche-Comté (FRC) Normandie (FRD) Nord-Pas de Calais – Picardie (FRE) Alsace - Champagne-Ardenne – Lorraine (FRF) Pays de la Loire (FRG) Bretagne (FRH)	Aquitaine - Limousin - Poitou-Charentes (FRI) Languedoc-Roussillon - Midi-Pyrénées (FRJ) Auvergne - Rhône-Alpes (FRK) Provence-Alpes-Côte d'Azur (FRL) Corse (FRM) RUP FR - Régions ultrapériphériques françaises (FRY)

Country		Number of regions at NUTS level		Average population size (2018)	Regions (NUTS code)	
		1	2			
HR	Croatia		2	2,052,700	Jadranska Hrvatska (HR03)	Kontinentalna Hrvatska (HR04)
IT	Italy		21	2,880,200	Piemonte (ITC1) Valle d'Aosta/Vallée d'Aoste (ITC2) Liguria (ITC3) Lombardia (ITC4) Provincia Autonoma Bolzano/Bozen (ITH1) Provincia Autonoma Trento (ITH2) Veneto (ITH3) Friuli-Venezia Giulia (ITH4) Emilia-Romagna (ITH5) Toscana (ITI1)	Umbria (ITI2) Marche (ITI3) Lazio (ITI4) Abruzzo (ITF1) Molise (ITF2) Campania (ITF3) Puglia (ITF4) Basilicata (ITF5) Calabria (ITF6) Sicilia (ITG1) Sardegna (ITG2)
LT	Lithuania		2	1,404,500	Sostinės regionas (LT01)	Vidurio ir vakarų Lietuvos regionas (LT02)
HU	Hungary		8	1,222,300	Budapest (HU11) Pest (HU12) Közép-Dunántúl (HU21) Nyugat-Dunántúl (HU22)	Dél-Dunántúl (HU23) Észak-Magyarország (HU31) Észak-Alföld (HU32) Dél-Alföld (HU33)
NL	Netherlands		12	1,431,800	Groningen (NL11) Friesland (NL12) Drenthe (NL13) Overijssel (NL21) Gelderland (NL22) Flevoland (NL23)	Utrecht (NL31) Noord-Holland (NL32) Zuid-Holland (NL33) Zeeland (NL34) Noord-Brabant (NL41) Limburg (NL42)
AT	Austria	3		2,940,800	Ostösterreich (AT1) Südösterreich (AT2)	Westösterreich (AT3)
PL	Poland		17	2,233,900	Małopolskie (PL21) Śląskie (PL22) Wielkopolskie (PL41) Zachodniopomorskie (PL42) Lubuskie (PL43) Dolnośląskie (PL51) Opolskie (PL52) Kujawsko-Pomorskie (PL61) Warmińsko-Mazurskie (PL62)	Pomorskie (PL63) Łódzkie (PL71) Świętokrzyskie (PL72) Lubelskie (PL81) Podkarpackie (PL82) Podlaskie (PL84) Warszawski stoleczny (PL91) Mazowiecki regionalny (PL92)
PT	Portugal		7	1,470,100	Norte (PT11) Algarve (PT15) Centro (PT16) Lisboa (PT17) Alentejo (PT18)	Região Autónoma dos Açores (PT20) Região Autónoma da Madeira (PT30)
RO	Romania		8	2,441,300	Nord-Vest (RO11) Centru (RO12) Nord-Est (RO21) Sud-Est (RO22)	Sud - Muntenia (RO31) Bucuresti - Ilfov (RO32) Sud-Vest Oltenia (RO41) Vest (RO42)
SI	Slovenia		2	1,033,400	Vzhodna Slovenija (SI03)	Zahodna Slovenija (SI04)
SK	Slovakia		4	1,360,800	Bratislavský kraj (SK01) Západné Slovensko (SK02)	Stredné Slovensko (SK03) Východné Slovensko (SK04)

