Regional Innovation Scoreboard 2023

Methodology Report

Independent
Expert
Report

Research and
Innovation

Regional Innovation Scoreboard 2023 – Methodology Report

European Commission
Directorate-General for Research and Innovation
Directorate G – Common Policy Centre
Unit G.1 – Common R&I Strategy & Foresight Service
Contact Alexandr Hobza, Chief Economist and Head of Unit G.1
Athina Karvounaraki
Alexis Stevenson
Email RTD-STATISTICS@ec.europa.eu
RTD-PUBLICATIONS@ec.europa.eu
Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs
Directorate A – Strategy and Economic Analysis
Unit A.1 – Chief Economist
Contact Román Arjona, Chief Economist and Head of Unit A.1
Xosé-Luís Varela-Irimia
Email GROW-A1@ec.europa.eu
European Commission
B-1049 Brussels

Manuscript completed in June 2023.

Regional Innovation Scoreboard 2023

Methodology Report

The report was prepared by

Hugo Hollanders and Nordine Es-Sadki

(Maastricht University – UNU-MERIT)

as part of the European Innovation Scoreboard project

for the European Commission, Directorate-General for Research and Innovation under

Framework Contract N° 2018/RTD/A2/OP/PP-07001-2018 Lot 2 (EDAR)

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 uses the EIS indicators for which data is available at the regional level, including regional data from the Community Innovation Survey (CIS). The RIS 2023 follows the methodology of the EIS 2023 and uses data for 239 regions across Europe for 21 of the 32 indicators used in the EIS 2023.

The RIS Methodology Report describes the indicators included in the RIS 2023, data availability, and methods used for estimating missing data. Section 2 provides details on the indicators used in the RIS 2023. 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 2023. Section 5 presents the definitions for the structural indicators used in regional profiles.

2. REGIONAL INNOVATION SCOREBOARD INDICATORS

2.1. A comparison between the indicators used in the EIS and RIS

In the RIS, regional innovation performance should, if possible, 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 21 of the 32 indicators used in the EIS 2023 (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:

- Regional data are not available for *Individuals who have above basic overall digital skills*. The indicator correlates highly at the country level with Households with broadband access, and regional data for the latter are available from Eurostat and used to calculate regional estimates for this indicator as follows:

  Regional score for Individuals who have above basic overall digital skills = Regional score for Households with broadband access / Country score for Households with broadband access * Country score for Individuals who have above basic overall digital skills

- For the indicators using expenditure data from the Community Innovation Survey (CIS) – Non-R&D innovation expenditures, Innovation expenditures per person employed in innovation-active enterprises, and Sales of new-to-market and new-to-enterprise innovations – the data refer only to SMEs and not to all enterprises[1].

- Regional data are not available for *Employed ICT specialists*. The indicator correlates highly at the country level with Employment in information and communication (NACE J), and regional data for the latter are available from Eurostat and used to calculate regional estimates for this indicator as follows:

- Regional data are not available for *Employed ICT specialists*. The indicator correlates highly at the country level with Employment in information and communication (NACE J), and regional data for the latter are available from Eurostat and used to calculate regional estimates for this indicator as follows:

  Regional score for Employed ICT specialists = Regional score for Employment in information and communication (NACE J) / Country score for Employment in information and communication (NACE J) * Country score for employed ICT specialists.

- For *PCT patent applications*, regional data have been extracted from the OECD's REGPAT database.

- 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, which are available from Eurostat.

For *Air emissions in fine particulates (PM2.5)* in Industry alternative data are used for Exposure to fine particulates (PM2.5), which have been extracted from the European Environmental Agency (EEA).

[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.

In this report the indicator names of the EIS will be used also for the indicators for which either alternative indicators will be used or where regional data have been estimated.

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

	EIS 2023	RIS 2023
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	Identical
	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*
Digitalisation	*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*
	Individuals who have above basic overall digital skills	Own estimates using Households with broadband access
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*
	Direct government funding and government tax support for business R&D	*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	Data for SMEs
	Innovation expenditures per person employed in innovation-active enterprises	Data for SMEs
Use of information technologies	*Enterprises providing training to develop or upgrade ICT skills of their personnel*	*No regional data*
	Employed ICT specialists	Estimates using Employment in information and communication
INNOVATION ACTIVITIES		
Innovators	SMEs introducing product innovations as percentage of SMEs	Identical
	SMEs introducing business process innovations as percentage of SMEs	Identical
Linkages	Innovative SMEs collaborating with others as percentage of SMEs	Identical
	Public-private co-publications per million population	Identical
	Job-to-job mobility of Human Resources in Science & Technology	*No regional data*
Intellectual assets	PCT patent applications per billion GDP (in Purchasing Power standards)	Identical
	Trademark applications per billion GDP (in Purchasing Power standards)	Identical
	Individual design applications per billion GDP (in Purchasing Power standards)	Design applications

	EIS 2023	RIS 2023
IMPACTS		
Employment impacts	Employment in knowledge-intensive activities as percentage of total employment	Employment in medium-high and high-tech manufacturing and knowledge-intensive services
	Employment in innovative enterprises	Data for SMEs
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-enterprise innovations as percentage of total turnover	Data for SMEs
Environmental sustainability	*Resource productivity*	*No regional data*
	Air emissions in fine particulates (PM2.5) in Industry	Exposure to fine particulates (PM2.5)
	Development of environment-related technologies	*No regional data*

2.2. Indicator definitions

This section presents detailed definitions for each of the indicators used in the RIS 2023. 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 2023, as shown in Table 1.

Percentage population aged 25-34 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 25 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 25 to 34 and will relatively quickly reflect changes in educational policies leading to more tertiary graduates
Data source	Eurostat, regional statistics
Data availability	NUTS 2: 2014 - 2021

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
Data source	Eurostat, regional statistics
Data availability	NUTS 2: 2014 - 2021
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
Data source	Numerator: Scopus. Data calculated by Science Metrix as part of a contract to the EC Denominator: Eurostat

Data availability	NUTS 2: 2015 – 2022

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 quality 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
Data source	Scopus. Data calculated by Science Metrix as part of a contract to the EC
Data availability	NUTS 2: 2013 - 2020

Individuals who have above basic overall digital skills	
Numerator	Number of individuals with above basic overall digital skills
Denominator	Total number of individuals aged 16 to 74
Rationale	Above basic overall digital skills represent the highest level of the overall digital skills indicator, which is a composite indicator based on selected activities performed by individuals aged 16-74 on the internet in four specific areas (information, communication, problem solving, content creation) during the previous 3 months
Data source	Own estimates combining EIS country level with regional data (Eurostat) on Households with broadband access
Data availability	NUTS 2: 2017 – 2021

R&D expenditures in the public sector as percentage of GDP	
Numerator	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
Data source	Eurostat, regional statistics
Data availability	NUTS 2: 2013 - 2020

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
Data source	Eurostat, regional statistics
Data availability	NUTS 2: 2013 - 2020
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
Difference with EIS	EIS indicator includes all enterprises
Data source	Community Innovation Survey: Eurostat and National Statistical Offices

Data availability	NUTS 1 and 2 for different countries for CIS 2014, CIS 2016, CIS 2018, CIS 2020

