European Innovation Scoreboard 2024

Methodology report

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Innovation

European Innovation Scoreboard 2024 Methodology Report

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European Innovation Scoreboard 2024 Methodology Report

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

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1. Introduction

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

The first edition of the EIS was published in 2001. Over time the measurement framework has been revised several times, with the latest major revision in 2021.

Section 2 discusses the measurement framework for the EIS 2024. Section 3 presents definitions for all the indicators. Section 4 provides a detailed discussion of the methodology used for calculating the Summary Innovation Index. Section 5 provides the definitions of the contextual indicators included in the EIS 2024 Country profiles.

All data and processed results are available in the EIS 2024 Replication Package.

2. EIS Measurement Framework

The EIS 2024 distinguishes between four main types of activities – Framework conditions, Investments, Innovation activities, and Impacts – and 12 innovation dimensions, capturing in total 32 indicators (Figure 1).Each main group includes an equal number of indicators and has an equal weight in the Summary Innovation Index.

Framework conditions capture the main drivers of innovation performance external to the firm and differentiates between three innovation dimensions:

- The Human resources dimension includes three indicators and measures the availability of a high-skilled and educated workforce. It includes three indicators, New doctorate graduates in STEM, Population aged 25-34 with completed tertiary education, and Population aged 25-64 involved in lifelong learning activities.

- Attractive research systems measure the international competitiveness of the science base by focusing on International scientific co-publications, Most cited publications, and Foreign doctorate students.

- Digitalisation measures the level of digital technologies and includes two indicators, Broadband penetration among enterprises and (the supply of) Individuals with above basic overall digital skills.

Investments captures investments made in both the public and business sector and differentiates between three innovation dimensions:

- The Finance and support dimension is based on three indicators including private funding (Venture capital investments), R&D expenditures in universities and government research organisations and Direct government funding and government tax support for business R&D.

- Firm investments measure R&D and Non-R&D investments that firms make to generate innovations, including Business R&D expenditures, Non-R&D innovation expenditures, and Innovation expenditures per person employed.

- Use of information technologies captures the use of information technologies based on two indicators: Enterprises actively increasing the ICT skills of their personnel and Employed ICT specialists.

Figure 1 Indicators included in the EIS 2023 measurement framework

Innovation activities capture different aspects of innovation in the business sector and differentiate between three innovation dimensions:

- The Innovators dimension includes two indicators measuring the introduction of innovations by SMEs on the market or within their organisations, covering both products and business process innovators.
- The Linkages dimension assesses the connections existing in the innovation ecosystem by measuring Collaboration efforts between innovating firms, Research collaboration between the private and public sector, and Job-to-job mobility of Human Resources in Science & Technology (HRST).
- Intellectual assets measure the performance in different forms of Intellectual Property Rights (IPR): PCT patent applications, Trademark applications, and Design applications.

Impacts captures the effects of enterprises' innovation activities and differentiates between three innovation dimensions:

- Employment impacts measure the impact of innovation activities on employment based on two indicators: Employment in knowledge-intensive activities and Employment in innovative enterprises.
- Sales impacts measure the economic impact of innovation and includes three indicators: Exports of medium and high-tech products, Exports of knowledge-intensive services, and Sales resulting from innovative products.
- Environmental sustainability captures improvements towards the reduction of negative environmental impacts, based on three indicators: Resource productivity, Exposure to Air pollution by fine particulates PM2.5, and the Development of environment-related technologies.
- Chapter 3 provides the details on the definition, calculation and interpretation of each indicator.

3. EIS Indicators

This chapter provides the definition, interpretation and data source for each indicator. For data from Eurostat, the code used by Eurostat is also provided. For some indicators more than one data source has been used, e.g. R&D expenditure data are taken from Eurostat, but for countries not covered by Eurostat, data from the OECD, UNESCO or national sources have been used.

Human Resources

1.1.1 New doctorate graduates in science, technology, engineering, and mathematics (STEM) per 1000 population aged 25-34	
Numerator	Number of doctorate graduates in science, technology, engineering, and mathematics (STEM)
Denominator	Population between and including 25 and 34 years
Interpretation	The indicator is a measure of the supply of new second-stage tertiary graduates in all fields of training (ISCED 8). For most countries, ISCED 8 captures PhD graduates. There is a complex relation between STEM-graduates and innovation in the private sector. STEM-graduates do well as employees within firms with many of them taking up managerial positions.
Data source	Eurostat (variable code: educ_uoe_grad07); OECD Education and Training, https://stats.oecd.org, April 2024

1.1.2 Percentage population aged 25-34 having completed tertiary education	
Numerator	Number of persons in age class with some form of post-secondary education
Denominator	Population between and including 25 and 34 years
Interpretation	This is a general indicator of the supply of advanced skills. It is not limited to science and technical fields, because the adoption of innovations in many areas, in particular in the service sectors, depends on a wide range of skills. The indicator focuses on a relatively young age cohort of the population, aged 25 to 34, and will therefore easily and quickly reflect changes in educational policies leading to more tertiary graduates.
Data source	Eurostat (variable code: edat_lfse_03); OECD Education and Training, https://stats.oecd.org, April 2024

1.1.3 Percentage population aged 25-64 participating in lifelong learning	
Numerator	The target population for lifelong learning statistics refers to all persons in private households aged between 25 and 64 years. The information collected relates to all education or training, whether or not relevant to the respondent's current or possible future job. Data are collected through the EU Labour Force Survey. The reference period for the participation in education and training is the four weeks preceding the interview, as is usual in the Labour Force Survey.
Denominator	Total population of the same age group, excluding those who did not answer the question concerning participation in (formal and non-formal) education and training
Interpretation	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 (variable code: trng_lfs_01); Population data from Eurostat (variable code: demo_pjan)

Attractive research systems

1.2.1 International scientific co-publications per million population	
Numerator	Number of scientific publications with at least one co-author based abroad.
Denominator	Total population.
Interpretation	International scientific co-publications are a proxy for the quality of scientific research as collaboration increases scientific productivity. For individual countries all publications with at least one co-author outside the country are included, For the EU only publications with at least one co-author in a non-EU Member State are included
Data source	Scopus database. Data calculated by Science-Metrix for the European Commission (DG Research and Innovation); Population data from Eurostat (variable code: demo_pjan)

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

1.2.2 Scientific publications among the top-10% most cited publications worldwide as percentage of total scientific publications of the country	
Denominator	Total number of scientific publications
Interpretation	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 database. Data calculated by Science-Metrix for the European Commission (DG Research and Innovation)

1.2.3 Foreign doctorate students as a percentage of all doctorate students	
Numerator	Number of doctorate students from foreign countries
Denominator	Total number of doctorate students
Interpretation	The share of foreign doctorate students reflects the mobility of students as an effective way of diffusing knowledge. Attracting high-skilled foreign doctorate students will secure a continuous supply of researchers.
Data source	Eurostat (variable code numerator: educ_uoe_mobs01; variable code denominator: educ_uoe_enra03)

Digitalisation

1.3.1 Broadband penetration	
Numerator	Number of enterprises with a maximum contracted download speed of the fastest fixed internet connection of at least 100 Mb/s
Denominator	Total number of enterprises
Interpretation	Realising Europe's full e-potential depends on creating the conditions for electronic commerce and the Internet to flourish. This indicator captures the relative use of this e-potential by the share of enterprises that have access to fast broadband. Data on the speed of mobile connections is not available, the indicator on the speed of fixed internet access is the most suitable proxy.
Data source	Eurostat, Community Survey of ICT Usage and E-commerce in Enterprises (variable code: isoc_ci_it_en2)

1.3.2 Individuals who have above basic overall digital skills (% share)	
Numerator	Number of individuals with above basic overall digital skills
Denominator	Individuals aged 16-74
Interpretation	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	Eurostat, EU survey on the ICT usage in households and by individuals (variable code: isoc_sk_dskl_i)

Finance and support

2.1.1 R&D expenditure in the public sector (percentage of GDP)	
Numerator	All R&D expenditures in the government sector (GOVERD) and the higher education sector (HERD)
Denominator	Gross Domestic Product
Interpretation	R&D expenditure represents one of the major drivers of economic growth in a knowledge-based economy. As such, trends in the R&D expenditure indicator provide key indications of the future competitiveness and wealth of the EU. Research and development spending is essential for making the transition to a knowledge-based economy as well as for improving production technologies and stimulating growth.
Data source	Eurostat (variable code: rd_e_gerdtot)

2.1.2 Venture capital expenditures (percentage of GDP)	
Numerator	Venture capital expenditures is defined as private equity being raised for investment in companies. Management buyouts, management buy-ins, and venture purchase of quoted shares are excluded. Venture capital includes early- stage (seed + start-up) and expansion and replacement capital.
Denominator	Gross Domestic Product
Interpretation	The amount of venture capital is a proxy for the relative dynamism of new business creation. In particular for enterprises using or developing new (risky) technologies, venture capital is often the only available means of financing their (expanding) business.
Data source	Venture capital data from Invest Europe. GDP data from Eurostat (variable code: nama_10_gdp)

2.1.3 Direct government funding and government tax support for business R&D (percentage of GDP)	
Numerator	Sum of GTARD and Direct funding of BERD
Denominator	Gross Domestic Product
Interpretation	Public financing of R&D can take two forms: Direct funding for R&D through instruments such as grants and public procurement, and Indirect support through the tax system. Direct funding is well captured in the official data on R&D expenditure by source of fund, differentiating between the following sources: Business enterprise sector, Government sector, Higher education sector, Private non-profit sector, and Abroad. Data on R&D funded by the Government sector are available from Eurostat (EU Member States and other European countries), OECD (OECD member states) and UIS (global coverage). Over time, more and more countries have introduced R&D tax incentives. The OECD has started to systematically collect data on R&D tax incentives since 2018 and with the support of the EC data are currently being collected on an annual basis and made available in the 'OECD R&D Tax Incentives database'.
Data source	OECD R&D Tax Incentive Database, http://oe.cd/rdtax, April 2023

Firm investments

2.2.1 R&D expenditure in the business sector (percentage of GDP)	
Numerator	All R&D expenditures in the business sector (BERD)
Denominator	Gross Domestic Product
Interpretation	The indicator captures the formal creation of new knowledge within firms. It is particularly important in the science-based sectors (pharmaceuticals, chemicals and some areas of electronics) where most new knowledge is created in or near R&D laboratories.
Data source	Eurostat (variable code: rd_e_gerdtot) ; OECD, https://data-explorer.oecd.org., April 2024 ; UNESCO Institute for Statistics, http://data.uis.unesco.org, April 2024.

2.2.2 Non-R&D innovation expenditures (percentage of turnover)	
Numerator	Sum of total innovation expenditure for enterprises, excluding intramural and extramural R&D expenditures
Denominator	Total turnover for all enterprises
Interpretation	This indicator measures non-R&D innovation expenditure as a percentage of total turnover. Several of the components of innovation expenditure, such as investment in equipment and machinery and the acquisition of patents and licenses, measure the diffusion of new production technology and ideas.
Data source	Eurostat (Community Innovation Survey) (variable code: numerator: inn_cis12_exp; denominator: inn_cis12_bas)

2.2.3 Innovation expenditures per person employed	
Numerator	Sum of total innovation expenditure by enterprises in all size classes in Purchasing Power Standard (PPS)
Denominator	Total employment in innovative enterprises in all size classes
Interpretation	The indicator measures the monetary input directly related to innovation activities.
Data source	Eurostat (Community Innovation Survey) (variable code: numerator: inn_cis12_exp; denominator: inn_cis12_bas)

Use of information technologies

2.3.1 Enterprises providing training to develop or upgrade ICT skills of their personnel	
Numerator	Number of enterprises that provided any type of training to develop ICT related skills of their personnel
Denominator	Total number of enterprises
Interpretation	ICT skills are particularly important for innovation in an increasingly digital economy. The share of enterprises providing training in that respect is a proxy for the overall skills development of employees.
Data source	Eurostat, Community Survey of ICT Usage and E-commerce in Enterprises (variable code: isoc_ske_ittn2)

2.3.2 ICT specialists (as a percentage of total employment)	
Numerator	Number of employed ICT specialists
Denominator	Total employment
Interpretation	Eurostat defines ICT specialists as "workers who have the ability to develop, operate and maintain ICT systems, and for whom ICT constitute the main part of their job". Operationalised in terms of ISCO codes, this definition converts into a statistical definition of ICT specialists as follows: from 2012 onwards - corresponding to the application of the ISCO-08, Eurostat and OECD adopted a joint approach to define the occupations to be treated as ICT specialists (OECD, 2016[1]).
Data source	Eurostat (variable code: isoc_ske_ittn2); OECD, https://stats.oecd.org, April 2024; UNECE Statistical database, https://w3.unece.org/PXWeb2015/pxweb/en/STAT/STAT__20-ME__3-MELF/25_en_MEEmpNace2A10Y_r.px/, April 2024

Innovators

3.1.1 SMEs introducing product innovations (percentage of SMEs)	
Numerator	Number of Small and medium-sized enterprises (SMEs) who introduced at least one product innovation either new to the enterprise or new to their market
Denominator	Total number of Small and medium-sized enterprises (SMEs)
Interpretation	Product innovation is a key ingredient to innovation as it can create new markets and improve competitiveness. Higher shares of product innovators reflect a higher level of innovation activities.
Comment	SMEs are defined as including all enterprises with 10 to 249 employees.
Data source	Eurostat (Community Innovation Survey) (variable code: numerator: inn_cis12_bas; denominator: inn_cis12_bas); OECD Innovation Indicators database, https://www.oecd.org/innovation/inno-stats.htm#indicators, April 2024

3.1.2 SMEs introducing business process innovations (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 Small and medium-sized enterprises (SMEs)
Interpretation	Many firms innovate not by improving new products but by improving their business processes. Business process innovations include process, marketing and organisational innovation.
Comment	SMEs are defined as including all enterprises with 10 to 249 employees
Data source	Eurostat (Community Innovation Survey) (variable code: numerator: inn_cis12_spec; denominator: inn_cis12_bas); OECD Innovation Indicators database, https://www.oecd.org/innovation/inno-stats.htm#indicators, April 2024.