Country		Number of regions at NUTS level		Average population size (2018)	Regions (NUTS code)	
		1	2			
FI	Finland		5	1,102,600	Helsinki-Uusimaa (FI1B) Etelä-Suomi (FI1C) Länsi-Suomi (FI19)	Pohjois- ja Itä-Suomi (FI1D) Åland (FI20)
SE	Sweden		8	1,265,000	Stockholm (SE11) Östra Mellansverige (SE12) Småland med öarna (SE21) Sydsverige (SE22)	Västsverige (SE23) Norra Mellansverige (SE31) Mellersta Norrland (SE32) Övre Norrland (SE33)
UK	United Kingdom	12		5,522,800	North East (UKC) North West (UKD) Yorkshire and The Humber (UKE) East Midlands (UKF) West Midlands (UKG) East of England (UKH)	London (UKI) South East (UKJ) South West (UKK) Wales (UKL) Scotland (UKM) Northern Ireland (UKN)
NO	Norway		7	756,500	Oslo og Akershus (NO01) Hedmark og Oppland (NO02) Sør-Østlandet (NO03) Agder og Rogaland (NO04)	Vestlandet (NO05) Trøndelag (NO06) Nord-Norge (NO07)
CH	Switzerland		7	1,212,000	Région lémanique (CH01) Espace Mittelland (CH02) Nordwestschweiz (CH03) Zürich (CH04)	Ostschweiz (CH05) Zentralschweiz (CH06) Ticino (CH07)
RS	Serbia[3]		4	1,750,400	Belgrade (RS11) Vojvodina (RS12)	Šumadija and Western Serbia (RS21) Southern and Eastern Serbia (RS22)

2.4 Regional data availability

Regional innovation data for five indicators are directly available from Eurostat. For Population aged 30-34 having completed tertiary education, Lifelong learning, R&D expenditures in the public sector, R&D expenditures in the business sector, and Employment in medium-high/high tech manufacturing and knowledge-intensive services, regional data can be extracted from Eurostat's online regional database. Regional patent data have been extracted from the OECD's REGPAT database. For the six indicators using Community Innovation Survey (CIS) data, regional data are not directly available from Eurostat, and a special data request has been made to National Statistical Offices to obtain regional CIS data. For the three indicators using bibliometric data, regional data have been made available by CWTS (Leiden University) as part of a contract with the European Commission (DG Research and Innovation). For Trademark applications and Design applications, regional data have been made available by Science Metrix as part of a contract with the European Commission (DG Research and Innovation).

Regional CIS data request

To collect regional CIS data, data requests were made by Eurostat in 2018 to National Statistical Offices of most Member States, excluding those countries for which NUTS 1 and NUTS 2 levels are identical to the country territory, or countries for which national CIS samples are too small to allow them to deliver reliable regional-level data, and to

[3] The NUTS codes for Serbia are not official codes but are used for ease of reference in the RIS 2019 and for producing the regional maps.

Norway, Serbia, and Switzerland. Eurostat was able to share regional CIS 2016 data for 25 countries (Austria, Belgium, Bulgaria, Croatia, Czechia, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Lithuania, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, and the United Kingdom) for the following indicators:

- Non-R&D innovation expenditure by SMEs (share of turnover in SMEs);
- SMEs innovating in-house (share of all SMEs);
- Innovative SMEs collaborating with others (share of all SMEs);
- SMEs with product or process innovation (share of all SMEs);
- SMEs with marketing or organisational innovations (share of all SMEs);
- Sales of new-to-market and new-to-firm innovations by SMEs (share of turnover in SMEs).

Regional CIS data are not publicly available and have been made explicitly available for the Regional Innovation Scoreboard by national statistical offices. The CIS assigns the innovation activities of multi-establishment enterprises to the region where the head office is located. There is a risk that regions without head offices score lower on the CIS indicators as some of the activities in these regions are assigned to those regions with head offices, and to minimise this risk, the regional CIS data excludes large firms (which are more likely to have multiple establishments in different regions) and focuses on SMEs only.

Data availability by indicator and country

For the most recent year, data availability is 90.9%, i.e. regional data are available for 3,676 out of a maximum of 4,046 observations. Data availability differs by indicator, with highest data availability for Lifelong learning, International scientific co-publications and Most-cited scientific publications (**Table 3**). Data availability is below average for Public and Business R&D expenditures.