Innovation expenditures per person employed in innovative SMEs	
Numerator	Sum of total innovation expenditure by SMEs in Purchasing Power Standards (PPS)
Denominator	Total employment in innovative enterprises SMEs
Rationale	The indicator measures the monetary input directly related to innovation activities.
Difference with EIS	EIS indicator includes all enterprises
Data source	Community Innovation Survey: Eurostat and National Statistical Offices
Data availability	NUTS 1 and 2 for different countries for CIS 2014, CIS 2016, CIS 2018, CIS 2020

ICT specialists (as a percentage of total employment)	
Numerator	Number of employed ICT specialists
Denominator	Total employment
Rationale	ICT skills are particularly important for innovation in an increasingly digital economy.
Data source	Own estimates combining EIS country level with regional data (Eurostat) on Employment in information and communication (NACE J)
Data availability	NUTS 1 and 2 for different countries for 2014 - 2021

SMEs introducing product innovations as percentage of SMEs	
Numerator	Number of Small and medium-sized enterprises (SMEs) who introduced at least one product innovation. A product innovation is the market introduction of a new or significantly improved good or service with respect to its capabilities, user friendliness, components, or sub-systems
Denominator	Total number of SMEs
Rationale	Product innovation is a key ingredient to innovation as they can create new markets and improve competitiveness. Higher shares of product innovators reflect a higher level of innovation activities
Data source	Community Innovation Survey: Eurostat and National Statistical Offices
Data availability	NUTS 1 and 2 for different countries for CIS 2014, CIS 2016, CIS 2018, CIS 2020

SMEs introducing business process innovations as percentage of SMEs	
Numerator	Number of Small and medium-sized enterprises (SMEs) who introduced at least one business process innovation either new to the enterprise or new to their market
Denominator	Total number of SMEs
Rationale	Many firms innovate not by improving new products but by improving their business processes. Business process innovations include process, marketing and organisational innovations.
Data source	Community Innovation Survey: Eurostat and National Statistical Offices
Data availability	NUTS 1 and 2 for different countries for CIS 2014, CIS 2016, CIS 2018, CIS 2020
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
Data source	Community Innovation Survey: Eurostat and National Statistical Offices
Data availability	NUTS 1 and 2 for different countries for CIS 2014, CIS 2016, CIS 2018, CIS 2020

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
Data source	Numerator: Scopus. Data calculated by Science Metrix as part of a contract to the EC Denominator: Eurostat
Data availability	NUTS 2: 2015 – 2022

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
Data source	Numerator: OECD, REGPAT. Denominator: Eurostat
Data availability	NUTS 2: two-year averages for 2014 - 2021

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
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: two-year averages for 2015 – 2022

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
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: two-year averages for 2015 - 2022

Employment in knowledge-intensive activities (percentage 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, and provide inputs to the innovative activities of other firms in all sectors of the economy
Difference with EIS	Aggregate data for Employment in Medium-high and high-tech manufacturing and Employment in Knowledge-intensive services used as a proxy
Data source	Eurostat
Data availability	NUTS 2: 2014 – 2021

Employment in innovative SMEs	
Numerator	Number of employed persons in innovative SMEs ('SMEs that have either introduced an innovation or have any kind of innovation activity, including SMEs with abandoned/suspended or on-going innovation activities)
Denominator	Total employment
Rationale	Innovation in enterprises has a profound impact on the employability of workers, but its effect in product- and process-innovation oriented firms varies across countries. Firm innovation proves to be specifically important during a time of economic recession. Although high-skilled employees are less affected by a recession than low-skilled employees, a notable positive effect is observed for low-skilled employees in innovative firms as well.
Data source	Community Innovation Survey: Eurostat and National Statistical Offices
Data availability	NUTS 1 and 2 for different countries for CIS 2018 and CIS 2020 Own estimates for 2014 and 2016 combining country-level data and region to country scores for 2018

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)
Difference with EIS	EIS indicator includes all enterprises
Data source	Community Innovation Survey: Eurostat and National Statistical Offices

Data availability	NUTS 1 and 2 for different countries for CIS 2014, CIS 2016, CIS 2018, CIS 2020

Air emissions by fine particulate matter (PM2.5) in the manufacturing sector	
Numerator	Air emissions by fine particulate matter (PM2.5) in the Manufacturing sector in Tonnes
Denominator	Value added in the Manufacturing sector - Chain linked volumes (2010), million euro
Rationale	Air pollution may be anthropogenic (human-induced) or of natural origin. Air pollution has the potential to harm both human health and the environment: particulate matter (PM), nitrogen dioxide and ground-level ozone are known to pose particular health risks. Long-term and peak exposures to these pollutants may be associated, among other impacts, with cardiovascular and respiratory diseases or an increased incidence of cancer. This indicator captures average concentration levels of fine particulate matter (PM2.5 — particles with a diameter of 2.5 micrometres or less) to which the population is exposed. The EU set an annual limit of 25 µg/m³ for fine particulate matter in Directive 2008/50/EC[2] on ambient air quality and cleaner air, while the World Health Organisation (WHO) set a more stringent, but non-binding guideline value, whereby annual mean concentrations should not exceed 10 µg/m³ in order to protect human health. PM2.5 is considered by the WHO as the pollutant with the highest impact on human health.
Difference with EIS	Alternative data used for Exposure to fine particulates (PM 2.5)
Data source	European Environmental Agency
Data availability	NUTS 2: 2013 - 2020

[2] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0050

2.3. Regional coverage

The Regional Innovation Scoreboard covers 239 regions in 22 EU Member States, Norway, Serbia, Switzerland, and the United Kingdom at different NUTS levels. 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. For this edition of the RIS, the NUTS 2021 classification is used for all countries.

Depending on differences in regional data availability, the RIS covers 47 NUTS 1 regions and 192 NUTS 2 regions (Table 2). In addition, the EU Member States Cyprus, Estonia, Latvia, 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 EU scores from the EIS 2023 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 68 million) is almost 4.5 million, whereas it is 2.8 million for an average NUTS 2 region in Italy (total population about 59 million). The average unit of regional innovation performance analysis is 1.6 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 2023 by country

Country	Number of regions at NUTS level		Average population size (2022)	Regions (NUTS code)	
	1	2			
EU Member States					
BE Belgium	3	--	3,872,500	Région de Bruxelles-Capitale / Brussels Hoofdstedelijk Gewest (BE1)	Vlaams Gewest (BE2) Région wallonne (BE3)
BG Bulgaria	--	6	1,139,800	Severozapaden (BG31) Severen tsentralen (BG32) Severoiztochen (BG33)	Yugoiztochen (BG34) Yugozapaden (BG41) Yuzhen tsentralen (BG42)
CZ Czechia	--	8	1,314,600	Praha (CZ01) Střední Čechy (CZ02) Jihozápad (CZ03) Severozápad (CZ04)	Severovýchod (CZ05) Jihovýchod (CZ06) Střední Morava (CZ07) Moravskoslezsko (CZ08)
DK Denmark		5	1,174,700	Hovedstaden (DK01) Sjælland (DK02) Syddanmark (DK03)	Midtjylland (DK04) Nordjylland (DK05)