[1] https://ec.europa.eu/eurostat/cache/metadata/Annexes/isoc_skslf_esms_an1.pdf

Linkages

3.2.1 Innovative SMEs collaborating with others (percentage of SMEs)	
Numerator	Number of Small and medium-sized enterprises (SMEs) with innovation co-operation activities including all enterprises that had any co-operation agreements on innovation activities with other enterprises or institutions in the three years of the survey period.
Denominator	Total number of Small and medium-sized enterprises (SMEs)
Interpretation	This indicator measures the degree to which SMEs are involved in innovation co- operation. Complex innovations, in particular in ICT, often depend on the ability to draw on diverse sources of information and knowledge or to collaborate in the development of an innovation. This 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.
Comment	SMEs are defined as including all enterprises with 10 to 249 employees.
Data source	Eurostat (Community Innovation Survey) (variable code: numerator: inn_cis12_co; denominator: inn_cis12_bas); OECD Innovation Indicators database, https://www.oecd.org/innovation/inno-stats.htm#indicators, April 2024

3.2.2 Public-private co-publications per million population	
Numerator	Number of public-private co-authored research publications with both domestic and foreign collaborators. The definition of the "private sector" excludes the private medical and health sector
Denominator	Total population
Interpretation	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	Scopus database. Data calculated by Science-Metrix for the European Commission (DG Research and Innovation). Population data from Eurostat (variable code: demo_pjan)

3.2.3 Job-to-job mobility of Human Resources in Science & Technology	
Numerator	Job-to-job mobility of Human Resources in Science & Technology
Denominator	Working age population aged 25-64
Interpretation	Human Resources in Science & Technology (HRST) are people who fulfil one or other of the following conditions: 1) have successfully completed a tertiary level education; 2) not formally qualified as above but employed in a S&T occupation where the above qualifications are normally required. Job-to-job mobility in this context is defined as the movement of individuals between one job and another from one year to the next. It does not include inflows into the labour market from a situation of unemployment or inactivity. Mobility of skilled personnel affects the degree of knowledge creation, which is one of the key drivers of innovation.
Data source	Eurostat (variable code: hrst_fl_mobsex)

Intellectual assets

3.3.1 PCT patent applications per billion GDP (in PPS)	
Numerator	Number of patent applications filed under the PCT, at international phase, designating the European Patent Office (EPO). Patent counts are based on the priority date, the inventor's country of residence and fractional counts.
Denominator	Gross Domestic Product in Purchasing Power Standard
Interpretation	The capacity of firms to develop new products will determine their competitive advantage. One measure of the rate of new product innovation is the number of patents. This indicator measures the number of PCT patent applications.
Data source	Patent data from the OECD; GDP data from Eurostat (variable code: nama_10_gdp)

3.3.2 Trademark applications per billion GDP (in PPS)	
Numerator	Number of trademark applications applied for at EUIPO
Denominator	Gross Domestic Product in Purchasing Power Standard
Interpretation	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 it is a form of communication, a basis for publicity and advertising.
Comment	Two-year averages have been used for calculating the normalised scores for this indicator, which are used for calculating the Summary Innovation Index.
Data source	Trademark data from European Union Intellectual Property Office (EUIPO); GDP data from Eurostat (variable code: nama_10_gdp)

3.3.3 Design applications per billion GDP (in PPS)	
Numerator	Number of individual designs applied for at the European Union Intellectual Property Office (EUIPO)
Denominator	Gross Domestic Product in Purchasing Power Standard
Interpretation	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 programmes. 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.
Comment	Two-year averages have been used for calculating the normalised scores for this indicator, which are used for calculating the Summary Innovation Index.
Data source	Design data from European Union Intellectual Property Office (EUIPO); GDP data from Eurostat (variable code: nama_10_gdp)

Employment impacts

4.1.1 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 tertiary education degree (ISCED 5-8).
Denominator	Total employment
Interpretation	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.
Data source	Eurostat (variable code: htec_kia_emp2)

4.1.2 Employment in innovative enterprises	
Numerator	Number of employed persons in innovative enterprises ('Enterprises that have either introduced an innovation or have any kind of innovation activity (including enterprises with abandoned/suspended or on-going innovation activities)
Denominator	Total employment for enterprises with 10 or more employees
Interpretation	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	Eurostat (Community Innovation Survey) (variable code: numerator: inn_cis12_bas; denominator: inn_cis12_bas)

Sales impacts

4.2.1 Exports of medium and high technology products as a share of total product exports	
Numerator	Value of medium and high-tech exports, in national currency and current prices, including exports of the following SITC Rev.3 products: 266, 267, 512, 513, 525, 533, 54, 553, 554, 562, 57, 58, 591, 593, 597, 598, 629, 653, 671, 672, 679, 71, 72, 731, 733, 737, 74, 751, 752, 759, 76, 77, 78, 79, 812, 87, 88 and 891
Denominator	Value of total product exports
Interpretation	The indicator measures the technological competitiveness of the EU, i.e. the ability to commercialise the results of research and development (R&D) and innovation in international markets. It also reflects product specialisation by country. Creating, exploiting and commercialising new technologies are vital for the competitiveness of a country in the modern economy. Medium and high technology products are key drivers for economic growth, productivity and welfare, and are generally a source of high value added and well-paid employment.
Data source	Eurostat for Member States (variable code: ComExt - DS-018995); UN Comtrade for non-EU countries

4.2.2 Knowledge-intensive services exports as percentage of total services exports	
Numerator	Exports of knowledge-intensive services is defined as the sum of credits in EBOPS 2011 (Extended Balance of Payments Services Classification) items: SC1 (Sea transport); SC2 (Air transport); SC3A (Space transport); SF (Insurance and pension services); SG (Financial services); SH (Charges for the use of intellectual property); SI (Telecommunications, computer, and information services); SJ (Other business services); SK1 (Audio-visual and related services)
Denominator	Total value of services exports
Interpretation	The indicator measures the competitiveness of the knowledge-intensive services sector. Competitiveness-enhancing measures and innovation strategies can be mutually reinforcing for the growth of employment, export shares, and turnover at the firm level. The indicator reflects the ability of an economy, notably resulting from innovation to export services with high levels of value added, and successfully take part in knowledge-intensive global value chains.
Data source	Joint Research Centre: Innovation Output Indicator; complemented with data from Eurostat (variable code: bop_its6_det), OECD, UN Comtrade.

4.2.3 Sales of new-to-market and new-to-enterprise innovations as percentage of turnover	
Numerator	Sum of total turnover of new or significantly improved products, either new-to-the- enterprise or new-to-the-market, for all enterprises
Denominator	Total turnover for all enterprises
Interpretation	This indicator measures the turnover of new or significantly improved products and includes both products which are only new to the enterprise 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-enterprise products).
Data source	Eurostat (Community Innovation Survey) (variable code: numerator: inn_cis12_prodt; denominator: inn_cis12_bas)

Environmental sustainability

4.3.1 Resource productivity	
Numerator	Gross Domestic Product (GDP)
Denominator	Domestic Material Consumption (DMC) in euros per kg
Interpretation	Resource productivity is a measure of the total amount of materials directly used by an economy (measured as domestic material consumption (DMC)) in relation to GDP. It provides insights into whether decoupling between the use of natural resources and economic growth is taking place. Domestic material consumption (DMC) measures the total amount of materials directly used by an economy and is defined as the annual quantity of raw materials extracted from the domestic territory, plus all physical imports minus all physical exports.
Data source	Eurostat (variable code: env_ac_rp)

4.3.2 Air emissions by fine particulate matter (PM2.5) in Industry	
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
Interpretation	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. 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 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.
Data source	Eurostat, Air emissions accounts (variable code: env_ac_ainah_r2); OECD, Global Burden of Disease air pollutant data and Global Human Settlement Layer population data, https://data-explorer.oecd.org/vis?locale=en&dataflow[datasourceId]=DisseminateFinalDMZ&dataflow[agencyId]=OECD.ENV.EPI&dataflow[dataflowId]=DSD_AIR_POL@DF_AIR_POLL, April 2024

4.3.3 Development of environment-related technologies, percentage of all technologies	
Numerator	Number of environment-related inventions
Denominator	Total number of patents
Interpretation	The number of environment-related inventions is expressed as a percentage of all domestic inventions (in all technologies). Indicators of technology development are constructed by measuring inventive activity using patent data across a wide range of environment-related technological domains, including environmental management, water-related adaptation, and climate change mitigation technologies. The counts used include only higher-value inventions (with patent family size ≥ 2).
Comment	Two-year averages have been used for calculating the normalised scores for this indicator, which are used for calculating the Summary Innovation Index.
Data source	OECD, Green Growth database, https://data-explorer.oecd.org, April 2024

4. Methodology for calculating composite scores

The overall performance of each country's innovation system has been summarised in a composite indicator, the Summary Innovation Index. Section 4.1 provides details on data availability per country and per indicator. Section 4.2 explains the methodology used for calculating the SII and performance relative to the EU.

4.1. Data availability

The EIS uses the most recent statistics from Eurostat and other internationally recognised sources as available at the time of analysis. International sources have been used wherever possible in order to ensure comparability between countries. A detailed overview of which data sources have been used for each indicator and country is available in Annex A.

For the calculation of normalised scores, data have been used for an eight-year period. The availability of data by indicator for this eight-year period (2017-2024) covered in the EIS 2024 is shown in Table 1. For all indicators, missing data have been imputed as explained in step 2 in Section 4.2. Country abbreviations in the column show for which countries no data are available.

For 15 indicators marked with an '#', full eight-year time series are not available (before imputation):

- For the seven indicators using CIS data, data are available for at most five individual years, as CIS data are collected once every two years (2014, 2016, 2018, 2020 and 2022). However, 2022 data is only available for a subset of CIS indicators.

- For seven indicators, there are also breaks in series for a majority of Member States, where the data before the break are not directly comparable with the data after the break. In these cases, data from before the break are excluded from the database, even if Eurostat published data for these years. The following indicators are affected by breaks in series:

  - 2 years for Individuals who have above basic overall digital skills

  - 3 years for four indicators: Percentage population aged 25-34 having completed tertiary education, Percentage population aged 25-64 participating in lifelong learning, ICT specialists (as a percentage of total employment), Employment in knowledge-intensive activities

  - 4 years for Broadband penetration

  - 7 years for Job-to-job mobility of Human Resources in Science & Technology

In addition, several indicators also include breaks in series for a limited number of countries only. In total, breaks in the data series are reported for 17 indicators counting at least one break in at least one country, including EU, neighbouring and global competitors and 14 indicators for EU 27 only.

- For Enterprises providing training to develop or upgrade ICT skills of their personnel data are available for 7 years as data are not available for 2021.

Table 1 Data availability by indicator

Innovation dimension / Indicator	Most recent year for which data are available	Number of years for which data are used for the EIS	Data availability EU Member States	Data availability European neighbouring countries
Human resources				
1.1.1 New doctorate graduates in STEM	2022	8 (2015-2022)	100% (99%)	100% (80%)
1.1.2 Percentage population aged 25-34 having completed tertiary education #	2023	3 (2021-2023)	100% (94%)	92% (46%) (UA)
1.1.3 Percentage population aged 25-64 participating in lifelong learning #	2023	3 (2021-2023)	100% (93%)	92% (40%) (UA)
Attractive research systems				
1.2.1 International scientific co-publications per million population	2023	8 (2016-2023)	100% (100%)	100% (92%)
1.2.2 Top 10% most cited publications	2021	8 (2014-2021)	100% (100%)	100% (92%)
1.2.3 Foreign doctorate students	2021	8 (2014-2021)	100% (92%)	92% (72%) (BA)
Digitalisation				

Innovation dimension / Indicator	Most recent year for which data are available	Number of years for which data are used for the EIS	Data availability EU Member States	Data availability European neighbouring countries
1.3.1 Broadband penetration #	2023	4 (2019-2023)	100% (95%)	83% (43%) (CH, IS)
1.3.2 Individuals who have above basic overall digital skills #	2023	2 (2021, 2023)	100% (100%)	75% (67%) (UA, UK, MD)
Finance and support				
2.1.1 R&D expenditure in the public sector	2022	8 (2015-2022)	100% (98%)	92% (64%) (AL)
2.1.2 Venture capital expenditures	2023	8 (2016-2023)	100% (100%)	92% (89%) (AL)
2.1.3 Direct government funding and government tax support for business R&D	2021	8 (2014-2021)	100% (96%)	92% (62%) (AL)
Firm investments				
2.2.1 R&D expenditure in the business sector	2022	8 (2015-2022)	100% (98%)	92% (64%) (AL)
2.2.2 Non R&D innovation expenditure #	2020	4 (2014, 2016, 2018, 2020)	100% (95%)	92% (38%) (CH)
2.2.3 Innovation expenditure per person employed #	2020	4 (2014, 2016, 2018, 2020)	100% (96%)	75% (33%) (AL, CH, UA)
Use of information technologies				
2.3.1 Enterprises providing training to develop or upgrade ICT skills of their personnel #	2022	7 (2015-2020, 2022)	100% (95%)	75% (38%) (MD, CH, IS)
2.3.2 ICT specialists #	2023	2 (2021, 2023)	100% (94%)	92% (44%) (UA)
Innovators				
3.1.1 SMEs introducing product innovations #	2022	5 (2014, 2016, 2018, 2020, 2022)	100% (99%)	100% (48%)
3.1.2 SMEs introducing business process innovations #	2022	5 (2014, 2016, 2018, 2020, 2022)	100% (99%)	100% (48%)
Linkages				
3.2.1 Innovative SMEs collaborating with others #	2022	5 (2014, 2016, 2018, 2020, 2022)	100% (100%)	92% (50%) (BA)
3.2.2 Public-private co-publications	2023	8 (2016-2023)	100% (100%)	100% (92%)
3.2.3 Job-to-job mobility of Human resources in Science & Technology #	2020	7 (2014-2020)	96% (85%) (IE)	67% (58%) (AL, BA, UA, MD)