Table 3: Regional data availability by indicator

	Data availability most recent year
Lifelong learning	100%
International scientific co-publications	100%
Most-cited scientific publications	100%
Population having completed tertiary education	99.2%
Public-private co-publications	95.4%
Trademark applications	95.4%
SMEs with product or process innovations	95.0%
SMEs with marketing or organisational innovations	95.0%
Innovative SMEs collaborating with others	95.0%
Sales of new-to-market and new-to-firm innovations in SMEs	95.0%
Employment in medium/high-tech manufacturing and knowledge-intensive services	92.9%
Design applications	92.4%
Non-R&D innovation expenditures in SMEs	92.0%
SMEs innovating in-house	92.0%
PCT patent applications	91.2%
All indicators	90.9%
R&D expenditures in the public sector	62.1%

	Data availability most recent year
R&D expenditures in the business sector	49.2%

There are large differences in regional data availability across countries. Data availability is perfect at 100% for eight countries, very good at 95% or more for another four countries, and good at 90% or more for three more countries (**Table 4**). Data availability is between 80% and 90% for seven countries. Data availability for Ireland, Norway and Switzerland is at 75% or just above. For Ireland below-average data availability is explained by a change from two regions using the NUTS 2013 classification to three regions using the NUTS 2016 classification. Not for all indicators data are already available for these 3 new regions. For Norway and Switzerland no 2017 data are available for both Public and Business R&D expenditures. For the Netherlands data availability is low as regional CIS 2016 data are not available.

Table 4: Regional data availability by country

		Data availability most recent year			Data availability most recent year
BG	Bulgaria	100%	PL	Poland	93.1%
HR	Croatia	100%		All regions	90.9%
CZ	Czechia	100%	AT	Austria	88.2%
DK	Denmark	100%	BE	Belgium	88.2%
SK	Slovakia	100%	SE	Sweden	88.2%
SI	Slovenia	100%	RS	Serbia	86.8%
RO	Romania	100%	FR	France	87.0%
UK	United Kingdom	100%	LT	Lithuania	82.4%
IT	Italy	99.7%	EL	Greece	80.5%
ES	Spain	96.3%	IE	Ireland	76.5%
FI	Finland	95.3%	NO	Norway	76.5%
PT	Portugal	95.0%	CH	Switzerland	76.5%
DE	Germany	94.1%	NL	Netherlands	52.9%
HU	Hungary	94.1%			

Timeliness of regional data

For the RIS 2019, most recent data refer to 2017 for six indicators (Population aged 30-34 with tertiary education, Lifelong learning, Public-private co-publications, Trademark applications, Design applications, and Employment in medium-high/high-tech manufacturing and knowledge-intensive services), 2016 for 10 indicators (International scientific co-publications, R&D expenditures in the public sector, R&D expenditures in the business sector, Non-R&D innovation expenditures, SMEs with product or process innovations, SMEs with marketing or organisational innovations, SMEs innovating in-house, Innovative SMEs collaborating with others, PCT patent applications, and Sales of new-to-market and new-to-firm innovations), and 2015 for one indicator (Most-cited scientific publications).

Following the availability of the most recent data, the RIS 2019 will present a Regional Innovation Index (RII) for five reference years:

- RII2019 using regional CIS 2016 data and the most recent data available at 17 April 2019;
- RII2017 using data two years less timely than those used for the RII2019 (including regional CIS 2014 data);
- RII2015 using data four years less timely than those used for the RII2019 (including regional CIS 2012 data);

- RII2013 using data six years less timely than those used for the RII2019 (including regional CIS 2010 data);
- RII2011 using data eight years less timely than those used for the RII2019 (including regional CIS 2008 data).

3. Imputation of missing data

3.1 Imputation techniques

The full RIS 2019 database contains 20,230 data cells (238 regions, 17 indicators, and 5 years). An exact percentage for overall data availability has not been calculated, as for older years the database includes both real data and data already imputed in previous versions of the Regional Innovation Scoreboard. To improve data availability, several imputation techniques have been used to provide estimates for all missing data.

To increase data availability, several imputation techniques have been used in the following order:

1. At the country level, if data for both the previous and following year are available
   - 1A) the average of both years will be used $X_C^T = (X_C^{T-1} + X_C^{T+1})/2$
   - else 1B) that of the previous year $X_C^T = X_C^{T-1}$
   - else 1C) that of the following year $X_C^T = X_C^{T+1}$

   where C denotes the country, T the current year, T-1 the previous year and T+1 the following year. If data are not available for the previous and following year, missing data will not be imputed.

The following steps apply for all indicators:

2. If regional data are available for the previous year, the ratio between the corresponding NUTS level and that at a higher aggregate level (NUTS 1 for NUTS 2 regions, country level for NUTS 1 regions) for the previous year is multiplied with the current value at the higher aggregate level:

   $X_R^T = (X_R^{T-1} / X_C^{T-1}) * X_C^T$, where R denotes the region, C the country (as the higher aggregate level), T the current year, and T-1 the previous year.