Country		Number of regions at NUTS level		Average population size (2022)	Regions (NUTS code)	
		1	2			
DE	Germany	9	29	2,190,500	Stuttgart (DE11) Karlsruhe (DE12) Freiburg (DE13) Tübingen (DE14) Oberbayern (DE21) Niederbayern (DE22) Oberpfalz (DE23) Oberfranken (DE24) Mittelfranken (DE25) Unterfranken (DE26) Schwaben (DE27) Berlin (DE3) Brandenburg (DE4) Bremen (DE5) Hamburg (DE6) Darmstadt (DE71) Gießen (DE72) Kassel (DE73) Mecklenburg-Vorpommern (DE8)	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 (DEC) Dresden (DED2) Chemnitz (DED4) Leipzig (DED5) Sachsen-Anhalt (DEE) Schleswig-Holstein (DEF) Thüringen (DEG)
IE	Ireland	--	3	1,686,700	Northern and Western (IE04) Southern (IE05)	Eastern and Midland (IE06)
EL	Greece	1	12	804,600	Attiki (EL3) Voreio Aigaio (EL41) Notio Aigaio (EL42) Kriti (EL43) 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)
ES	Spain	2	17	2,496,500	Galicia (ES11) Principado de Asturias (ES12) Cantabria (ES13) País Vasco (ES21) Comunidad Foral de Navarra (ES22) La Rioja (ES23) Aragón (ES24) Comunidad de Madrid (ES3) Castilla y León (ES41) Castilla-la Mancha (ES42)	Extremadura (ES43) Cataluña (ES51) Comunitat Valenciana (ES52) Illes Balears (ES53) Andalucía (ES61) Región de Murcia (ES62) Ciudad de Ceuta (ES63) Ciudad de Melilla (ES64) Canarias (ES7)
FR	France	14	--	4,484,000	Île de France (FR1) Centre - Val de Loire (FRB) Bourgogne - Franche-Comté (FRC) Normandie (FRD) Hauts-de-France (FRE) Grand Est (FRF) Pays de la Loire (FRG) Bretagne (FRH)	Nouvelle-Aquitaine (FRI) Occitanie (FRJ) Auvergne - Rhône-Alpes (FRK) Provence-Alpes-Côte d'Azur (FRL) Corse (FRM) RUP FR - Régions ultrapériphériques françaises (FRY)
HR	Croatia	--	4	965,600	Panonska Hrvatska (HR02) Jadranska Hrvatska (HR03)	Kontinentalna Hrvatska (HR04) Grad Zagreb (HR05)

Country		Number of regions at NUTS level		Average population size (2022)	Regions (NUTS code)	
		1	2			
IT	Italy	--	21	2,811,000	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	1,403,000	Sostinės regionas (LT01)	Vidurio ir vakarų Lietuvos regionas (LT02)
HU	Hungary	--	8	1,211,100	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	1,465,900	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	--	2,993,000	Ostösterreich (AT1) Südösterreich (AT2)	Westösterreich (AT3)
PL	Poland	--	17	2,215,000	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	2	5	1,478,900	Norte (PT11) Algarve (PT15) Centro (PT16) Lisboa (PT17)	Alentejo (PT18) Região Autónoma dos Açores (PT2) Região Autónoma da Madeira (PT3)
RO	Romania	--	8	2,380,300	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	1,053,600	Vzhodna Slovenija (SI03)	Zahodna Slovenija (SI04)
SK	Slovakia	--	4	1,358,700	Bratislavský kraj (SK01) Západné Slovensko (SK02)	Stredné Slovensko (SK03) Východné Slovensko (SK04)
FI	Finland	1	4	1,109,600	Helsinki-Uusimaa (FI1B) Etelä-Suomi (FI1C) Länsi-Suomi (FI19)	Pohjois- ja Itä-Suomi (FI1D) Åland (FI2)

Country		Number of regions at NUTS level		Average population size (2022)	Regions (NUTS code)	
		1	2			
SE	Sweden	--	8	1,306.500	Stockholm (SE11) Östra Mellansverige (SE12) Småland med öarna (SE21) Sydsverige (SE22)	Västsverige (SE23) Norra Mellansverige (SE31) Mellersta Norrland (SE32) Övre Norrland (SE33)
Non-EU countries						
NO	Norway[3]	--	6	904.200	Innlandet (NO02) Trøndelag (N006) Nord-Norge (NO07)	Oslo og Viken (NO08) Agder og Sør-Østlandet (NO09) Vestlandet (NO0A)
CH	Switzerland	--	7	1,248,400	Région lémanique (CH01) Espace Mittelland (CH02) Nordwestschweiz (CH03) Zürich (CH04)	Ostschweiz (CH05) Zentralschweiz (CH06) Ticino (CH07)
RS	Serbia	--	4	1,699,300	Belgrade (RS11) Vojvodina (RS12)	Šumadija and Western Serbia (RS21) Southern and Eastern Serbia (RS22)
UK	United Kingdom	12	--	5,573,000	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)

2.4. Regional CIS data request

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. 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.

To collect regional CIS data, data requests were made by Eurostat in 2023 to National Statistical Offices of most Member States, and to Serbia and Norway. Regional CIS 2020 data have been made available by 21 countries: Austria, Belgium, Bulgaria, Croatia, Czechia, Finland, Germany, Greece, Hungary, Ireland, Italy, Lithuania, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain and Sweden. Regional CIS 2020 for France were shared but too late to be used for the RIS 2023. No regional CIS 2020 data have been made available for Denmark and the Netherlands. Three countries shared data for NUTS 1 regions, 18 countries shared data for NUTS 2 regions (Table 3). For 20 countries regional CIS 2020 data were shared for all seven CIS indicators. For Italy regional CIS 2020 data were not shared for Non-R&D innovation expenditures and Innovation expenditures per person employed due to data confidentiality.

[3] For Norway there are 7 NUTS 2 regions, but for the region Jan Mayen and Svalbard (NO0B) data are not available for any indicator and this region is excluded from the RIS 2023.

Section 2.6 explains how results for the indicators using regional CIS 2020 data have been estimated. Regional data have been obtained for the following indicators:

- SMEs introducing product innovations as percentage share of all SMEs
- SMEs introducing business process innovations as percentage share of all SMEs
- Innovative SMEs cooperating others as percentage share of all SMEs
- Employment in innovative SMEs as percentage of total employment in SMEs
- Non-R&D innovation expenditure by SMEs as percentage of total turnover by SMEs
- Innovation expenditure per person employed in SMEs
- Sales from product innovations new-to-market and new-to-enterprise as percentage of total turnover by SMEs