Innovation dimension / Indicator	Most recent year for which data are available	Number of years for which data are used for the EIS	Data availability EU Member States	Data availability European neighbouring countries
Intellectual assets				
3.3.1 PCT patent applications	2020	8 (2013-2020)	100% (100%)	100% (98%)
3.3.2 Trademark applications	2022	8 (2015-2022)	100% (100%)	100% (98%)
3.3.3 Design applications	2022	8 (2015-2022)	100% (100%)	100% (98%)
Employment impacts				
4.1.1 Employment in knowledge-intensive activities #	2023	3 (2021-2023)	100% (94%)	100% (46%)
4.1.2 Employment in innovative enterprises #	2020	4 (2014, 2016, 2018, 2020)	100% (99%)	92% (54%) (UA)
Sales impacts				
4.2.1 Medium and high technology product exports	2023	8 (2016-2023)	100% (100%)	100% (93%)
4.2.2 Knowledge-intensive service exports	2022	8 (2015-2022)	100% (100%)	100% (100%)
4.2.3 Sales of new-to-market and new-to enterprise innovations #	2020	4 (2014, 2016, 2018, 2020)	100% (93%)	100% (54%)
Environmental sustainability				
4.3.1 Resource productivity	2022	8 (2015-2022)	100% (100%)	75% (71%) (ME, UA, MD)
4.3.2 Air emissions by fine particulates (PM2.5) in Industry	2021	8 (2014-2021)	100% (100%)	58% (49%) (BA, ME, MK, MD, UA)
4.3.3 Development of environment-related technologies	2019	8 (2012-2019)	100% (98%)	100% (100%)

Note: The figures in brackets indicate the data coverage before imputation. The countries in brackets indicate the countries for which data are missing for all years.

The availability of data after imputation of missing data by country for the eight-year period covered in the EIS 2024 is shown in Table 2. For all Member States, except Ireland, data availability is 100%. For 7 neighbouring European countries, data availability is above 90%, while for 4 it is above 80%. Data availability is relatively weak (below 75%) for Ukraine.

Table 2 Data availability by country after imputation of missing data

Country code	Country	Data availability	Country code	Country	Data availability
BE	Belgium	100%	AT	Austria	100%
BG	Bulgaria	100%	PL	Poland	100%
CZ	Czechia	100%	PT	Portugal	100%

Country code	Country	Data availability	Country code	Country	Data availability
DK	Denmark	100%	SI	Slovenia	100%
DE	Germany	100%	SK	Slovakia	100%
EE	Estonia	100%	FI	Finland	100%
IE	Ireland	97%	SE	Sweden	100%
EL	Greece	100%	AL	Albania	81%
ES	Spain	100%	BA	Bosnia and Herzegovina	88%
FR	France	100%	IS	Iceland	94%
HR	Croatia	100%	MK	North Macedonia	97%
IT	Italy	100%	ME	Montenegro	94%
CY	Cyprus	100%	NO	Norway	100%
LV	Latvia	100%	RS	Serbia	100%
LT	Lithuania	100%	CH	Switzerland	88%
LU	Luxembourg	100%	TR	Türkiye	100%
HU	Hungary	100%	UA	Ukraine	72%
MT	Malta	100%	UK	United Kingdom	97%
NL	Netherlands	100%	MD	Moldova	84%
RO	Romania	100%			

4.2. Calculation of the Summary Innovation Index

The overall performance of each country's innovation system has been summarised in a composite indicator, the Summary Innovation Index. The methodology used for calculating the Summary Innovation Index is explained below. “All countries” include all Member States and other European neighbouring countries included in the EIS. The methodology for calculating average innovation performance for the EU and its major global competitors is comparable to that used for calculating average innovation performance for the EU Member States but using a smaller set of countries and a smaller set of indicators.

Step 1: Setting reference years

For each indicator, a reference year is identified for all countries based on data availability for all those countries for which data availability is at least 75%. For most indicators, this reference year lags two years behind the year in which the EIS is published. In the present edition of the EIS, the data relates to the actual performance in 2023 for 10 indicators, 2022 for 11 indicators, 2021 for 4 indicators, 2020 for 6 indicators and 2019 for 1 indicator.

Step 2: Imputing for missing values

Reference year data are then used for the EIS publication year (2024), the next available year for the year before the EIS publication year (2023), and so on going back in time. If data for a year-in-between are not available, missing values are replaced with the value from the previous year.

If data are not available at the beginning of the time series, missing values are replaced with the next available year. The following examples clarify this step and show how 'missing' data are imputed. If data are missing for all years, no data will be imputed (the indicator will not contribute to the Summary Innovation Index).

Table 3 Examples how to impute missing data

Latest year missing	2024	2023	2022	2021	2020
Available data	N/A	45	40	35	30
Use most recent year	45	45	40	35	30
Year-in-between missing	2024	2023	2022	2021	2020
Available data	50	N/A	40	35	30
Substitute with previous year	50	40	40	35	30
Beginning-of-period missing	2024	2023	2022	2021	2020
Available data	50	45	40	35	N/A
Substitute with next available year	50	45	40	35	35

Step 3: Identifying and replacing outliers

Chauvenet's Criterion in statistical theory is used to determine outliers. Positive outliers are identified as those country scores which are higher than the mean across all countries plus twice the standard deviation. Negative outliers are identified as those country scores which are smaller than the mean across all countries minus twice the standard deviation. These outliers are replaced by the respective maximum and minimum values observed over all the years and all countries excluding the identified outliers. With replacing positive (or negative) outliers, more countries can share the highest (lowest) normalised score of 1 (0). Table 5 summarises the outliers per indicator and year (negative outliers are shown in italics) for the full time series including imputed values. Years refer to the reference years in the EIS 2023.

Table 4 Outliers by indicator

Innovation dimension / Indicator	Outliers (Positive / Negative)
Human resources	
1.1.1 New doctorate graduates in STEM	SI 2021; CH 2017-2023; UK 2020-2021
1.1.2 Percentage population aged 25-34 having completed tertiary education	IE 2022-204; LU 2022; *RO 2024*
1.1.3 Percentage population aged 25-64 participating in lifelong learning	FI 2022; SE 2022-2024; DK 2024
Attractive research systems	
1.2.1 International scientific co-publications per million population	DK 2022-2024; CY 2023-2024; IS 2017-2024; CH 2019-2024
1.2.2 Top 10% most cited publications	--
1.2.3 Foreign doctorate students	LU 2017-2024; MT 2023-2024
Digitalisation	
1.3.1 Broadband penetration	DK 2023-2024 ; *HR 2021; AL 2022*
1.3.2 Individuals who have above basic overall digital skills	NL 2022, 2024; FI 2024

Innovation dimension / Indicator	Outliers (Positive / Negative)
Finance and support	
2.1.1 R&D expenditure in the public sector	DK 2017-2024
2.1.2 Venture capital expenditures	EE 2022-2024; FR 2023-2024; DK 2024; FI 2023-2024; SE 2023; UK 2022-2023
2.1.3 Direct government funding and government tax support for business R&D	FR 2017-2024; AT 2023; PT 2023; UK 2021-2024; IS 2023-2024
Firm investments	
2.2.1 R&D expenditure in the business sector	BE 2022-2024; SE 2019-2024
2.2.2 Non-R&D innovation expenditures	RS 2020
2.2.3 Innovation expenditure per person employed	BE 2022, 2024; RS 2020
Use of information technologies	
2.3.1 Enterprises providing training to develop or upgrade ICT skills of their personnel	FI 2024; NO 2017-2021; *RO 2019*
2.3.2 ICT specialists	LU 2024; SE 2022-2024; *AL 2019*
Innovators	
3.1.1 SMEs introducing product innovations	EE 2020; EL 2022; CY 2020; ME 2024; *RO 2018; UA 2022*
3.1.2 SMEs introducing business process innovations	EL 2022; *RO 2018, 2020, 2022, 2024; UA 2020-2022*
Linkages	
3.2.1 Innovative SMEs collaborating with others	CY 2020; SE 2024; NO 2022, 2024; UK 2018, 2022
3.2.2 Public-private co-publications	DK 2020-2024; IS 2017-2023; CH 2017-2024
3.2.3 Job-to-job mobility of Human Resources in Science & Technology	DK 2021*; RO 2023-2024*
Intellectual assets	
3.3.1 PCT patent applications	FI 2017-2024; SE 2017-2024; CH 2024
3.3.2 Trademark applications	CY 2017-2024; MT 2017-2024
3.3.3 Design applications	BG 2017; LU 2017-2018; MT 2017-2020
Employment impacts	
4.1.1 Employment in knowledge-intensive activities	LU 2022-2024
4.1.2 Employment in innovative enterprises	*RO 2018, 2020, 2022, 2024*
Sales impacts	

Innovation dimension / Indicator	Outliers (Positive / Negative)
4.2.1 Medium and high technology product exports	*AL 2017-2023*; *IS 2017-2024*; *NO 2022-2024*
4.2.2 Knowledge-intensive services export	--
4.2.3 Sales of new-to-market and new-to-enterprise innovations	IE 2024; AL 2022, 2024
Environmental sustainability	
4.3.1 Resource productivity	NL 2019, 2023-2024; CH 2018-2023; UK 2021-2022
4.3.2 Air emissions by fine particulates (PM2.5) in Industry	--
4.3.3 Development of environment-related technologies	BG 2020; DK 2017, 2022-2024; EE 2017; MT 2021-2022, 2021; AL 2018, 2021-2024; BA 2017-2018, 2023-2024; MD 2019; *MK 2019, 2022*

Step 4: Transforming data that have highly skewed distributions across countries

Most of the indicators are fractional indicators with values between 0% and 100%. Some indicators are unbound indicators, where values are not limited to an upper threshold. These indicators can be highly volatile and can have skewed data distributions (where most countries show low performance levels, and a few countries show exceptionally high levels of performance). For these indicators where the degree of skewness across the full eight-year period is above one, data have been transformed using a square root transformation, i.e. using the square root of the indicator value instead of the original value. For the following indicators data have been transformed: Venture capital expenditures, Non-R&D innovation expenditures, PCT patent applications, Trademark applications, and Air emissions by fine particulates (PM2.5) in industry (Table 6).

Table 5 Skewness of the indicators before and after a possible data transformation

Innovation dimension / Indicator	Skewness	Skewness after transformation
Human resources		
1.1.1 New doctorate graduates in STEM	0.394	--
1.1.2 Percentage population aged 25-34 having completed tertiary education	0.159	--
1.1.3 Percentage population aged 25-64 participating in lifelong learning	0.582	--
Attractive research systems		
1.2.1 International scientific co-publications per million population	0.699	--
1.2.2 Top 10% most cited publications	0.087	--
1.2.3 Foreign doctorate students	0.649	--
Digitalisation		
1.3.1 Broadband penetration	0.071	--

Innovation dimension / Indicator	Skewness	Skewness after transformation
1.3.2 Individuals who have above basic overall digital skills	0.071	--
Finance and support		
2.1.1 R&D expenditure in the public sector	0.087	--
2.1.2 Venture capital expenditures	1.05	0.156
2.1.3 Direct government funding and government tax support for business R&D	0.777	--
Firm investments		
2.2.1 R&D expenditure in the business sector	0.537	--
2.2.2 Non-R&D innovation expenditures	1.495	0.31
2.2.3 Innovation expenditure per person employed	0.763	--
Use of information technologies		
2.3.1 Enterprises providing training to develop or upgrade ICT skills of their personnel	0.106	--
2.3.2 ICT specialists	-0.048	--
Innovators		
3.1.1 SMEs introducing product innovations	-0.098	--
3.1.2 SMEs introducing business process innovations	-0.288	--
Linkages		
3.2.1 Innovative SMEs collaborating with others	0.68	--
3.2.2 Public-private co-publications	0.879	--
3.2.3 Job-to-job mobility of Human Resources in Science & Technology	0.022	--
Intellectual assets		
3.3.1 PCT patent applications	1.076	0.517
3.3.2 Trademark applications	1.642	0.461
3.3.3 Design applications	0.542	--
Employment impacts		
4.1.1 Employment in knowledge-intensive activities	0.032	--
4.1.2 Employment in innovative enterprises	-0.277	--

Innovation dimension / Indicator	Skewness	Skewness after transformation
Sales impacts		
4.2.1 Medium and high technology product exports	-0.548	--
4.2.2 Knowledge-intensive services export	0.031	--
4.2.3 Sales of new-to-market and new-to-enterprise innovations	0.687	--
Environmental sustainability		
4.3.1 Resource productivity	0.662	--
4.3.2 Air emissions by fine particulates (PM2.5) in Industry	1.7	1.013
4.3.3 Development of environment-related technologies	0.505	--

Step 5: Determining Maximum and Minimum scores

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

Step 6: Calculating re-scaled scores

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

Step 7: Calculating composite innovation indexes

For each year, a composite Summary Innovation Index is calculated as the unweighted average of the re-scaled scores for all indicators where all indicators receive the same weight (1/32 if data are available for all 32 indicators).