3. If regional data for the previous year are *not* available, the same procedure as in step 2 will be applied using the ratio between the corresponding NUTS level and that at a higher aggregate level (NUTS 1 for NUTS 2 regions, country level for NUTS1 regions) for the following year:

   $X_R^T = (X_R^{T+1} / X_C^{T+1}) * X_C^T$, where R denotes the region, C the country (as the higher aggregate level), T the current year, and T+1 the following year.

4. If there are no regional data for both the previous nor the following year, the higher-level aggregate will be used (NUTS 1 for NUTS 2 regions, country level for NUTS 1 regions), first that for the current year, and, if not available, that for the previous year, otherwise that for the following year:

   $X_R^T = X_C^T$ or $X_R^T = X_C^{T-1}$ or $X_R^T = X_C^{T+1}$, where R denotes the region, C the country (as the higher aggregate level), t the current year, T-1 the previous year, and T+1 the following year.

5. If there are no regional and no country-level data available for the current, previous and following year, missing data will not be imputed.

For steps 3 to 5, section 3.2 will provide several examples of the different imputation steps.

Data availability after imputation

Data availability after imputation improves to 98.9% with data missing for only 225 observations. For some regions, data could not be imputed. Data availability is 100% for almost all countries, except for:

- Finland (95.3%): data missing for 4 indicators for *Åland* (FI20);
- France (98.7%): data mussing for 2 regions (FRM and FRY);
- Greece (95.9%): incomplete data for 7 regions;
- Ireland (94.1%) no data for patent applications for all regions;
- Italy (99.7%): data missing for Employment in medium-high/high tech manufacturing and knowledge-intensive services for *Valle d'Aosta/Vallée d'Aoste* (ITC2);
- Poland (99.3%): data missing for Employment in medium/high tech manufacturing and knowledge-intensive services for two regions (PL43 and PL52);
- Portugal (95.8%): data missing for three regions (PT15, PT20 and PT30);
- Serbia (94.1%): data missing for PCT patent applications for all regions;
- Spain (97.8%): data missing for 3 regions (ES63, ES64 and ES70);
- Switzerland (95.1%): data missing for Non-R&D innovation expenditure for all regions.

3.2 Examples of imputations

Example 1: Regional data are available for the previous year

If regional data are available for the previous year, the ratio between the corresponding NUTS level and that at a higher aggregate level for the previous year is multiplied with the current value at the higher aggregate level ($(X_R^{T-1} / X_C^{T-1}) * X_C^T$):

R&D expenditure in the public sector as a percentage of GDP: Groningen (NL11)

	2012	**2014**
NL11	1.50	Missing
NL1	0.73	0.68
NL11	1.40	Estimate: 1.40 (=(0.68/0.73)*1.50)

Example 2: Regional data are available for the following year

If regional data are available for the following year, the ratio between the corresponding NUTS level and that at a higher aggregate level for the following year is multiplied with the current value at the higher aggregate level ($(X_R^{T+1} / X_C^{T+1}) * X_C^T$):

R&D expenditure in the public sector as a percentage of GDP: Etelä-Suomi (FI1C)

	2008	**2010**
FI1C	Missing	1.35
FI1	0.92	1.14
FI1C	Estimate: 1.09 (=(0.92/1.14)*1.35)	1.09

4. Composite indicators

4.1 Normalising data

Ideally, for calculating composite indicators, the individual indicators should follow a normal distribution. Most of the indicators are fractional indicators with values between 0% and 100%, and most of these follow a normal distribution (cf. **Table 5**). Some indicators are unbound indicators, where values are not limited to an upper threshold. These indicators can have skewed data distributions (where most regions show low performance levels, and a few regions show exceptionally high performance levels).

For all indicators, data will be transformed using a square root transformation if the degree of skewness of the raw data exceeds 1 such that the skewness of the transformed data is below 1. This transformation will be applied after the imputation of missing data. **Table 5** summarises the degree of skewness before and after the transformation. For the following indicators, the degree of skewness was above one so that data have been transformed: Lifelong learning, International scientific co-publications, R&D expenditures in the public sector, R&D expenditures in the business sector, Non-R&D innovation expenditures, Public-private co-publications, EPO patent applications, Trademark applications, Design applications, and Sales of new-to-market and new-to-firm innovations.