Table 3: Summary of CIS 2020 data received by NUTS level

	SMEs introducing product innovations	SMEs introducing business process innovations	Innovative SMEs cooperating with others	Employment share in innovative SMEs	Non-R&D innovation expendi-tures in SMEs	Innovation expendi-tures per person employed in SMEs	Sales share from product innovations in SMEs
Belgium (BE)	1	1	1	1	1	1	1
Bulgaria (BG)	2	2	2	2	2	2	2
Czechia (CZ)	2	2	2	2	2	2	2
Germany (DE)	2	2	2	2	2	2	2
Ireland (IE)	2	2	2	2	2	2	2
Greece (EL)	2	2	2	2	2	2	2
Spain (ES)	2	2	2	2	2	2	2
France (FR)	*1*	*1*	*1*	*1*	*1*	*1*	*1*
Croatia (HR)	2	2	2	2	2	2	2
Italy (IT)	2	2	2	2	n/a	2	n/a
Lithuania (LT)	2	2	2	2	2	2	2
Hungary (HU)	2	2	2	2	2	2	2
Austria (AT)	1	1	1	1	1	1	1
Poland (PL)	2	2	2	2	2	2	2
Portugal (PT)	2	2	2	2	2	2	2
Romania (RO)	2	2	2	2	2	2	2
Slovenia (SI)	2	2	2	2	2	2	2
Slovakia (SK)	2	2	2	2	2	2	2
Finland (FI)	2	2	2	2	2	2	2
Sweden (SE)	2	2	2	2	2	2	2
Norway (NO)	2	2	2	2	2	2	2
Serbia (RS)	2	2	2	2	2	2	2

2.5. Regional data availability

Regional innovation data for four indicators are directly available from Eurostat. For Population aged 25-34 having completed tertiary education, Lifelong learning, R&D expenditures in the public sector, R&D expenditures in the business sector, regional data have been extracted from Eurostat's online regional database. Regional patent data have been extracted from the OECD's REGPAT database. For the seven indicators using Community Innovation Survey (CIS) data, regional data are not available from Eurostat, and a special data request has been made to National Statistical Offices (NSOs) to obtain

regional CIS data. For the three indicators using bibliometric data, regional data have been calculated by Science Metrix as part of a contract with the European Commission (DG Research and Innovation). For the Trademark applications and Design applications. regional data have been calculated by Fraunhofer ISI as part of a contract with the European Commission (DG Research and Innovation using raw data made available by the European Union Intellectual Property Office.

An exact overview of data availability is possible for those indicators where data have been extracted from public sources, like Eurostat, or where data have been made available by external organisations. For the indicators using CIS data, an overview of data availability for all years is not possible as regional data from the 2014, 2016 and 2018 CIS have been extracted from the RIS databases, which only include imputed data. The special request agreement with Eurostat and the NSOs providing regional data includes a rule that the contractor must delete the confidential regional data once the RIS report is published.

Table 4 summarises data availability for 8 years for the 14 indicators not using CIS data. Data availability is above 98% for 6 indicators and above 90% for another 5 indicators. Data availability is below 90% for 3 indicators and lowest for Individuals who have above basic overall digital skills.

Table 4: Regional data availability by indicator

Indicator	Data availability 2016-2023	Data not available for
Population aged 25-34 having completed tertiary education	98.3%	1 year: 1 FR region 2 years: 12 UK regions 8 years: 1 FI region
Population aged 25-64 participating in lifelong learning	98.7%	1 year: 1 EL region 2 years: 12 UK regions
International scientific co-publications	99.0%	1 year, 12 UK regions 2 years: 4 RS regions
Most-cited scientific publications	99.6%	8 years: FI2
Individuals who have above basic overall digital skills	60.6%	1 year: 13 FR, 2 SI, 3 NO regions 2 years: 1 FR, 12 UK regions 4 years: 2 LT, 2 HU regions 5 years: 8 SE, 7 CH, 4 RS regions 6 years: 8 CZ regions 7 years: 9 DE regions 8 years: 29 DE, 12 EL, 3 HR, 17 PL regions[4]
R&D expenditures in the public sector	87.4%	8 years: 8 FR, 12 NL, 3 NO, 7 CH regions
R&D expenditures in the business sector	90.4%	8 years: 8 FR, 12 NL, 3 NO regions
Employed ICT specialists	85.8%	2 years: 12 UK regions 8 years: 4 DE, 8 EL, 2 ES, 1 FR, 2 IT, 6 PL, 3 PT, 2 RO, 1 FI, 2 NO regions
Public-private co-publications	96.8%	2 years: 4 RS regions 3 years: 12 UK regions 6 years: 3 NO regions
PCT patent applications	95.4%	8 years: 3 HR, 2 HU, 2 PL, 4 RS regions
Trademark applications	98.3%	8 years: 4 RS regions
Design applications	98.3%	8 years: 4 RS regions

[4] Data availability is poor for German, Greek and Polish regions as the data on Households with broadband access, which are used to estimate the indicator, are only available for NUTS 1 regions in these countries.

Indicator	Data availability 2016-2023	Data not available for
Employment in knowledge-intensive activities	94.6%	8 years: 1 FI, 12 UK regions
Air emissions in fine particulates (PM2.5) in Industry	93.3%	8 years: 1 ES, 1 FR, 2 PT, 12 UK regions

For the indicators using CIS 2020 data, data are not available for all indicators for the regions from Denmark, France, the Netherlands, Switzerland and the United Kingdom (Table 5). For Innovation expenditures per person employed in innovation-active enterprises also no data are available for 6 Norwegian regions due to a mistake in the transmitted data. For Non-R&D innovation expenditures as percentage of total turnover and Sales of new-to-market and new-to-enterprise innovations as percentage of total turnover no data are available for 21 Italian regions due to data confidentiality. For all these regions values have been estimated based on either regional data from earlier innovation surveys or national level data from the CIS 2020 (see Section 2.6).

Table 5: Regional data availability by indicator using CIS 2020 data

Indicator	Data not available for	
Non-R&D innovation expenditures as percentage of total turnover	71 regions (29.7%)	5 DK regions, 14 FR regions, 21 IT regions, 12 NL regions, 7 CH regions, 12 UK regions
Innovation expenditures per person employed in innovation-active enterprises	56 regions (23.4%)	5 DK regions, 14 FR regions, 12 NL regions, 6 NO regions, 7 CH regions, 12 UK regions
SMEs introducing product innovations as percentage of SMEs	50 regions (20.9%)	5 DK regions, 14 FR regions, 12 NL regions, 7 CH regions, 12 UK regions
SMEs introducing business process innovations as percentage of SMEs	50 regions (20.9%)	5 DK regions, 14 FR regions, 12 NL regions, 7 CH regions, 12 UK regions
Innovative SMEs collaborating with others as percentage of SMEs	50 regions (20.9%)	5 DK regions, 14 FR regions, 12 NL regions, 7 CH regions, 12 UK regions
Employment in innovative enterprises	50 regions (20.9%)	5 DK regions, 14 FR regions, 12 NL regions, 7 CH regions, 12 UK regions
Sales of new-to-market and new-to-enterprise innovations as percentage of total turnover	71 regions (29.7%)	5 DK regions, 14 FR regions, 21 IT regions, 12 NL regions, 7 CH regions, 12 UK regions

2.6. Imputation of missing data

The full RIS 2023 database contains 40,152 data cells (239 regions, 21 indicators, and 8 years). For almost all indicators, data are missing for some regions and some years. Data availability after imputations for missing data equals 98.7%. This section provides more details on the imputation techniques. To improve data availability, several imputation techniques have been used to provide estimates for all missing data 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.