Step 8: Calculating relative-to-EU performance scores

Performance scores relative to the EU are then calculated as the SII of the respective country divided by the SII of the EU multiplied by 100. Relative performance scores are calculated for the full eight-year period compared to the performance of the EU in 2017 and for the latest year also to that of the EU in 2024. For the definition of the performance groups, only the performance scores relative to the EU in 2023 have been used.

4.3. International benchmarking

The methodology for calculating the average innovation performance for the EU and its major global competitors is similar to that used for calculating the average innovation performance for the EU Member States but using a smaller set of countries and a smaller set of indicators. However, due to a different number of indicators and differences in definitions or data sources for some of the indicators,

some additional manipulations are required to align the results with those of the EU in the benchmarking for the European countries.

For all global competitors and the EU, the innovation indexes are adjusted by multiplying with the ratio between the normalised scores for the EU calculated in the benchmarking for the European countries and the international benchmarking, and the normalised scores for the EU calculated in the global comparison. This ensures that both current performance and trend results for the EU are consistent between both analyses (cf. Table 7 using the data from this year's report). The corrected normalised scores are then used to calculate performance levels relative to the EU in 2024 for the most recent year and relative to the EU in 2017 for all years.

Table 6 Adjustment factors used for aligning the results between the European and global benchmarking analysis

		2017	2018	2019	2020	2021	2022	2023	2024
1	EU Innovation Index - International benchmark	0.502	0.505	0.509	0.523	0.529	0.542	0.55	0.553
2	EU Innovation Index - European benchmark	0.55	0.55	0.548	0.553	0.553	0.577	0.581	0.585
3	Correction applied to all global competitors and the EU calculated as the ration of the results in row 2 and row 1	0.913	0.918	0.929	0.946	0.957	0.939	0.947	0.945

4.4. Performance group membership

For determining performance group membership, the EIS uses the following classification scheme and corresponding scores for EIS 2024:

- Innovation Leaders are all countries with a relative performance in 2024 above 125% of the EU average in 2024 (corresponding to a score of 137.4 when indexed to EU 2017).
- Strong Innovators are all countries with a relative performance in 2024 between 100% and 125% of the EU average in 2024 (corresponding to a range of scores from 110.0 to 137.4 when indexed to EU 2017).
- Moderate Innovators are all countries with a relative performance in 2024 between 70% and 100% of the EU average in 2024 (corresponding to a range of scores from 77.0 to 110.0 when indexed to EU 2017).
- Emerging Innovators are all countries with a relative performance in 2024 below 70% of the EU average in 2024 (corresponding to a score below 77.0 when indexed to EU 2017).

4.5. Comparability over time

It must be stressed that comparisons with results from the previous EIS reports are not possible, not even for the same years in both reports. Although the methodology in this year's report is the same as in the EIS 2023, results for the same year, e.g. 2023 in the EIS 2023 and 2023 in this year's report, are different due to several reasons:

- By adding new data at the end of the time series for each indicator and removing data at the start of the time series, the highest and lowest data scores used for calculating normalised scores across all countries and all years for an indicator can change, directly impacting these normalised scores.
- Timeliness refers to the year for which the most recent data are available. For the EIS 2024 seven indicators have been updated with two additional years and 16 with one additional year compared to their availability in 2023.

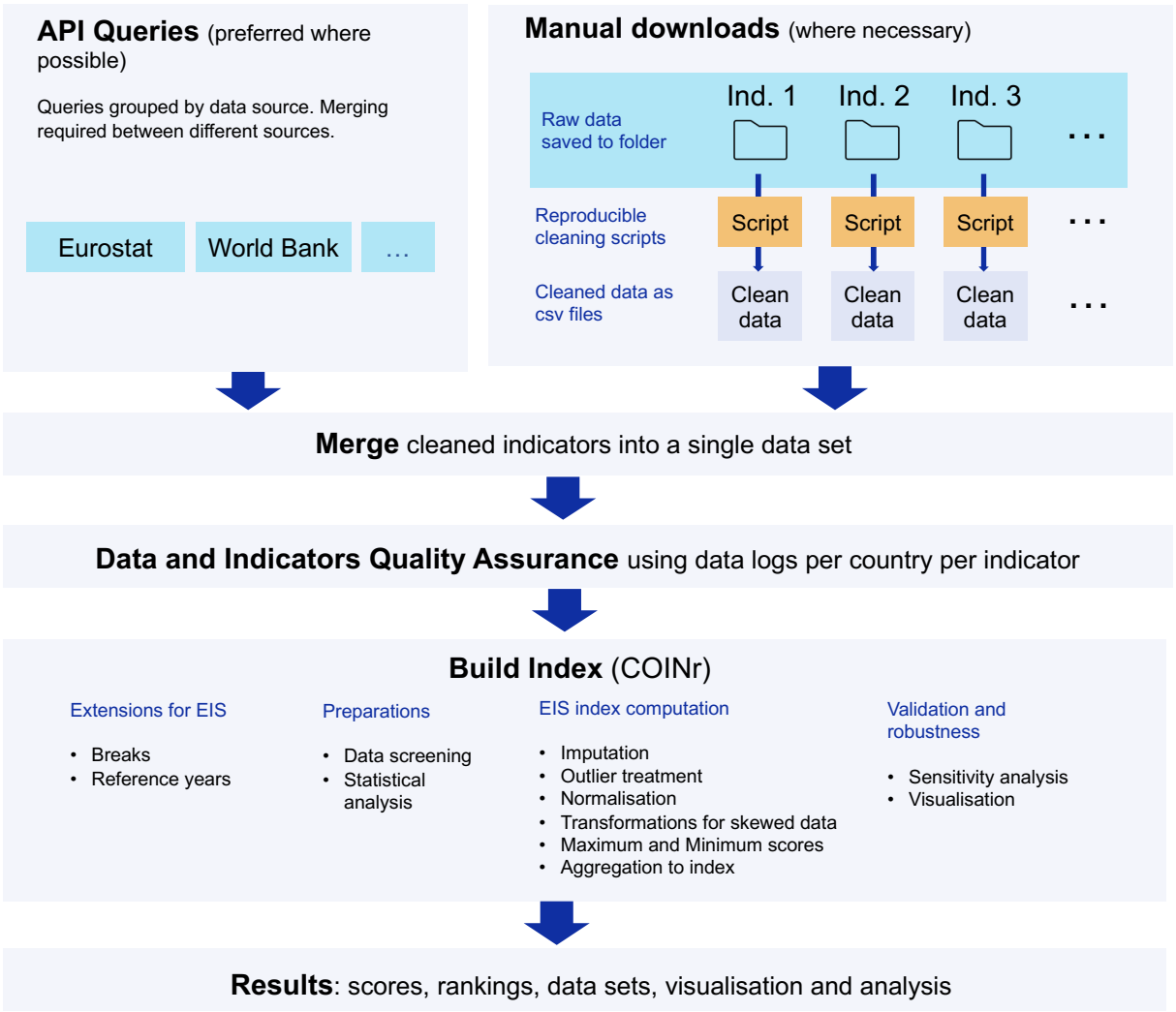
- Breaks in series for indicators and individual countries impact the most recent year used. In total, breaks in the data series are reported for 17 indicators counting at least one break in at least one country, including EU, neighbouring and global competitors and 14 indicators for EU 27 only.

Consequently, one should only use the results for all years in this report to compare performance over time. More details on data sources, timeliness and breaks are provided in the EIS Methodology Report 2024.

4.6. Automation

The data collection and calculation process for the EIS has been automated for the 2024 release. The approach is summarised in Figure 1 below.

Figure 2 EIS automation process



The construction of the summary index for 2024 has been performed using the COINr package[2] adapted and extended to the EIS following the 2023 methodology. COINr is an open-source R package recently developed by the European Commission's Competence Centre for Composite Indicators and Scoreboards[3], and implements international guidelines and best practices in composite

[2] See: https://bluefoxr.github.io/COINr/

[3] See: https://composite-indicators.jrc.ec.europa.eu/

indicator construction[4]. It allows highly detailed and flexible construction and analysis of composite indicators, including imputation, normalisation, outlier treatment and sensitivity analysis.

This approach provides a highly replicable and easy to follow data pipeline which feeds into the COINr package and automatically provides the main outputs of the EIS. Since the data collection, processing and outputs are largely based on code (using the R software), all code is packaged together and hosted on GitHub which also facilitates the auditing process.

To ensure the accuracy of calculations and the correct application of the methodology, the EIS results for 2023 were reproduced using the COINr package as a validation step, before calculating the updated index for 2024 using the latest data.

5. Structural differences between countries

5.1. Contextual indicators: European countries

In response to the need for contextual analysis to better understand performance differences on the innovation indicators used in the main measurement framework, a set of contextual indicators is included in the Country profiles. The contextual indicators used in the European comparison, the years for which average performance has been calculated, and data sources used are shown in Table 7. Complete definitions of all contextual indicators are also provided in this section.

Table 7 Contextual indicators in the European Innovation Scoreboard – European countries

Dimension/ Indicator	Period	Source
Performance and structure of the eonomy		
GDP per capita (PPS)	Average 2021-2023	Eurostat
Average annual GDP growth (%)	Between 2021 and 2023	Eurostat
Employment share Manufacturing (NACE C) (%)	Average 2020-2022	Eurostat
of which High and Medium high tech (%)	Average 2020-2022	Eurostat
Employment share Services (NACE G-N) (%)	Average 2020-2022	Eurostat
of which Knowledge-intensive sectors (%)	Average 2020-2022	Eurostat
Turnover share SMEs (%)	Average 2018-2020	Eurostat
Turnover share large companies (%)	Average 2018-2021	Eurostat
Foreign-controlled entreprises - share of value added (%)	Average 2018-2022	Eurostat
Business and entrepreneurship		
Enterprise births (10+ employees) (%)	Average 2018-2020	Eurostat
Total early-stage Entrepreneurial Activity (TEA)	Average 2020-2022	Global Entrepreneurship Monitor

[4] Nardo M, Saisana M, Saltelli A, Tarantola S, Hoffmann A, Giovannini E. Handbook on Constructing Composite Indicators: Methodology and User Guide. Paris (France): OECD publishing; 2008. JRC47008. https://publications.jrc.ec.europa.eu/repository/handle/JRC47008

Dimension/ Indicator	Period	Source
(%)		
FDI net inflows (% GDP)	Average 2021-2023	World Bank: World Development Indicators
Top R&D spending enterprises per 10 million population	Average 2021-2023	EU Industrial R&D Investment Scoreboard
Buyer sophistication (1 to 7 best)	Average 2018-2020	World Economic Forum
Innovation profiles		
In-house product innovators with market novelties	2018-2020	Eurostat, National Statistical Offices
In-house product innovators without market novelties	2018-2020	Eurostat, National Statistical Offices
In-house business process innovators	2018-2020	Eurostat, National Statistical Offices
Innovators that do not develop innovations themselves	2018-2020	Eurostat, National Statistical Offices
Innovation active non-innovators	2018-2020	Eurostat, National Statistical Offices
Non-innovators with potential to innovate	2018-2020	Eurostat, National Statistical Offices
Non-innovators without disposition to innovate	2018-2020	Eurostat, National Statistical Offices
Governance and policy framework		
Corruption Perceptions Index	Average 2021-2023	Transparency International
Basic-school entrepreneurial education and training (1 to 5 best)	Average 2020-2022	Global Entrepreneurship Monitor
Government procurement of advanced technology products (1 to 7 best)	Average 2018-2020	World Economic Forum
Innovation procurement as a share of total public procurement	2022	Tenders Electronic Daily and National Public Procurement data
Rule of law (-2.5 to 2.5 best)	Average 2020-2022	World Bank: Worldwide Governance Indicators
Climate Change		
Circular material use rate	Average 2020-2022	Eurostat
Greenhouse gas emissions intensity of energy consumption	Average 2019-2021	European Environment Agency (EEA), Eurostat
Eco-Innovation Index	2022	EC, DG Environment
Demography		
Population size (millions)	Average 2021-2023	Eurostat
Average annual population growth (%)	Between 2021 and 2023	Eurostat
Population density (inhabitants / km2)	Average 2020-2022	Eurostat

Performance and structure of the economy

GDP per capita in purchasing power standards[5] is a measure for interpreting real income differences between countries. Higher income can increase the demand for new innovative goods and services. Economic growth is captured by the average annual growth rate of GDP for 2020-2022. In economies that grow faster, increasing demand may provide more favourable conditions for enterprises to sell their goods and services.

Differences in economic structures are important. In particular, differences in the share of manufacturing industry in GDP, and in the so-called high-tech activities in manufacturing and services, are important factors that explain why countries can perform better or worse on indicators like business R&D expenditures, PCT patents, and innovative enterprises. Medium-high and high-tech industries have higher technological intensities than other industries. These industries, on average, will have higher R&D expenditures, more patent applications, and higher shares of innovating enterprises. Countries with above-average shares of these industries are expected to perform better on several EIS indicators. For example, for the EU on average, 85% of R&D expenditures in manufacturing are accounted for by medium-high and high-technology manufacturing industries[6][7]. Also, the share of enterprises that introduced a product and/or business process innovation is higher in medium-high and high-technology manufacturing industries compared to all core industries covered in the Community Innovation Survey[8].

Foreign ownership, including ownership from both other EU Member States and non-Member States, is important as, on average, about 30% of business R&D expenditures in EU Member States is made by foreign affiliates, which is significantly higher compared to Japan and the United States and comparable to Australia and Canada[9]. The share of foreign-controlled enterprises in value-added serves as a proxy for differences in the impact of foreign ownership on the economy.