Table 5: Degree of skewness and transformation

	Degree of skewness	
	before trans-formation	after trans-formation
Population having completed tertiary education	0.351	---
Lifelong learning	0.953	---
International scientific co-publications	1.573	0.577
Most-cited scientific publications	-0.062	---
R&D expenditures in the public sector	1.139	0.234
R&D expenditures in the business sector	1.324	0.366
Non-R&D innovation expenditures in SMEs	1.363	0.293
SMEs with product or process innovations	0.133	---
SMEs with marketing or organisational innovations	0.155	---
SMEs innovating in-house	-0.084	---
Innovative SMEs collaborating with others	0.794	---
Public-private co-publications	2.124	0.741
PCT patent applications	1.468	0.844
Trademark applications	0.930	---
Design applications	1.648	0.561
Employment in medium-high/high tech manufacturing and knowledge-intensive services	0.253	---
Sales of new-to-market and new-to-firm innovations in SMEs	1.356	0.346

The data are normalised using the min-max procedure. The minimum score observed for all regions across all five biennial observations is first subtracted from the transformed score. The result is then divided by the difference between the maximum and minimum scores observed for all regions across all five yearly observations. The maximum normalised score is equal to 1 and the minimum normalised score is equal to 0:

$$\hat{X}_r = \frac{\widetilde{X}_r - MIN(\forall_r \widetilde{X}_r)}{MAX(\forall_r \widetilde{X}_r) - MIN(\forall_r \widetilde{X}_r)}$$

4.2 Regional Innovation Index

Average innovation performance is measured using composite indicators. The Regional Innovation Index (RII) is calculated as the unweighted average of the normalised scores of the 17 indicators.

A comparison of the Regional Innovation Index at the country level with the Summary Innovation Index in the European Innovation Scoreboard shows that, due to using a more restricted set of indicators in the RIS, countries' performance relative to the EU average in the RIS is different from that in the European Innovation Scoreboard. The following correction is therefore applied to the composite indicator scores:

1) Calculate the ratios of the EIS 2019 Summary Innovation Index at country level with that of the EU: EIS_index_CTR / EIS_index_EU;
2) Calculate the ratios of the RIS 2019 Regional Innovation Index at country level with that of the EU: RIS_index_CTR / RIS_index_EU;
3) Calculate the correction factor by dividing the ratios 1) and 2).

These country correction factors are then multiplied with the RII for each region in the corresponding country to obtain final RII scores.

Relative performance scores are calculated by dividing the RII of the region by that of the EU and multiplying by 100. For trend performance, RIIs for all years are divided by that of the EU in 2011.

4.3 Regional performance group membership

The RIS 2019 uses the classification scheme used in the European Innovation Scoreboard:

- Innovation Leaders are all regions with a relative performance more than 20% above the EU average in 2019;
- Strong Innovators are all regions with a relative performance between 90% and 120% of the EU average in 2019;
- Moderate Innovators are all regions with a relative performance between 50% and 90% of the EU average in 2019;
- Modest Innovators are all regions with a relative performance below 50% of the EU average in 2019.

The RIS 2017 introduced three subgroups within each performance group to allow for more diversity at the regional level: the top one-third regions (+), the middle one-third regions, and the bottom one-third regions (-), creating the following 12 performance groups: Innovation Leaders +, Innovation Leaders, Innovation Leaders -, Strong + Innovators, Strong Innovators, Strong - Innovators, Moderate + Innovators, Moderate Innovators, Moderate - Innovators, Modest + Innovators, Modest Innovators, and Modest - Innovators.

5. Structural indicators

5.1 Selected indicators to measure regional structural definitions

The RIS 2017 introduced structural data in the regional profiles to help users to better understand the impact of structural differences on observed scores. Brief analyses of structural differences by region will be performed in the regional profiles. The RIS 2019 includes data for the same set of structural indicators in the regional profiles.

Important are differences in economic structures, with differences in the share of industry in GDP an important factor that could explain why regions performance better or worse on indicators like business R&D expenditures, PCT patent applications and innovative enterprises. The regional profiles will for each region include, if data are available from Eurostat, data on the composition of regional employment, using average employment shares for the years 2014-2018, for the following industries: Agriculture & Mining, Manufacturing, Utilities & Construction, Services, and Public administration.

Enterprise characteristics are important for explaining differences in R&D spending and innovation activities. Larger enterprises are more likely to be innovative. Regional data on the average number of employees in an enterprise are used to measure differences in enterprise size effects across regions.