Data availability after imputation equals 98.7% with data missing for only 66 data cells for each year. For the following cases, data could not be imputed:

- Population having completed tertiary education: 1 region (FI2)
- Most-cited scientific publications: 1 region (FI2)
- Digital skills: 1 region (FI2)
- Non-R&D innovation expenditures: 7 regions (CH01, CH02, CH03, CH04, CH05, CH06, CH07)
- Innovation expenditures per person employed: 7 regions (CH01, CH02, CH03, CH04, CH05, CH06, CH07)
- ICT specialists: 32 regions (BG31, DED5. DE72, DEB2, DEC, EL41, EL42, EL43, EL51, EL53, EL54, EL62, EL65, ES63, ES64, FRM, ITC2, PL43, PL52, PL62, PL72, PL84, PL92, PT15, PT2, PT3, RO22, RO41, FI2, NO02, NO07)
- Employment in knowledge-intensive activities: 1 region FI2)
- Air emissions in fine particulates: 16 regions (ES7, FRY, PT2, PT3, UKC, UKD, UKE, UKF, UKG, UKH, UKI, UKJ, UKK, UKL, UKM, UKN)

3. COMPOSITE INDICATORS

3.1. 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 6). 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 levels of performance).

For all indicators first positive outliers are identified as those region scores which are higher than the mean across all regions and years plus twice the standard deviation. Negative outliers are identified as those region scores which are smaller than the mean across all regions and years minus twice the standard deviation. This calculation rule is known as the Z-score method for identifying outliers.

These outliers are replaced by the respective maximum and minimum values observed over all the years and all regions. The maximum and minimum values are determined by the first real observations below (for positive outliers) or above (for negative outliers) the calculation rule to identify outliers.

Table 6: Degree of skewness and transformation

	Degree of skewness	
	before transformation	after transformation
Population aged 25-34 having completed tertiary education	0.234	---
Population aged 25-64 participating in lifelong learning	0.811	---
International scientific co-publications	0.998	---
Most-cited scientific publications	-0.222	---
Individuals who have above basic overall digital skills	0.353	---
R&D expenditures in the public sector	1.312	0.331
R&D expenditures in the business sector	1.201	0.213
Non-R&D innovation expenditures	2.013	0.616
Innovation expenditures per person employed	1.318	0.050
Employed ICT specialists	0.963	---
SMEs with product innovations	-0.175	---
SMEs with business process innovations	-0.178	---
Innovative SMEs collaborating with others	0.526	---
Public-private co-publications	1.078	0.355
PCT patent applications	1.084	0.396
Trademark applications	0.917	---
Design applications	1.208	0.318
Employment in knowledge-intensive activities	0.052	---
Employment in innovative SMEs	-0.584	---
Sales of new-to-market and new-to-enterprise product innovations	0.780	---
Air emissions in fine particulates (PM2.5) in Industry	0.356	---

After the data is corrected for outliers, all indicators will be examined on their degree of skewness. 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 and after the treatment of outliers. Table 6 summarises the degree of skewness before and after the transformation. For the following seven indicators, the degree of skewness was above one and data have been transformed: R&D expenditures in the public sector, R&D

expenditures in the business sector, Non-R&D innovation expenditures, Innovation expenditures per person employed, Public-private co-publications, PCT patent applications, and Design applications.

The data are normalised using the min-max procedure. The minimum score observed for all regions across all four 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 four yearly observations. The maximum normalised score is equal to 1 and the minimum normalised score is equal to 0:

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

3.2. 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 21 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 EIS.

The RIS uses data for fewer indicators, 21 compared to 32 in the EIS. In addition, definitions are different for several of the 21 indicators, and for several indicators, regional data are less timely than the country level data used in the EIS. Small differences in definitions exist for four indicators using CIS data, where the EIS uses data for all enterprises and the RIS data for SMEs (cf. the definitions in section 2.2). For three indicators regional data do not exist. Instead data have been estimated using regional data from comparable variables that correlate highly with the indicators used in the EIS: Individuals who have above basic overall digital skills, Employed ICT skills, and Employment in knowledge-intensive activities (cf. the definitions in section 2.2).

Some examples will highlight these differences in results. First, the EIS can be recalculated using only the data for the 21 indicators used in the RIS. The EIS rank results are shown in Figure 1, and those using data for only 21 indicators in Figure 2. A visual comparison shows that for several Member States ranks are different, and five Member States would be in a different performance group. Based on the results for 21 indicators, Austria would be an Innovation Leader instead of a Strong Innovator, France would be a Moderate Innovator instead of a Strong Innovator, Estonia would be a Strong Innovator instead of a Moderate Innovator, Hungary would be an Emerging Innovator instead of a Moderate Innovator, and Croatia would be a Moderate Innovator instead of an Emerging Innovator. Such differences between the EIS and RIS would be difficult to explain to the users who would not know which results to use.

Figure 1 EIS 2023: rank results using country data for all 32 indicators

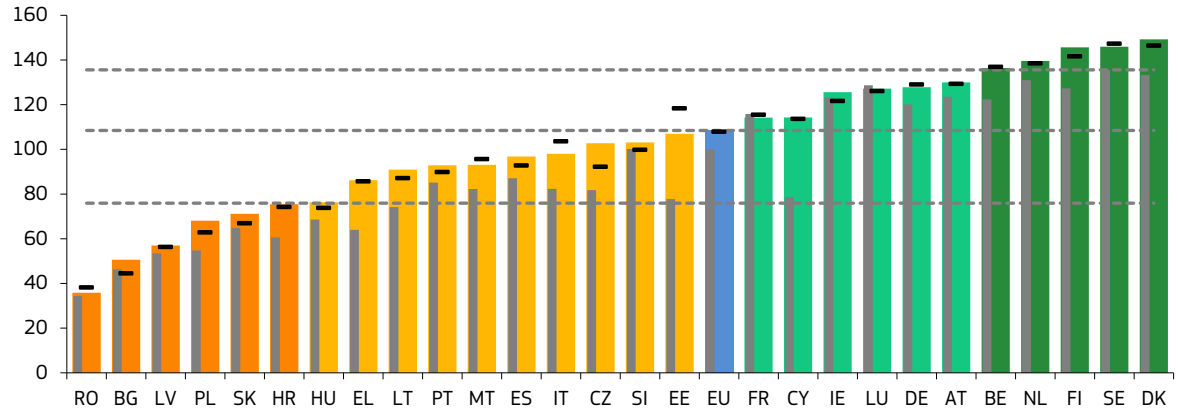
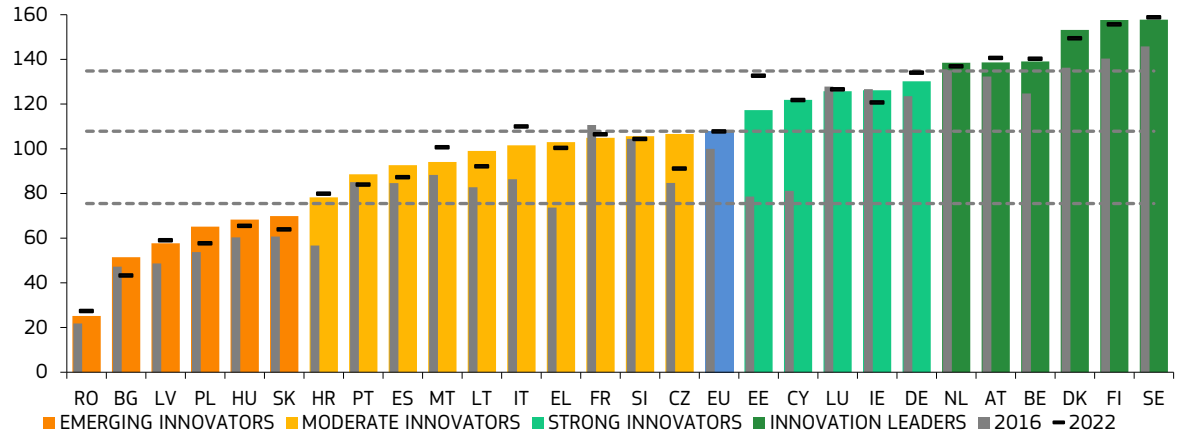