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[5] The purchasing power standard, abbreviated as 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. PPS is the technical term used by Eurostat for the common currency in which national accounts aggregates are expressed when adjusted for price level differences using PPPs. Thus, PPPs can be interpreted as the exchange rate of the PPS against the Euro.

[6] Based on NACE Rev. 2 3-digit level, manufacturing industries can be classified into high-technology, medium-high technology, medium-low-technology, and low-technology. The high-technology and medium-high technology industries include: Chemicals and chemical products (20); Basic pharmaceutical products and pharmaceutical preparations (21); Weapons and ammunition (25.4*); Computer, electronic and optical products (26); Electrical equipment (27); Machinery and equipment not elsewhere classified (28); Motor vehicles, trailers and semi-trailers (29); Other transport equipment (30) excluding Building of ships and boats (30.1); Air and spacecraft and related machinery (30.3); and Medical and dental instruments and supplies (32.5**). If data are only available at the NACE Rev. 2 2-digit level, industries identified with an * are classified as medium-low-technology, and industries identified with an ** are classified as low-technology, and thus excluded from the high-technology and medium-high technology industries (Source: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:High-_tech_classification_of_manufacturing_industries).

[7] Average results for 2016-2018 for 24 Member States for which data are available for at least one year. Data were extracted from Eurostat (Business enterprise R&D expenditure in high-tech sectors - NACE Rev. 2 [htec_sti_exp2].

[8] In accordance with Commission Regulation No 995/2013, the following industries and services are included in the Core target population covered in the CIS: Core Industry (excluding construction): Mining and quarrying (B), Manufacturing (C) (10-12: Manufacture of food products, beverages and tobacco; 13-15: Manufacture of textiles, wearing apparel, leather and related products; 16-18: Manufacture of wood, paper, printing and reproduction; 20: Manufacture of chemicals and chemical products; 21: Manufacture of basic pharmaceutical products and pharmaceutical preparations; 19-22 Manufacture of petroleum, chemical, pharmaceutical, rubber and plastic products; 23: Manufacture of other non-metallic mineral products; 24: Manufacture of basic metals; 25: Manufacture of fabricated metal products, except machinery and equipment; 26: Manufacture of computer, electronic and optical products; 25-30: Manufacture of fabricated metal products (except machinery and equipment), computer, electronic and optical products, electrical equipment, motor vehicles and other transport equipment; 31-33: Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment, Electricity, gas, steam and air conditioning supply (D), Water supply, sewerage, waste management and remediation activities (E) (36: Water collection, treatment and supply; 37-39: Sewerage, waste management, remediation activities). Core Services: Wholesale trade, except of motor vehicles and motorcycles (46), Transport and storage (H) (49-51: Land transport and transport via pipelines, water transport and air transport; 52-53: Warehousing and support activities for transportation and postal and courier activities); Information and communication (J) (58: Publishing activities; 61: Telecommunications; 62: Computer programming, consultancy and related activities; 63: Information service activities), Financial and insurance activities (K) (64: Financial service activities, except insurance and pension funding; 65: Insurance, reinsurance and pension funding, except compulsory social security; 66: Activities auxiliary to financial services and insurance activities), Professional, scientific and technical activities (M) (71-73: Architectural and engineering activities; technical testing and analysis; Scientific research and development; Advertising and market research).

[9] Average results for 2011-2017 for 14 Member States for which data were available (Austria, Belgium, Czechia, Finland, France, Germany, Hungary, Ireland, Italy, Netherlands, Poland, Slovenia Spain, and Sweden). Source of the data: OECD Main Science and Technology Indicators.

Business and entrepreneurship

Entrepreneurship is important for introducing new innovations on the market. The degree of entrepreneurship is measured by two contextual indicators measuring the share of new enterprise births in the economy and Total early-stage Entrepreneurial activity (TEA), which measures the share of the adult population aged 18–64 years who are in the process of starting a business (a nascent entrepreneur) or who started a business which is not older than 42 months at the time of the respective survey (owner-manager of a new business).

Inflows of new technologies are important as they add to a country's economic and technological capacities. Inward Foreign direct investment (FDI) can have a positive impact on innovation performance, although there are differences depending on the complexity of the receiving industry, political and economic framework conditions as well as the quality of the institutions of the receiving countries. Inward FDI flows are measured over a three-year period, as average net inflows of investments to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor.

Enterprise characteristics are important for explaining differences in R&D spending and innovation activities. Large enterprises, defined as enterprises with 250 or more employees, account for almost 80 percent of EU business R&D expenditures, whereas SMEs, defined as enterprises with 10 to 249 employees, account for only one-fifth. The presence of large R&D spending enterprises is captured by the EU Industrial R&D Investment Scoreboard, which provides economic and financial data and analysis of the top corporate R&D investors from the EU and abroad[10].

Demand is an important driver of innovation. According to the Oslo Manual (2018)[11], demand factors shape innovation activity in two major ways: for the development of new products, as firms modify and differentiate products to increase sales and market share; and for the improvement of the production and supply processes in order to reduce costs and lower prices. A robust indicator measuring the demand for innovation is currently not available. The Executive Opinion Survey of the World Economic Forum includes an indicator that provides a measure of the preferences of individual consumers for innovative products. The degree of Buyer sophistication measures, on a scale from 1 (low) to 7 (high), whether buyers focus more on price or quality of products and services.

Innovation profiles

Innovation is a highly diverse activity. Enterprises can innovate through product or business process innovation, with the latter including process, marketing and organisational innovation. Enterprises can adopt new technologies developed by other enterprises or they engage in intensive in-house research and innovation activities. The capabilities needed by enterprises to innovate are very different in kind and size. More simple aggregate indicators of the percentage of 'innovative' enterprises in a particular country, as those currently used in the EIS, most likely provide information of limited value to policy makers. Instead, innovation indicators should differentiate between 'styles' or 'modes' of innovation in order to provide a clear picture of the structure of innovation capabilities within different businesses, economies, and countries (Arundel and Hollanders, 2005)[12].

Building on earlier work by academics and the OECD, Eurostat, UNU-MERIT (Maastricht University), ZEW – Leibniz Centre for European Economic Research, in collaboration with most National Statistical Offices, developed a taxonomy of innovating and non-innovating enterprises based on CIS 2016 and CIS 2018 micro data. The following characteristics were used to identify seven mutually exclusive detailed innovation profiles: the degree of newness of product innovations, own in-house capacities to innovate, and R&D activities. Of these, four innovation profiles capture different types of enterprises that have introduced an innovation (product or business process) and three innovation profiles capture non-innovators:

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[10] http://iri.jrc.ec.europa.eu/scoreboard.html

[11] The Oslo Manual is the foremost international source of guidelines for the collection and use of data on innovation activities in industry. OECD/Eurostat (2018), Oslo Manual: Guidelines for Collecting, Reporting and Using Data on Innovation, 4th Edition, OECD Publishing, Paris. DOI: https://doi.org/10.1787/9789264304604-en

[12] https://cris.maastrichtuniversity.nl/files/64448310/Arundel_Hollanders_EXIS.pdf

- In-house product innovators with market novelties, including all enterprises that introduced a product innovation that was developed by the enterprise and that was not previously offered by competitors).

- In-house product innovators without market novelties, including all enterprises that introduced a product innovation that was developed by the enterprise but that is only new to the enterprise itself.

- In-house business process innovators, including all enterprises that did not introduce a product innovation, but that did introduce a business process innovation that was developed by the enterprise.

- Innovators that do not develop innovations themselves, including all enterprises that introduced an innovation of any kind but did not develop it themselves (enterprises without significant own innovation capabilities).

- Innovation active non-innovators, including all enterprises that did not introduce any innovation but that either had ongoing or abandoned innovation activities.

- Non-innovators with potential to innovate, including all enterprises that did not introduce any innovation, and which had no ongoing or abandoned innovation activities but that did consider to innovate.

- Non-innovators without disposition to innovate, including all other enterprises, those that neither introduced an innovation nor had any ongoing or abandoned innovation activities nor considered to innovate.

Data on Innovation profiles should not be interpreted as “more is better”. Instead, the data should be used to better understand differences in the composition of different types of enterprises in a country, thereby helping policy makers to design policies that better target different enterprises.

Results for the EU are shown in Table 9 for all enterprises. About 12% of enterprises are In-house innovators with market novelties, and about 13% of enterprises are In-house innovators without market novelties. In-house business process innovators account for 16.5% of enterprises. Innovators that do not develop innovations themselves account for 6.5% of enterprises. About 4% of enterprises are Innovation active non-innovators. Non-innovators account for almost half of EU enterprises. Non-innovators with potential to innovate account for 17% of all enterprises, and Non-innovators without disposition to innovate form the largest group accounting for 31% of all enterprises. Table 9 also shows which Member States have the highest and lowest share for each of the innovation profiles.

Table 8 Distribution of enterprises and employment for seven Innovation profiles in the EU (based on CIS 2020 data)

	Share of enterprises		
	EU	Highest share	Lowest share
In-house product innovators with market novelties	12.2%	24.1% (BE)	2.2% (RO)
In-house product innovators without market novelties	12.8%	23.3% (EL)	2.7% (LV)
In-house business process innovators	16.5%	33.4% (EE)	2.9% (RO)
Innovators that do not develop innovations themselves	6.5%	14.0% (SI)	0.4% (EE)
Innovation active non-innovators	4.1%	6.3% (FI)	0.5% (RO)
Non-innovators with potential to innovate	17.2%	41.5% (ES)	0.0% (FI)
Non-innovators without disposition to innovate	30.7%	62.4% (RO)	12.9% (DE)

Governance and policy framework

Institutional and legal differences between countries may make it more difficult to engage in business activities. The Corruption Perceptions Index is a composite index based on a combination of surveys and assessments of corruption from 13 different sources and scores and ranks countries based on how corrupt a country's public sector is perceived to be, with a score of 0 representing a very high level of corruption and a score of 100 representing a very low level of corruption. The CPI is published by Transparency International, and the data are included in the EU Sustainable Development Goals indicator set to monitor progress on SDG Goal 16 on Peace, justice and strong institutions.

Entrepreneurial skills are important for successfully transforming ideas and inventions into innovations. These skills can be acquired on the job but also by formal schooling. Basic-school entrepreneurial education and training measures the extent to which training in creating or managing SMEs is incorporated within the education and training system at primary and secondary levels.

Governments play an important role in enhancing the innovation capacities of an economy. Government procurement of advanced technology products measures the extent to which government procurement decisions foster technological innovation – from 1 (not at all) to 7 (extremely effectively). Trust is important for creating a business environment for undertaking risky innovative activities. The Rule of law index captures differences in the extent to which people have confidence in and abide by the rules of society. Rule of law measures differences in the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.

Climate change

As the natural environment increasingly suffers from the loss of biodiversity, pollution and climate change, the relationship between innovation performance and environment sustainability grows in importance. EU level policy developments, such as the European Green Deal and the Recovery plan for Europe, underline the need to take account of the pivotal role of research and innovation in contributing to tackle societal challenges. In addition to the new innovation dimension on Environmental sustainability and the three indicators captured in this dimension, three additional indicators are included in the Contextual indicators relevant for measuring climate change and the role of innovation.

The circular material use rate measures, in percentages, the share of material recovered and fed back into the economy - thus saving extraction of primary raw materials - in overall material use. The circular material use rate is defined as the ratio of the circular use of materials (U) to the overall material use (M). It covers households, the private and the public sector. A higher circular material use rate value indicates more secondary materials substituting for primary raw materials, i.e. avoiding the environmental impacts of extracting primary material. Data for all 27 Member States and the United Kingdom are available from Eurostat.

Greenhouse gas emissions intensity of energy consumption is an indicator that is part of the EU Sustainable Development Goals (SDG) indicator set. It is used to monitor progress towards Goal 13 on climate action and SDG 7 on affordable and clean energy. The indicator is calculated as the ratio between energy related GHG emissions and gross inland consumption of energy. It expresses how many tonnes CO2 equivalents of energy related GHGs are being emitted in a certain economy per unit of energy that is being consumed. Lower scores on this indicator imply an improvement in environmental performance. Data source is the European Environment Agency (EEA) and data for all 27 Member States and other countries are available from Eurostat.

The Eco-Innovation index is a composite indicator based on 16 sub-indicators in five thematic areas: eco-innovation inputs, eco-innovation activities, eco-innovation outputs, resource efficiency outcomes and socio-economic outcomes. The overall score of an EU Member State is calculated by the unweighted mean of the 16 sub-indicators. It shows how well individual Member States perform in eco- innovation compared to the EU average, which is equated with 100 (index EU=100). The index is part of the Eco-Innovation Scoreboard (Eco-IS)[13]. For the EIS, results from the 2023 edition of the Eco-IS are used.

[13] hhttps://ec.europa.eu/environment/ecoap/indicators/index_en

Demography

Structural data also includes population size and the average annual growth rate of population for 2020- 2022. Increasing demand following an increasing population may provide more favourable conditions for enterprises to sell their goods and services. Densely populated areas are more likely to be more innovative for several reasons. Firstly, knowledge diffuses more easily when people and enterprises are located closer to each other. Secondly, in more densely populated areas there tends to be a concentration of government and educational services. Densely populated areas provide better training opportunities and employ above-average shares of highly educated people. Furthermore, the amount of natural assets per capita tends to decline with population density. This positively impacts on the share of Medium and high-tech product exports and the share of employment in knowledge intensive activities.

The remainder of this section presents the definitions of the structural indicators used for EU Member States and other European or neighbouring countries.