Densely populated areas are also more likely to be more innovative for several reasons. First, with people and enterprises being at closer distance, knowledge diffuses more easily. Second, in urbanised areas there tends to be a concentration of government and educational services. These provide better training opportunities and employ above-average shares of highly educated people. Structural data also include indicators measuring the size of the regional economy, including two indicators measuring GDP per capita, both in Euros and in purchasing power standards[4], which are a better measure for interpreting real income differences between regions.

5.2 Definitions of structural indicators

Composition of employment, %-shares, average 2015-2018	
	Agriculture & Mining (NACE Rev. 2 A-B)
Numerator	Employment in the respective industries
Denominator	Total employment
Calculated as	Average percentage for the years 2015 to 2018
Data source	Eurostat: Employment in technology and knowledge-intensive sectors by NUTS 2 regions (from 2008 onwards, NACE Rev. 2)
	Manufacturing (NACE Rev. 2 C)
Numerator	Employment in the respective industry
Denominator	Total employment
Calculated as	Average percentage for the years 2015 to 2018
Data source	Eurostat: Employment in technology and knowledge-intensive sectors by NUTS 2 regions (from 2008 onwards, NACE Rev. 2)
	Utilities and Construction (NACE Rev. 2 D-F)

[4] The purchasing power standard (PPS), is an artificial currency unit. Theoretically, one PPS can buy the same amount of goods and services in each country. However, price differences across borders mean that different amounts of national currency units are needed for the same goods and services depending on the country. PPS are derived by dividing any economic aggregate of a country in national currency by its respective purchasing power parities.

Numerator	Employment in the respective industries
Denominator	Total employment
Calculated as	Average percentage for the years 2015 to 2018
Data source	Eurostat: Employment in technology and knowledge-intensive sectors by NUTS 2 regions (from 2008 onwards, NACE Rev. 2)
	Services (NACE Rev. 2 G-N)
Numerator	Employment in the respective industries
Denominator	Total employment
Calculated as	Average percentage for the years 2015 to 2018
Data source	Eurostat: Employment in technology and knowledge-intensive sectors by NUTS 2 regions (from 2008 onwards, NACE Rev. 2)
	Public administration (NACE Rev. 2 O-U)
Numerator	Employment in the respective industries
Denominator	Total employment
Calculated as	Average percentage for the years 2015 to 2018
Data source	Eurostat: Employment in technology and knowledge-intensive sectors by NUTS 2 regions (from 2008 onwards, NACE Rev. 2)
Average number of persons employed per enterprise, average 2015-2016	
Numerator	Total number of persons employed by active enterprises
Denominator	Number of active enterprises
Calculated as	Average percentage for the years 2015 and 2016
Data source	Eurostat: Business demography by size class and NUTS 3 regions

GDP per capita, PPS, 2017	
Indicator	Nominal Gross Domestic Product per capita
Unit	Purchasing power standard (PPS) per inhabitant
Data source	Eurostat: Gross domestic product (GDP) at current market prices by NUTS 2 regions
GDP per capita growth, 2013-2017	
Indicator	Growth of Nominal Gross Domestic Product per capita
Unit	Purchasing power standard (PPS) per inhabitant
Calculated as	Compound average growth rate (CAGR) between 2013 and 2017: CAGR = (GDP per capita in 2017 / GDP per capita in 2013)^(1/4) - 1
Data source	Eurostat: Gross domestic product (GDP) at current market prices by NUTS 2 regions
Degree of urbanisation (%), 2018	
Indicator	Share of households living in densely populated areas and intermediate density areas

Definition of urbanisation	"The degree of urbanisation (DEGURBA) creates a classification of all LAU2s (Local Administrative Units - Level 2/municipalities) into the following three categories: (1) Cities (densely populated areas) (Code 1) (2) Towns and suburbs (intermediate density areas) (Code 2) (3) Rural areas (thinly populated areas) (Code 3)" For more details: http://ec.europa.eu/eurostat/ramon/miscellaneous/index.cfm?TargetUrl=DSP_DEGURBA
Data source	Eurostat: Number of households by degree of urbanisation and NUTS 2 regions
Population density, 2017	
Numerator	Inhabitants per km2
Data source	Eurostat: Population density by NUTS 3 region
Population size (thousands), 2018	
Indicator	Population on 1 January
Data source	Eurostat: Population on 1 January by NUTS 2 region


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