Figure 2 EIS 2023: rank results using country data for the 21 indicators included in the RIS



To align the country level results between both reports, the following correction is therefore applied to the composite indicator scores:

1) Calculate the ratios of the EIS 2023 Summary Innovation Index at country level with that of the EU: EIS_index_CTR / EIS_index_EU;

2) Calculate the ratios of the RIS 2023 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 (Table 7). 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 2016.

The EIS is the main tool for calculating the performance score for countries. The regional data in the RIS are used to calculate variation in regional scores in and between countries. To avoid having all regions in a country scoring above or below the country result in the EIS, and to avoid having a country and many regions in that country in a different performance group than that of the country in the EIS, country results in the RIS are 'anchored' to those in the EIS. The RIS is thus the main tool for identifying regional variation within

countries, and this information is then combined with the results of the EIS to have one set of harmonized results for countries and regions.

Table 7: Country correction scores

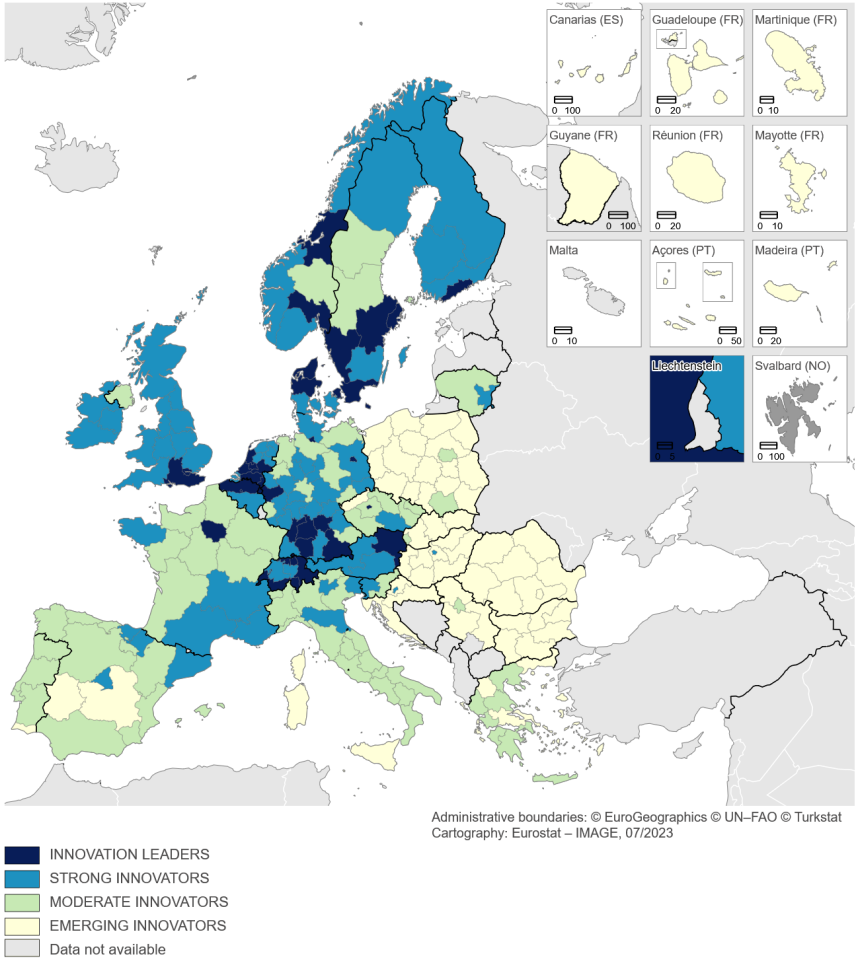
	2016	2017	2018	2019	2020	2021	2022	2023
Belgium (BE)	1.063	1.064	1.079	1.060	1.039	1.071	1.060	1.037
Bulgaria (BG)	0.972	0.929	0.924	0.919	0.927	0.856	0.806	0.840
Czechia (CZ)	1.018	1.004	0.998	0.994	1.015	1.035	1.035	1.008
Denmark (DK)	1.095	1.107	1.083	1.081	1.102	1.060	1.059	1.089
Germany (DE)	1.147	1.147	1.150	1.138	1.141	1.115	1.107	1.112
Ireland (IE)	1.058	1.081	1.090	1.103	1.077	1.039	1.051	1.030
Greece (EL)	0.864	0.858	0.852	0.852	0.887	0.857	0.885	0.836
Spain (ES)	1.009	1.023	1.040	1.051	1.075	1.051	1.049	1.033
France (FR)	1.151	1.131	1.144	1.117	1.124	1.115	1.130	1.082
Croatia (HR)	0.950	0.943	0.844	0.834	0.845	0.865	0.874	0.890
Italy (IT)	0.969	0.961	0.975	0.962	0.995	0.968	0.969	0.972
Lithuania (LT)	0.923	0.913	0.882	0.933	0.939	0.914	0.947	0.937
Hungary (HU)	1.146	1.134	1.145	1.029	1.045	1.045	1.038	1.060
Netherlands (NL)	1.054	1.058	1.057	1.050	1.058	1.083	1.088	1.058
Austria (AT)	1.031	1.018	1.011	0.990	0.986	0.993	1.008	1.011
Poland (PL)	0.994	1.004	0.978	1.045	1.039	1.056	1.027	1.004
Portugal (PT)	0.919	0.909	0.906	0.894	0.921	0.945	0.957	0.924
Romania (RO)	1.158	1.137	1.075	1.012	1.048	1.084	1.058	1.011
Slovenia (SI)	1.023	0.998	1.021	1.005	0.992	0.954	0.958	0.971
Slovakia (SK)	1.064	1.071	1.002	1.001	0.991	1.004	0.984	1.011
Finland (FI)	0.960	0.947	0.946	0.940	0.945	0.947	0.952	0.965
Sweden (SE)	1.009	1.029	1.022	1.014	1.010	1.003	1.006	0.987
Norway (NO)	0.962	0.957	0.955	0.949	0.951	0.945	0.976	0.970
Switzerland (CH)	1.023	1.024	1.029	1.050	1.053	1.045	1.029	1.025
Serbia (RS)	0.906	0.858	0.891	0.857	0.887	0.861	0.885	1.069
United Kingdom (UK)	0.989	1.015	1.025	1.034	1.047	1.102	1.122	1.094

A visual comparison of the results for the 4 main performance groups is shown in Figure 3, with the RIS 2023 results on the left and the results not using correction scores on the right. At first glance it might seem as if both maps are the same, but there are clear differences in colours and thus performance groups in e.g., but not only, Croatia, Greece, Finland, and Italy.