Performance and structure of the economy

GDP per capita (PPS)	
Indicator	Nominal Gross Domestic Product per capita
Unit	Purchasing power standard (PPS) per inhabitant
Calculated as	Average value for the years 2020 to 2022
Data source	Eurostat: Annual national accounts data

Average annual GDP growth (%)	
Indicator	Gross Domestic Product at market prices
Unit	Chain linked volumes, index 2016=100
Calculated as	Average annual growth rate between 20210 and 20232
Data source	Eurostat: Annual national accounts data

Employment share Manufacturing (NACE C) (%)	
Numerator	Employment in Manufacturing (NACE Rev. 2 C)
Denominator	Total employment
Calculated as	Average percentage share for the years 202019 to 2022
Data source	Eurostat: Employment in technology and knowledge-intensive sectors at the national level, by type of occupation

Employment share Manufacturing - Of which High and Medium high-tech (%)	
Numerator	Total employment in the following industries:

Employment share Manufacturing - Of which High and Medium high-tech (%)	
	- High technology: Basic pharmaceutical products and pharmaceutical preparations (NACE Rev. 2 21); Computer, electronic and optical products (NACE Rev. 2 26); Air and spacecraft and related machinery (NACE Rev. 2 30.3) - Medium-high-technology: Chemicals and chemical products (NACE Rev. 2 20); Weapons and ammunition (NACE Rev. 2 25.4); Electrical equipment (NACE Rev. 2 27) ; Machinery and equipment not elsewhere classified (NACE Rev. 2 28); Motor vehicles, trailers and semi-trailers (NACE Rev. 2 29); Other transport equipment (NACE Rev. 2 30) excluding Building of ships and boats (NACE Rev. 2 30.1) and excluding Air and spacecraft and related machinery (NACE Rev. 2 30.3); Medical and dental instruments and supplies (NACE Rev. 2 32.5)
Denominator	Employment in Manufacturing (NACE Rev. 2 C)
Calculated as	Average percentage share for the years 2019 2020 to 20221
Data source	Eurostat: Employment in technology and knowledge-intensive sectors at the national level, by type of occupation

Employment share Services (NACE G-N) (%)	
Numerator	Employment in Services (NACE Rev. 2 G-N)
Denominator	Total Employment
Calculated as	Average percentage share for the years 2019 2020 to 20221
Data source	Eurostat: Employment in technology and knowledge-intensive sectors at the national level, by type of occupation

Employment share Services - Of which Knowledge-intensive services (%)	
Numerator	Aggregate of employment in the following industries: Water transport; Air transport (NACE Rev. 2 50-51); Publishing activities; Motion picture, video and television programme production, sound recording and music publishing activities; Programming and broadcasting activities; Telecommunications; computer programming, consultancy and related activities; Information service activities (NACE Rev. 2 58-63); Financial and insurance activities (NACE Rev. 2 64-66); Legal and accounting activities; Activities of head offices, management consultancy activities; Architectural and engineering activities, technical testing and analysis; Scientific research and development; Advertising and market research; Other professional, scientific and technical activities; Veterinary activities (NACE Rev. 2 69-75); Employment activities (NACE Rev. 2 78); Security and investigation activities (NACE Rev. 2 80)
Denominator	Employment in Services (NACE Rev. 2 G-N)
Calculated as	Average percentage share for the years 2019 2020 to 20221
Data source	Eurostat: Employment in technology and knowledge-intensive sectors at the national level, by type of occupation

Turnover share SMEs (%)	
Numerator	Turnover in enterprises with 10 to 249 persons employed
Denominator	Turnover in Total business economy; repair of computers, personal and household goods; except financial and insurance activities

Turnover share SMEs (%)	
Calculated as	Average percentage share for the years 2018 to 2020
Data source	Eurostat: Annual enterprise statistics by size class for special aggregates of activities

Turnover share large enterprises (%)	
Numerator	Turnover in enterprises with 250 persons employed or more
Denominator	Turnover in Total business economy; repair of computers, personal and household goods; except financial and insurance activities
Calculated as	Average percentage share for the years 2018 to 2021
Data source	Eurostat: Annual enterprise statistics by size class for special aggregates of activities

Share of foreign controlled enterprises (%)	
Numerator	Value added by foreign-controlled enterprises at factor cost in million euros for Non-financial business economy. A foreign-controlled enterprise shall mean that the controlling institutional unit is resident in a different country from the one where the institutional unit over which it has control is resident[14]
Denominator	Value added, gross.
Calculated as	Average percentage share for the years 2018 to 2022
Data source	Eurostat: Foreign control of enterprises by economic activity and a selection of controlling countries (from 2008 onwards) [fats_g1a_08] Eurostat: GDP and main components (output, expenditure, and income) [nama_10_gdp]

Business and entrepreneurship

Enterprise births (10+ employees) (%)	
Numerator	Number of births of enterprises in year t
Size class	10 employees or more
Industries	Business economy except activities of holding companies
Denominator	Population of active enterprises in year t
Size class	10 employees or more
Industries	Business economy except activities of holding companies
Calculated as	Average percentage share for the years 2018 to 2020

[14] A more detailed explanation is available at: http://ec.europa.eu/eurostat/cache/metadata/EN/fats_esms.htm

Enterprise births (10+ employees) (%)	
Data source	Eurostat: Business demography data

Total early-stage Entrepreneurial Activity (TEA) (%)	
Indicator	Percentage of population aged 18-64 who are either a nascent entrepreneur or owner-manager of a new enterprise (less than 3.5 years old)[15]
Calculated as	Average for the years 2020 to 2024
Data source	Global Entrepreneurship Monitor

FDI net inflows (% GDP)	
Indicator	Foreign direct investment, net inflows (% of GDP)
Unit	Average percentage share for the years 2021 to 2023
Data source	World Bank (World Development Indicators) - Series name: BX.KLT.DINV.WD.GD.ZS

Top R&D spending enterprises per 10 million population	
Numerator	Number of enterprises in the top 2500 enterprises investing the largest sums in R&D in the world
Denominator	Population
Calculated as	Average number for the years 2021 to 2023
Data source	European Commission (IPTS) - The EU Industrial R&D Investment Scoreboard

Buyer sophistication (1 to 7 best)	
Indicator	Average response to the following question: “In your country, on what basis do buyers make purchasing decisions? [1 = based solely on the lowest price; 7 = based on sophisticated performance attributes]”
Calculated as	Average number for the years 2018 to 2020
Data source	World Economic Forum, Global Competitiveness Report

Innovation profiles

In-house product innovators with market novelties	
Indicator	This group includes all enterprises that introduced a product innovation that was developed

[15] Total Entrepreneurial Activity (TEA) is explained in detail at http://www.gemconsortium.org/wiki/1176

In-house product innovators with market novelties	
	by the enterprise and that was not previously offered by competitors (‘new to the market’).
Calculated as	Enterprises are identified based on a combination of different questions in the CIS 2020. Full details are available in the following document: https://circabc.europa.eu/ui/group/47133480-29c1-4c23-9199-%2072a631f4fd96/library/be99ed75-c7ab-4119-804c-42867652481c
Data source	Eurostat and National Statistical Offices
In-house product innovators without market novelties	
Indicator	This group includes all enterprises that introduced a product innovation that was developed by the enterprise but that is identical or very similar to products already offered by competitors (‘only new to the enterprise itself’).
Unit	
Calculated as	Enterprises are identified based on a combination of different questions in the CIS 2020. Full details are available in the following document: https://circabc.europa.eu/ui/group/47133480-29c1-4c23-9199-%2072a631f4fd96/library/be99ed75-c7ab-4119-804c-42867652481c
Data source	Eurostat and National Statistical Offices

In-house business process innovators	
Indicator	This group includes all enterprises that did not introduce a product innovation, but that did introduce a business process innovation that was developed by the enterprise.
Calculated as	Enterprises are identified based on a combination of different questions in the CIS 2020. Full details are available in the following document: https://circabc.europa.eu/ui/group/47133480-29c1-4c23-9199-%2072a631f4fd96/library/be99ed75-c7ab-4119-804c-42867652481c
Data source	Eurostat and National Statistical Offices

Innovators that do not develop innovations themselves	
Indicator	This group includes all enterprises that introduced an innovation of any kind but did not develop it themselves (enterprises without significant own innovation capabilities).
Calculated as	Enterprises are identified based on a combination of different questions in the CIS 2020. Full details are available in the following document: https://circabc.europa.eu/ui/group/47133480-29c1-4c23-9199-%2072a631f4fd96/library/be99ed75-c7ab-4119-804c-42867652481c
Data source	Eurostat and National Statistical Office

Innovation active non-innovators	
Indicator	This group includes all enterprises that did not introduce any innovation but that either had ongoing or abandoned innovation activities.
Calculated as	Enterprises are identified based on a combination of different questions in the CIS 2020. Full details are available in the following document: https://circabc.europa.eu/ui/group/47133480-29c1-4c23-9199-%2072a631f4fd96/library/be99ed75-c7ab-4119-804c-42867652481c
Data source	Eurostat and National Statistical Office

Non-innovators with potential to innovate	
Indicator	This group includes all enterprises that did not introduce any innovation, and which had no ongoing or abandoned innovation activities but that did consider to innovate.
Calculated as	Enterprises are identified based on a combination of different questions in the CIS 2020. Full details are available in the following document: https://circabc.europa.eu/ui/group/47133480-29c1-4c23-9199-%2072a631f4fd96/library/be99ed75-c7ab-4119-804c-42867652481c
Data source	Eurostat and National Statistical Office

Non-innovators without disposition to innovate	
Indicator	This group includes all other enterprises, those that neither introduced an innovation nor had any ongoing or abandoned innovation activities nor considered to innovate.
Calculated as	Enterprises are identified based on a combination of different questions in the CIS 2020. Full details are available in the following document: https://circabc.europa.eu/ui/group/47133480-29c1-4c23-9199-%2072a631f4fd96/library/be99ed75-c7ab-4119-804c-42867652481c
Data source	Eurostat and National Statistical Office

Governance and policy framework

Corruption Perceptions Index (0 to 100 best)	
Indicator	Corruption Perceptions Index is a composite index based on a combination of surveys and assessments of corruption from 13 different sources and scores and ranks countries based on how corrupt a country's public sector is perceived to be, with a score of 0 representing a very high level of corruption and a score of 100 representing a very clean country.
Calculated as	Average for the years 2021 to 2023
Data source	Eurostat SDG indicator set

Basic-school entrepreneurial education and training (1 to 5 best)	
Indicator	The indicator measures the extent to which training in creating or managing SMEs is incorporated within the education and training system at primary and secondary school levels.
Calculated as	Average for the years 2020 to 2024
Data source	Global Entrepreneurship Monitor

Government procurement of advanced technology products (1 to 7 best)	
Indicator	The indicator measures the extent to which government procurement decisions in a country foster technological innovation by providing the average response to the following question: "Government purchase decisions for the procurement of advanced technology products are (1 = based solely on price, 7 = based on technical performance and innovativeness)"
Calculated as	Average for the years 2018 to 2020
Data source	World Economic Forum

Rule of law (-2.5 to 2.5 best)	
Indicator	Rule of law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.
Calculated as	Average for the years 2020 to 2022
Data source	Worldwide Governance Indicators

Climate change

Circular material use rate	
Indicator	The circular material use is defined as the ratio of the circular use of materials to the overall material use. IT measures the share of material recovered and fed back into the economy - thus saving extraction of primary raw materials - in overall material use. The overall material use is measured by summing up the aggregate domestic material consumption (DMC) and the circular use of materials. DMC is defined in economy-wide material flow accounts. The circular use of materials is approximated by the amount of waste recycled in domestic recovery plants minus imported waste destined for recovery plus exported waste destined for recovery abroad. Waste recycled in domestic recovery plants comprises the recovery operations R2 to R11 - as defined in the Waste Framework Directive 75/442/EEC. The imports and exports of waste destined for recycling - i.e. the amount of imported and exported waste bound for recovery – are approximated from the European statistics on international trade in goods. A higher circularity rate value indicates means that more secondary materials substitute for primary raw materials thus reducing the environmental impacts of extracting primary material. (https://ec.europa.eu/eurostat/web/products-datasets/-/cei_srm030)
Calculated as	Average for the years 2020 to 2024
Data source	Eurostat

Greenhouse gas emissions intensity of energy consumption	
Indicator	The indicator is part of the EU Sustainable Development Goals (SDG) indicator set. It is used to monitor progress towards Goal 13 on climate action and SDG 7 on affordable and clean energy. SDG 13 aims to implement the commitment to the United Nations Framework Convention on Climate Change and operationalise the Green Climate Fund. It aims to strengthen countries' resilience and adaptive capacity to climate-related hazards and natural disasters by integrating climate change mitigation and adaptation measures into national strategies, policies and planning. SDG 7 calls for ensuring universal access to modern energy services, improving energy efficiency and increasing the share of renewable energy.
Calculated as	The indicator is calculated as the ratio between energy related GHG emissions and gross inland consumption of energy. It expresses how many tonnes CO2 equivalents of energy related GHGs are being emitted in a certain economy per unit of energy that is being consumed. The data on energy emissions are being sourced from the GHG emissions reported to the UNFCCC.

Greenhouse gas emissions intensity of energy consumption	
	Average for the years 2019 to 2021
Data source	European Environment Agency (EEA), Eurostat

Eco-Innovation Index	
Indicator	The Eco-Innovation Index shows how well individual Member States perform in eco-innovation compared to the EU average, which is equated with 100 (index EU=100). The index complements other measurement approaches of innovativeness of EU countries and aims to promote a holistic view on economic, environmental and social performance.
Calculated as	The indicator is based on 16 sub-indicators from eight contributors in five thematic areas: eco-innovation inputs, eco-innovation activities, eco-innovation outputs, resource efficiency outcomes and socio-economic outcomes. The overall score of an EU Member State is calculated by the unweighted mean of the 16 sub- indicators.
Data source	European Commission: 2022 Eco-Innovation Scoreboard https://ec.europa.eu/environment/ecoap/indicators/index_en

Demography

Population size	
Indicator	Population on 1 January
Calculated as	Average value for the years 2021 to 2023
Data source	Eurostat: Population data

Average annual population growth (%)	
Indicator	Population on 1 January
Calculated as	Average annual growth rate between 2021 to 2023
Data source	Eurostat: Population data

Population density	
Indicator	Inhabitants per km2
Calculated as	Average value for the years 2020 to 2022
Data source	Eurostat

5.2. Contextual indicators: Global economic competitors

For international benchmarking, a comparable list of contextual indicators has been used from various data sources. The list of contextual indicators used in the international comparison, the years for which average performance has been calculated, and the data sources used are shown in Table 9.

Table 9 Contextual indicators in the international comparison – Global competitors

Contextual indicator	Period	Source
Performance and structure of the economy		
GDP per capita, PPP (international dollars)	Average 2020-2022	World Bank - World Development Indicators
Average annual GDP growth (%)	2020-2022	World Bank - World Development Indicators
Employment share in Agriculture (%)	Average 2020-2022	World Bank - World Development Indicators
Employment share in Industry (%)	Average 2020-2022	World Bank - World Development Indicators
Employment share in Services (%)	Average 2020-2022	World Bank - World Development Indicators
Manufacturing – share in total value-added (note: Value added data are used as employment data are not available)	Average 2020-2022	World Bank - World Bank national accounts data and OECD National Accounts data files
Business and entrepreneuship		
Total early-stage Entrepreneurial Activity (TEA) (%)	Average 2021-2023	Global Entrepreneurship Monitor
FDI net inflows (% GDP)	Average 2020-2022	World Development Indicators
Top R&D spending enterprises per 10 million population	Average 2020-2022	EU Industrial R&D Investment Scoreboard
Top R&D spending enterprises, average R&D spending, million Euros	Average 2020-2022	EU Industrial R&D Investment Scoreboard
Number of Unicorns	March 2024	CBS Insights: https://www.cbinsights.com/research-unicorn-companies
Buyer sophistication (1 to 7 best)	Average 2015-2017	World Economic Forum
Goverance and policy framework		
Corruption perception index	Average 2021-2023	Transparency International
Ease of starting a business (0 to 100 best)	Average 2018-2020	World Bank - Doing Business
Basic-school entrepreneurial education and training (1 to 5 best)	Average 2021-2023	Global Entrepreneurship Monitor
Government procurement of advanced technology products (1 to 7 best)	Average 2015-2017	World Economic Forum
Rule of law (-2.5 to 2.5 best)	Average 2020-2022	World Bank - Worldwide Governance Indicators
Demography		
Population size (millions)	Average 2020-2022	World Bank - World Development Indicators
Average annual population growth (%)	2020-2022	World Bank - World Development Indicators
Population density (inhabitants / km2)	Average 2019-2021	World Bank - World Development Indicators

Perfomance and structure of the economy

GDP per capita (PPP)	
Indicator	GDP per capita, PPP (current international $)
Calculated as	Average value for the years 2020 to 2022
Data source	World Bank (World Development Indicators) - Series name: NY.GDP.PCAP.PP.CD

Average annual GDP growth (%)	
Indicator	GDP per capita (constant 2011 US$)
Calculated as	Average annual growth rate between 2020 to 2024
Data source	World Bank (World Development Indicators) - Series name: NY.GDP.MKTP.KD

Employment share in Agriculture (%)	
Indicator	Employment in agriculture (% of total employment)
Calculated as	Average percentage share for the years 2020 to 2022
Data source	World Bank (World Development Indicators) - Series name: SL.AGR.EMPL.ZS

Employment share in Industry (%)	
Indicator	Employment in industry (% of total employment)
Calculated as	Average percentage share for the years 2020 to 2022
Data source	World Bank (World Development Indicators) - Series name: SL.IND.EMPL.ZS

Employment share in Services (%)	
Indicator	Employment in services (% of total employment)
Calculated as	Average percentage share for the years 2020 to 2022
Data source	World Bank (World Development Indicators) - Series name: SL.SRV.EMPL.ZS

Manufacturing – share in total value added (%)	
Indicator	Value added in manufacturing, million US$
Denominator	Gross domestic product, million US$
Calculated as	Average percentage share for the years 2020 to 2022
Data source	United Nations Industrial Development Organization (UNIDO)

Business and entrepreneurship

Total early-stage Entrepreneurial Activity (TEA) (%)	
Indicator	Percentage of population aged 18-64 who are either a nascent entrepreneur or owner-manager of a new enterprise (less than 3.5 years old)[16]
Calculated as	Average for the years 2021 to 2023
Data source	Global Entrepreneurship Monitor

FDI net inflows (% GDP)	
Indicator	Foreign direct investment, net inflows (% of GDP)
Calculated as	Average percentage share for the years 2020 to 2022
Data source	World Bank (World Development Indicators) – Series name: BX.KLT.DINV.WD.GD.ZS

Top R&D spending enterprises per 10 million population	
Indicator	Number of enterprises in the top 2500 enterprises investing the largest sums in R&D in the world
Data source	European Commission (IPTS) - The EU Industrial R&D Investment Scoreboard
Calculated as	Average number for the years 2020 to 2024
Denominator	Population
Data source	World Bank: World Development Indicators

Top R&D spending enterprises, average R&D spending, million Euros	
Indicator	Average R&D spending per enterprise listed in the top 2500 enterprises investing the largest sums in R&D in the world
Calculated as	Average number for the years 2020 to 2024
Data source	European Commission (IPTS) - The EU Industrial R&D Investment Scoreboard

Number of Unicorns	
Indicator	A unicorn is a private start-up company which, over time, has been valued at $1 billion or more
Calculated as	Total number of Unicorns listed March 2024
Data source	CB Insights: https://www.cbinsights.com/research-unicorn-companies

[16] Total Entrepreneurial Activity (TEA) is explained in detail at http://www.gemconsortium.org/wiki/1176

Buyer sophistication (1 to 7 best)	
Indicator	Average response to the following question: “In your country, on what basis do buyers make purchasing decisions? [1 = based solely on the lowest price; 7 = based on sophisticated performance attributes]”
Calculated as	Average number for the years 2015 to 2017
Data source	World Economic Forum, Global Competitiveness Report

Governance and policy framework

Corruption Perceptions Index (0 to 100 best)	
Indicator	Corruption Perceptions Index is a composite index based on a combination of surveys and assessments of corruption from 13 different sources and scores and ranks countries based on how corrupt a country’s public sector is perceived to be, with a score of 0 representing a very high level of corruption and a score of 100 representing a very clean country.
Calculated as	Average for the years 2021 to 2023
Data source	Transparency International

Basic-school entrepreneurial education and training (1 to 5 best)	
Indicator	The indicator measures the extent to which training in creating or managing SMEs is incorporated within the education and training system at primary and secondary school levels.
Calculated as	Average for the years 2021 to 2023
Data source	Global Entrepreneurship Monitor

Government procurement of advanced technology products (1 to 7 best)	
Indicator	The indicator measures the extent to which government procurement decisions in a country foster technological innovation by providing the average response to the following question: “Government purchase decisions for the procurement of advanced technology products are (1 = based solely on price, 7 = based on technical performance and innovativeness)”
Calculated as	Average for the years 2015 to 2017
Data source	World Economic Forum

Rule of law (-2.5 to 2.5 best)	
Indicator	Rule of law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.
Calculated as	Average for the years 2020 to 2022
Data source	World Bank: Worldwide Governance Indicators

Demography

Population size	
Indicator	Population on 1 January
Unit	Average value for the years 2020 to 2022
Data source	World Bank (World Development Indicators) - Series name: SP.POP.TOTL

Average annual population growth (%)	
Indicator	Population on 1 January
Calculated as	Average annual growth rate between 2020 to 2022
Data source	World Bank (World Development Indicators) - Series name: SP.POP.TOTL

Population density	
Indicator	Population density (people per sq. km of land area)
Calculated as	Average value for the years 2019 to 2021
Data source	World Bank (World Development Indicators) - Series name: EN.POP.DNST

Annex A Manual for extracting and compiling EIS data

This Annex describes how raw data have been collected for each indicator.

For data from Eurostat, the variable names are added between [ ]. These can be used in the search box on Eurostat's website (https://ec.europa.eu/eurostat/web/main/home) to access the data.

Data from the OECD are available at: https://data-explorer.oecd.org/

Data on exports from UN Comtrade are available at: https://comtradeplus.un.org/

Data from UNESCO are available at: http://data.uis.unesco.org/

Data from the World Bank are available at: https://databank.worldbank.org/

1.1.1 New doctorate graduates in science, technology, engineering and mathematics (STEM) per 1000 population aged 25-34

Data for EU Member States and other European countries are extracted from Eurostat:

- Dataset: Graduates at doctoral level, in science, math., computing, engineering, manufacturing, construction, by sex - per 1000 of population aged 25-34 [educ_uoe_grad07]:
    - SEX: Total
    - UNIT: Per thousand inhabitants
- Data are available for 2013-2022.

Data for Moldova have been made available by the National Bureau of Statistics of the Republic of Moldova. Data are available for 2015-2023.

Data for Bosnia and Herzegovina, Montenegro and Ukraine was taken from the EIS 2023, which used data from UNESCO UIS, which has since been discontinued.

1.1.2 Percentage population aged 25-34 having completed tertiary education

Data for EU Member States and other European countries are extracted from Eurostat:

- Dataset: Population by educational attainment level, sex and age (%) - main indicators [edat_lfse_03]:
    - AGE: From 25 to 34 years
    - ISCED11: Tertiary education (levels 5-8)
    - SEX: Total
    - UNIT: Percentage
- Data are available for 2002-2023.
- For all EU Member States and other European countries for which data are available for 2021, these data are flagged by Eurostat as a break in time series. None of the data before 2021 is used and all values for the years before 2021 are replaced by the value for 2021.

Data for Albania have been made available by the Institute of Statistics of Albania (INSTAT). Data are available for 2014-2022.

Data for Moldova have been made available by the National Bureau of Statistics of the Republic of Moldova. Data are available for 2015-2022.

Data are not available for Ukraine.

1.1.3 Percentage population aged 25-64 participating in lifelong learning

Data for EU Member States and other European countries are extracted from Eurostat:

- Dataset: Participation rate in education and training (last 4 weeks) by sex and age [trng_lfs_01]:
    - AGE: From 25 to 64 years
    - SEX: Total
    - UNIT: Percentage
- Data are available for 2004-2022.

- For all EU Member States and other European countries for which data are available for 2021, these data are flagged by Eurostat as a break in time series. None of the data before 2021 is used and all values for the years before 2021 are replaced by the value for 2021.

Data for Albania have been made available by the Institute of Statistics of Albania (INSTAT). Data are available for 2017.

Data for Moldova have been made available by the National Bureau of Statistics of the Republic of Moldova. Data are available for 2015-2022.

Data for Ukraine are not available.

1.2.1 International scientific co-publications per million population

Data on number of international scientific co-publications for all countries are calculated and made available by Science-Metrix for the years 2010-2023. Data have been calculated using full counting and have been extracted from Scopus.

Population data for EU Member States and other European countries are extracted from Eurostat:

- Dataset: Population on 1 January by age and sex [demo_pjan]:
  - AGE: Total
  - SEX: Total
  - UNIT: Number

Population data for all years for Bosnia and Herzegovina and from 2021 onwards for the United Kingdom are extracted from the World Development Indicators of the World Bank:

- Dataset: Population, total – SP.POP.TOTL

The indicator is calculated by dividing the number of international scientific co-publications by the population size in millions.

Data are available for 2010-2023.

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

Data on the percentage share of publications among the top 10% most cited publications for all countries are calculated and made available by Science-Metrix for the years 2010-2021. Data have been calculated using fractional counting and have been extracted from Scopus.

Data are available for 2010-2021.

1.2.3 Foreign doctorate students as a percentage of all doctorate students.

Data for EU Member States and other European countries are extracted from Eurostat:

- For the numerator, the following data are extracted:

  Dataset: Mobile students from abroad enrolled by education level, sex and field of education [educ_uoe_mobs01]:
  - ISCED11: Doctoral or equivalent level
  - ISCEDF13: Total
  - Sex: Total
  - Unit: Number
- For the denominator, the following data are extracted:

  Dataset: Pupils and students enrolled by education level, sex and field of education [educ_uoe_enra03]:
  - ISCED11: Doctoral or equivalent level
  - ISCEDF13: Total
  - Sex: Total
  - Unit: Number
- The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by 100.

- Data are available for 2013-2022.

Data for Albania have been made available by the Institute of Statistics of Albania (INSTAT). Data are available for 2018-2022.

Data for Moldova have been made available by the National Bureau of Statistics of the Republic of Moldova. Data are available for 2015-2023.

Data for Ukraine have been made available by the State Statistics Service of Ukraine. Data are available for 2017-2023.

Data for Montenegro was taken directly from EIS 2023, for which it was provided by the Statistical Office of Montenegro (MONSTAT).

Data are not available for Bosnia and Herzegovina.