The larger the difference in indicator coverage between the EIS and RIS, the larger differences in results could be. Figure 4 shows an example only using the data for the 7 indicators using CIS data. Results are quite different, with e.g. all regions in Greece being Innovation Leaders. Only by using the correction scores, these kind of ‘inconsistent’ results with those in the EIS can be prevented.

Figure 3 RIS results with and without aligning country scores the EIS

RIS 2023 main performance groups (Innovation Leaders – dark blue, Strong Innovators – lighter blue, Moderate Innovators - green, Emerging Innovators – yellow)



Main performance groups (Innovation Leaders – dark blue, Strong Innovators – lighter blue, Moderate Innovators - green, Emerging Innovators – yellow) not using correction scores

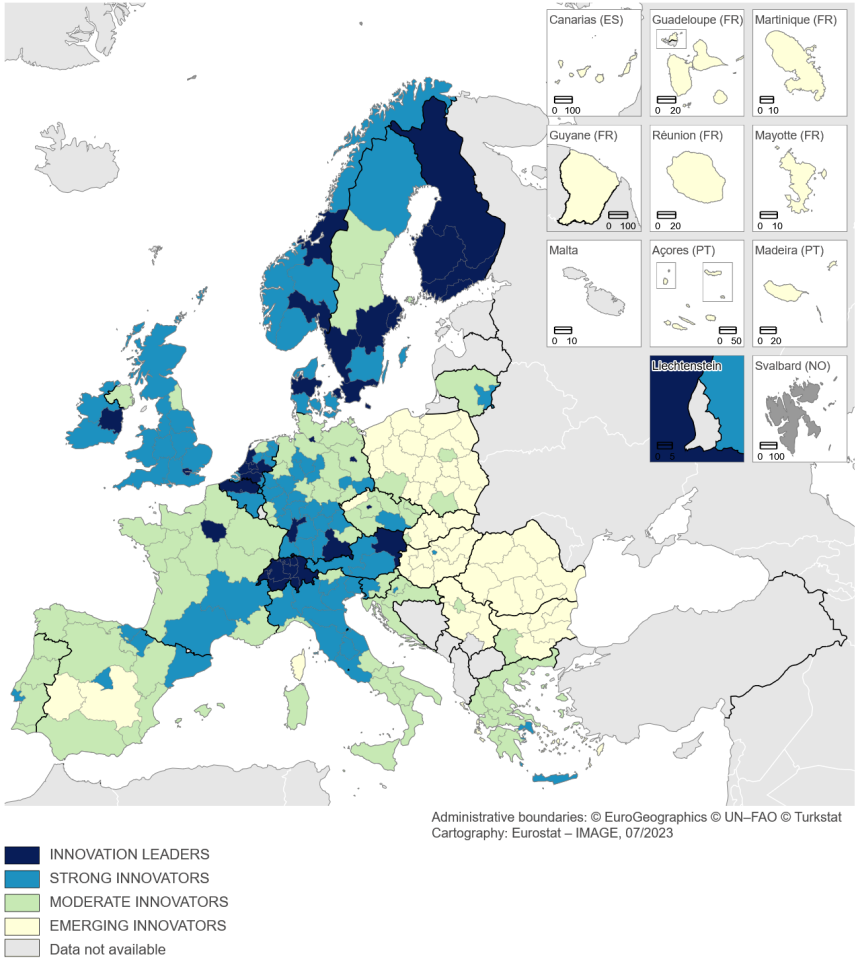
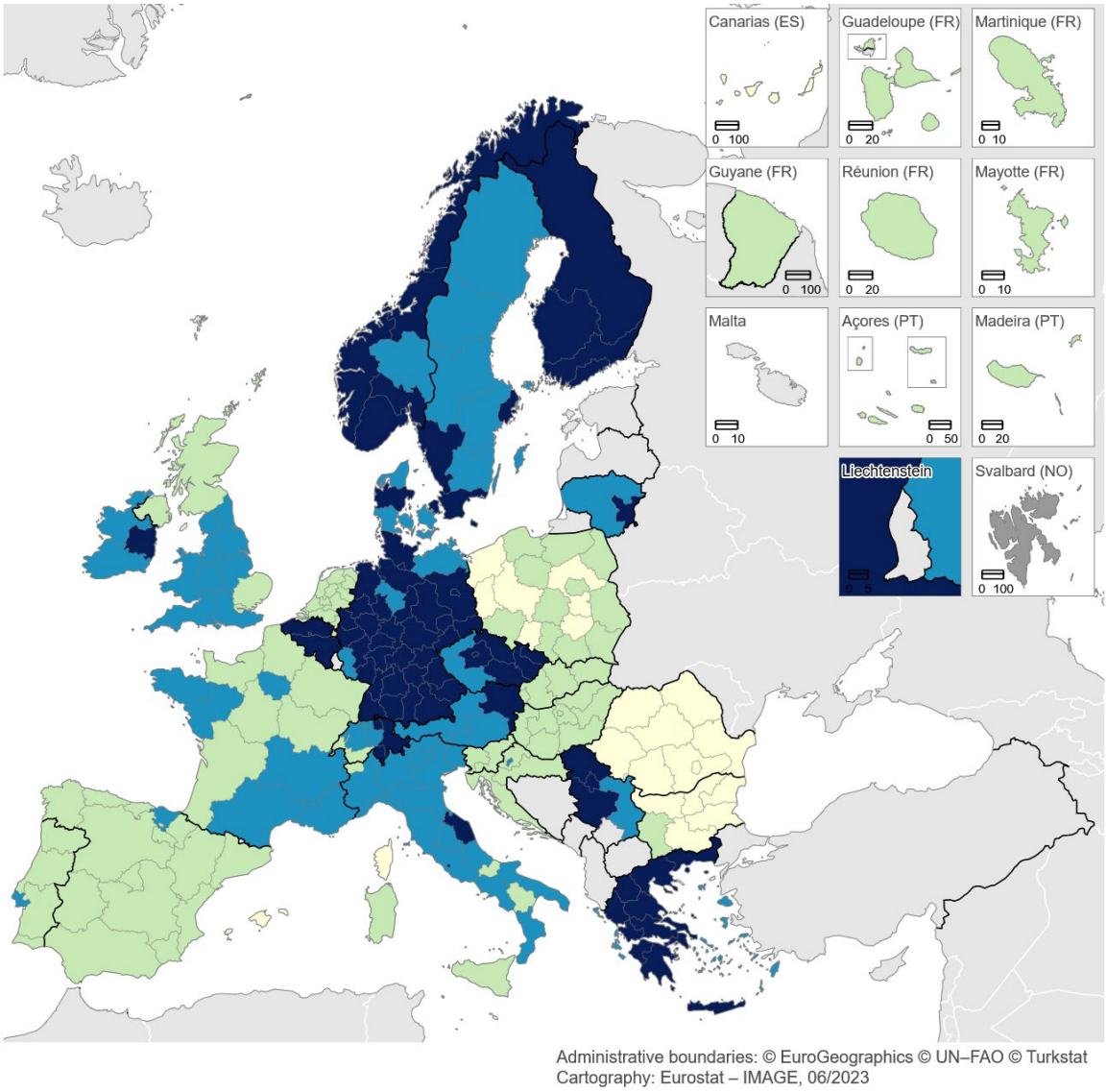


Figure 4 Results using a very restricted set of 7 indicators using CIS data only



3.3. Regional performance group membership

The RIS 2023 uses the classification scheme used in the European Innovation Scoreboard:

- Innovation Leaders are all regions with a relative performance more than 125% of the EU average in 2023
- Strong Innovators are all regions with a relative performance between 100% and 125% of the EU average in 2023
- Moderate Innovators are all regions with a relative performance between 70% and 100% of the EU average in 2023
- Emerging Innovators are all regions with a relative performance below 70% of the EU average in 2023

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 (-). For the RIS 2023, sub-groups are defined in a similar way to the 4 main groups using performance thresholds based on dividing the performance range in each group in three equal parts (Table 8).

Table 8: Defining performance sub-groups

Group	Top sub-group (+)	Middle sub-group	Bottom sub-group (-)
Innovation Leaders	Innovation Leaders + Above 145.9% above EU average	Innovation Leaders Between 135.4% and 145.9% of EU average	Innovation Leaders - Between 125% and 135.4% of EU average
Strong Innovators	Strong Innovators + Between 116.7% and 125% of EU average	Strong Innovators Between 108.3% and 116.7% of EU average	Strong Innovators – Between 100% and 108.3% of EU average
Moderate Innovators	Moderate Innovators + Between 90% and 100% of EU average	Moderate Innovators Between 80% and 90% of EU average	Moderate Innovators – Between 70% and 80% of EU average
Emerging Innovators	Emerging Innovators + Between 53.3% and 70% of EU average	Emerging Innovators Between 36.0% and 53.3% of EU average	Emerging Innovators – Below 36.0 of EU average

3.4. Performance change over time

The RIS 2023 includes two sets of performance changes over time. The performance change of the region compared to itself, and the performance change compared to the EU. Performance change over time of the region compared to itself is calculated as follows:

Region growth: [(RII_2023 - RII_2016) / RII_2016] x 100

Where RII_2023 is the Regional Innovation Index (RII) of the region in 2023, and RII_2016 the RII of the region in 2016. Over the last eight years, performance has increased for 211 regions, including all regions in Austria, Belgium, Croatia, Czechia, Denmark, Greece, Italy, Hungary, Lithuania, Netherlands, Norway, Poland, Portugal, Serbia, Slovakia, Slovenia, and Spain. Performance has declined in 28 regions, including 12 regions in France, four in Germany and Switzerland, two in Romania and Sweden, and one in Bulgaria, Finland, Ireland, and the United Kingdom.

Performance change over time of the region compared to the EU is calculated as follows:

Region growth compared to the EU: [(RII_2023 - RII_EU_2016) / RII_EU_2016] x 100

Where RII_2023 is the Regional Innovation Index (RII) of the region in 2023, and RII__EU_2016 the RII of the European Union in 2016. EU performance increased with 8.5%-points over the 8-year reference period (2016 to 2023). Compared to the EU, 126 regions improved their performance by more than 8.5%, whereas for 113 regions performance declined compared to that of the EU. Relative to EU, performance increased for more than half of the Moderate Innovators and Emerging Innovators, and less than half of the Innovation Leaders and Strong Innovators.

4. STRUCTURAL INDICATORS

4.1. Selected indicators to measure regional structural definitions

The RIS uses 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 are included in the regional profiles.

Differences in economic structures are relevant. Differences in the share of industry in the GDP is an important factor that could explain why regions perform better or worse on indicators like business R&D expenditures, PCT patent applications and innovative enterprises. The regional profiles will include for each region, when data are available from Eurostat, data on the composition of regional employment, using average employment shares for the years 2019-2021 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 a closer distance, knowledge diffuses more easily. Second, in urbanised areas, there tends to be a concentration of government and educational services. These services 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[5], which are a better measure for interpreting real income differences between regions.

4.2. Definitions of structural indicators

This section presents detailed definitions for each of the contextual indicators used in regional profiles complementing the RIS 2023. For each indicator, the following information is provided: definitions of the numerator and denominator, the source of the data, and data availability.

Composition of employment, %-shares, average 2019-2021	
	• Agriculture & Mining (NACE Rev. 2 A-B) • Manufacturing (NACE Rev. 2 C) • Utilities and Construction (NACE Rev. 2 D-F) • Services (NACE Rev. 2 G-N) • Public administration (NACE Rev. 2 O-U)
Numerator	Employment in the respective industries
Denominator	Total employment
Calculated as	Average percentage for the years 2021 to 2023
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 2016-2018	

[5] 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	Total number of persons employed by active enterprises
Denominator	Number of active enterprises
Calculated as	Average percentage for the years 2018 to 2020
Data source	Eurostat: Business demography by size class and NUTS 3 regions
GDP per capita, PPS, 2021	
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, 2017-2021	
Indicator	Growth of Nominal Gross Domestic Product per capita
Unit	Purchasing power standard (PPS) per inhabitant
Calculated as	Compound average growth rate (CAGR) between 2017 and 2021: CAGR = (GDP per capita in 2021 / GDP per capita in 2017)^(1/4) - 1
Data source	Eurostat: Gross domestic product (GDP) at current market prices by NUTS 2 regions
Degree of urbanisation (%), 2021	
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, 2019	
Numerator	Inhabitants per km2
Data source	Eurostat: Population density by NUTS 3 region
Population size (thousands), 2021	
Indicator	Population on 1 January
Data source	Eurostat: Population on 1 January by NUTS 2 region

GETTING IN TOUCH WITH THE EU

In person

All over the European Union there are hundreds of Europe Direct centres. You can find the address of the centre nearest you online (european-union.europa.eu/contact-eu/meet-us_en).

On the phone or in writing

Europe Direct is a service that answers your questions about the European Union.
You can contact this service:

- by freephone: 00 800 6 7 8 9 10 11 (certain operators may charge for these calls),
- at the following standard number: +32 22999696,
- via the following form: european-union.europa.eu/contact-eu/write-us_en.

FINDING INFORMATION ABOUT THE EU

Online

Information about the European Union in all the official languages of the EU is available on the Europa website (european-union.europa.eu).

EU publications

You can view or order EU publications at op.europa.eu/en/publications. Multiple copies of free publications can be obtained by contacting Europe Direct or your local documentation centre (european-union.europa.eu/contact-eu/meet-us_en).

EU law and related documents

For access to legal information from the EU, including all EU law since 1951 in all the official language versions, go to EUR-Lex (eur-lex.europa.eu).

EU open data

The portal data.europa.eu provides access to open datasets from the EU institutions, bodies and agencies. These can be downloaded and reused for free, for both commercial and non-commercial purposes. The portal also provides access to a wealth of datasets from European countries.

Within the context of the European Innovation Scoreboard (EIS), the Regional Innovation Scoreboard (RIS) Methodology Report provides more detail on the methodology used for the RIS and the construction of the Regional Innovation Indicator (RII). The Methodology Report also provides detailed methodological information on the indicators used for both the RII and the Structural indicators that aim to provide a better understanding of the impact of structural differences on innovation performance scores.

Studies and reports