1.3.1 Broadband penetration

Data for EU Member States and other European countries are extracted from Eurostat:

- Dataset: Type of connections to the internet by NACE Rev.2 activity [isoc_ci_it_en2]:
  - INDIC_IS: The maximum contracted download speed of the fastest fixed line internet connection is at least 100 Mb/s
  - NACE_R2: All activities (except agriculture, forestry and fishing, and mining and quarrying), without financial sector
  - UNIT: Percentage of enterprises
- Data are available for 2020-2023.
- Note that data used from the same data source up to the year 2020 for previous versions of the EIS are no longer comparable to the data currently available from 2021 onwards. On average the difference between the new time series starting in 2021 and the previous time series ending in 2020 is a ratio of 2 between the new 2021 values and the old 2020 values.

Data for Moldova have been made available by the National Bureau of Statistics of the Republic of Moldova. Data are available for 2021-2022.

Data for Ukraine have been made available by the State Statistics Service of Ukraine. Data are available for 2018-2019 and 2021.

Data are not available for Iceland and Switzerland.

1.3.2 Individuals who have above basic overall digital skills (share of population)

Data for EU Member States and other European countries are extracted from Eurostat:

- Dataset: Individuals' level of digital skills (from 2021 onwards) [isoc_sk_dskl_i21]:
  - IND_TYPE: All Individuals
  - INDIC_IS: Individuals with above basic overall digital skills (all five component indicators are at above basic level)
  - UNIT: Percentage of individuals
- Data are available for 2021 and 2023.
- Note that data used from the same data source (Individuals' level of digital skills [isoc_sk_dskl_i] (until 2019)) up to the year 2019 for previous versions of the EIS are no longer comparable to the data currently available from 2021 onwards. On average the difference between the new time series starting in 2021 and the previous time series ending in 2019 is a ratio of one-third between the new 2021values and the 2019 values.

Data are not available for Moldova, Ukraine and United Kingdom.

2.1.1 R&D expenditure in the public sector (percentage of GDP)

Data for EU Member States and other European countries are extracted from Eurostat:

- Dataset: Gross domestic expenditure on R&D (GERD) by sector of performance [rd_e_gerdtot]:
  - For the government sector:
    - SECTPERF: Government sector

        - UNIT: Percentage of gross domestic product (GDP)
    - For the higher education sector:
        - SECTPERF: Higher education sector
        - UNIT: Percentage of gross domestic product (GDP)

- The indicator is calculated as the sum of the share of R&D expenditure by the government as a percentage of GDP and of the share of R&D expenditure by the higher education sector as a percentage of GDP.
- Data are available for 2010-2022.

Data for Moldova have been made available by the National Bureau of Statistics of the Republic of Moldova. Data are available for 2015-2022.

Data for Ukraine have been made available by the State Statistics Service of Ukraine. Data are available for 2021-2022.

Data are not available for Albania.

2.1.2 Venture capital expenditures (percentage of GDP)

Data on venture capital expenditures for EU Member States and other European countries are collected from Invest Europe / EDC and Eurostat:

- Invest Europe / EDC has made available data on 'Equity investments according to the country of the portfolio company' (Table 27). Data for the numerator are calculated as the difference between 'Total equity investment' and 'Buyout'.
- Data are available for 2009-2023.

Data on Gross Domestic Product for most EU Member States and other European countries are extracted from Eurostat:

- Dataset: GDP and main components (output, expenditure and income) [nama_10_gdp]:
    - NA_ITEM: Gross domestic product at market prices
    - UNIT: Current prices, million euro

Data on Gross Domestic Product for all years for Ukraine, and from 2020 onwards for the United Kingdom are extracted from the World Bank Development Indicators of the World Bank:

- Dataset: GDP, PPP (current international $) NY.GDP.MKTP.CD
    - GDP (current US$)
    - GDP (current LCU)
- Data are converted into Euros using the Euro-US$ exchange rate calculated by using the same data in current US$ and current LCU for one of the Eurozone countries

For all countries, venture capital expenditures as a share of GDP is then calculated as venture capital expenditures divided by GDP multiplied by 100.

The indicator is calculated as a three-year unweighted average:

- 2017 as the unweighted average of the percentage shares for 2015-2017
- 2018 as the unweighted average of the percentage shares for 2016-2018
- 2019 as the unweighted average of the percentage shares for 2017-2019
- 2020 as the unweighted average of the percentage shares for 2018-2020
- 2021 as the unweighted average of the percentage shares for 2019-2021
- 2022 as the unweighted average of the percentage shares for 2020-2022
- 2023 as the unweighted average of the percentage shares for 2021-2023

Data are not available for Albania.

2.1.3 Direct government funding and government tax support for business R&D (percentage of GDP)

Data for EU Member States and other European countries are collected from the OECD:

- Source: OECD R&D Tax Incentives Database. R&D tax expenditure and direct government funding of BERD. Last consulted in April 2024.
    - Measure: Government budget allocations for R&D (GBARD) and Government-financed BERD.
    - Unit of measure: Percentage of GDP.
- The indicator is calculated as the sum of the government budget allocations for R&D (GBARD) as a percentage of GDP and of the government-financed BERD as a percentage of GDP.
- Data are available for 2010-2021.

Data for Bosnia and Herzegovina, North Macedonia, Montenegro and Serbia are collected from Eurostat:

- Dataset: GERD by sector of performance and source of funds [rd_e_gerdfund]:
    - SECTFUND: Government sector
    - SECTPERF: Business enterprise sector
    - UNIT: Percentage of gross domestic product (GDP)
- Data are available for 2010-2021.

Data for Moldova have been made available by the National Bureau of Statistics of the Republic of Moldova. Data are available for 2017-2018.

Data for Ukraine have been made available by the State Statistics Service of Ukraine. Data are available for 2021.

Data are not available for Albania.

2.2.1 R&D expenditure in the business sector (percentage of GDP)

Data for EU Member States and other European countries are extracted from Eurostat:

- Dataset: Gross domestic expenditure on R&D (GERD) by sector of performance [rd_e_gerdtot]:
    - SECTPERF: Business enterprises sector
    - UNIT: Percentage of gross domestic product (GDP)
- Data are available for 2010-2022.

Data for Moldova have been made available by the National Bureau of Statistics of the Republic of Moldova. Data are available for 2015-2018.

Data for Ukraine have been made available by the State Statistics Service of Ukraine. Data are available for 2021-2022.

Data are not available for Albania.

2.2.2 Non-R&D innovation expenditures (percentage of turnover)

Data for EU Member States and other European countries are extracted from Eurostat:

- Data from the Community Innovation Survey CIS 2020 for 2020:
    - Numerator: Enterprises and expenditure of enterprises on innovation activities by area of expenditure, NACE Rev. 2 activity and size class [inn_cis12_exp]:
        - EXPEND: Expenditure on innovation (excluding R&D)
        - INDIC_INN: Expenditure in 2020
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: Total
        - UNIT: Thousand euro
    - Denominator: Enterprises, employed persons and turnover by type of enterprise, NACE Rev. 2 activity and size class [inn_cis12_bas]:
        - ENTERPR: Total
        - INDIC_INN: Turnover in 2020
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)

        - SIZECLAS: Total
        - UNIT: Thousand euro
    - The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by 100.
    - The EU aggregate is calculated using only data for those Member States for which both numerator and denominator data are available.

- Data from the Community Innovation Survey CIS 2018 for 2018:
    - Numerator: Expenditures of enterprises by area of expenditure, NACE Rev. 2 activity and size class [inn_cis11_exp]:
        - ENTERPR: Total
        - EXPEND: Expenditure on innovation (excluding R&D)
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: Total
        - UNIT: Thousand euro
    - Denominator: Enterprises, employed persons and turnover by type of enterprise, NACE Rev. 2 activity and size class [inn_cis11_bas]:
        - ENTERPR: Total
        - INDIC_INN: Turnover in 2018
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: Total
        - UNIT: Thousand euro
    - The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by 100.
    - The EU aggregate is calculated using only data for those Member States for which both numerator and denominator data are available.

- Data from the Community Innovation Survey CIS 2016 for 2016:
    - Numerator: Expenditures in product and/or process innovative enterprises by area of expenditure, NACE Rev. 2 activity and size class [inn_cis10_exp]:
        - EXPEND: Expenditure on innovation (excluding R&D); Acquisition of machinery, equipment and software; Acquisition of other external knowledge
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: Total
        - UNIT: Thousand euro

      The numerator is calculated as the sum of the expenditure on innovation, the acquisition of machinery, equipment and software, and the acquisition of other external knowledge.
    - Denominator: Basic economic information on the enterprises by NACE Rev. 2 activity and size class [inn_cis10_bas]:
        - ENTERPR: Total
        - INDIC_INN: Turnover in 2016
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: Total
        - UNIT: Thousand euro
    - The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by 100.
    - The EU aggregate is calculated using only data for those Member States for which both numerator and denominator data are available.

- Data from the Community Innovation Survey CIS 2014 for 2014:
  - Numerator: Innovation activities and expenditures in the enterprises by NACE Rev. 2 activity and size class [inn_cis9_exp]:
    - INDIC_INN: Total innovation expenditures in 2014; Expenditures in in-house R&D in 2014; Expenditures in external R&D in 2014
    - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
    - SIZECLAS: Total
    - UNIT: Thousand euro

    The numerator is calculated as the difference between total innovation expenditures in 2014 and total R&D expenditures (the sum of expenditures in in-house R&D in 2014 and expenditures in external R&D in 2014).
  - Denominator: Basic economic information on the enterprises by NACE Rev. 2 activity and size class [inn_cis9_bas]:
    - INDIC_INN: Turnover in 2014
    - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
    - SIZECLAS: Total
    - TYPE_INN: Total
    - UNIT: Thousand euro
  - The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by 100.
  - The EU aggregate is calculated using only data for those Member States for which both numerator and denominator data are available.

In addition, the following data have been used/extracted:

- Data for Albania have been made available by the Institute of Statistics of Albania (INSTAT). Data are available for 2018-2020.
- Data for Moldova have been made available by the National Bureau of Statistics of the Republic of Moldova. Data are available for 2016-2022.
- Data for the United Kingdom have been made available by the Department for Business & Trade of the United Kingdom. Data are available for 2020.
- Data for Bosnia and Herzegovina, and Ukraine were taken directly from the EIS 2023, for which they were provided by the respective national statistics institutes of these countries.

Data are not available for Switzerland.

2.2.3 Innovation expenditure per person employed

Data for EU Member States and other European countries are extracted from Eurostat:

- Data from the Community Innovation Survey CIS 2020 for 2020:
  - Numerator: Enterprises and expenditure of enterprises on innovation activities by area of expenditure, NACE Rev. 2 activity and size class [inn_cis12_exp]:
    - EXPEND: Expenditure on innovation (including R&D)
    - INDIC_INN: Expenditure in 2020
    - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
    - SIZECLAS: Total
    - UNIT: Thousand euro
  - Denominator: Enterprises, employed persons and turnover by type of enterprise, NACE Rev. 2 activity and size class [inn_cis12_bas]:
    - ENTERPR: Total
    - INDIC_INN: Employed persons in 2020
    - NACE_R2: Innovation core activities (Com.Reg. 995/2012)

        - SIZECLAS: Total
        - UNIT: Number
    - The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by 100.
    - The EU aggregate is calculated using only data for those Member States for which both numerator and denominator data are available.

- Data from the Community Innovation Survey CIS 2018 for 2018:
    - Numerator: Expenditures of enterprises by area of expenditure, NACE Rev. 2 activity and size class [inn_cis11_exp]:
    - ENTERPR: Total
        - EXPEND: Expenditure on innovation (including R&D)
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: Total
        - UNIT: Thousand euro
    - Denominator: Enterprises, employed persons and turnover by type of enterprise, NACE Rev. 2 activity and size class [inn_cis11_bas]:
        - ENTERPR: Total
        - INDIC_INN: Employed persons in 2018
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: Total
        - UNIT: Number
    - Purchasing Power Standards (PPPs): GDP and main components (output, expenditure and income) [nama_10_gdp]:
        - NA_ITEM: Gross domestic product at market prices
        - UNIT: Current prices, million purchasing power standards (PPS, EU27 from 2020); Current prices, million euro

      PPPs are calculated as the ratio between Current prices, million purchasing power standards (PPS, EU27 from 2020) and Current prices, million euro.
    - The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by the value for PPP.
    - The EU aggregate is calculated using only data for those Member States for which both numerator and denominator data are available.

- Data from the Community Innovation Survey CIS 2016 for 2016:
    - Numerator: Expenditures in product and/or process innovative enterprises by area of expenditure, NACE Rev. 2 activity and size class [inn_cis10_exp]:
        - EXPEND: Expenditure on innovation (including R&D)
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: Total
        - UNIT: Thousand euro
    - Denominator: Basic economic information on the enterprises by NACE Rev. 2 activity and size class [inn_cis10_bas]:
        - ENTERPR: Total
        - INDIC_INN: Employees in 2016
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: Total

        - UNIT: Number
    - Purchasing Power Standards (PPPs): GDP and main components (output, expenditure and income) [nama_10_gdp]:
        - NA_ITEM: Gross domestic product at market prices
        - UNIT: Current prices, million purchasing power standards (PPS, EU27 from 2020); Current prices, million euro

      PPPs are calculated as the ratio between Current prices, million purchasing power standards (PPS, EU27 from 2020) and Current prices, million euro.
    - The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by the value for PPP.
    - The EU aggregate is calculated using only data for those Member States for which both numerator and denominator data are available.

- Data from the Community Innovation Survey CIS 2014 for 2014:
    - Numerator: Innovation activities and expenditures in the enterprises by NACE Rev. 2 activity and size class [inn_cis9_exp]:
        - INDIC_INN: Total innovation expenditures in 2014
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: Total
        - UNIT: Thousand euro
    - Denominator: Basic economic information on the enterprises by NACE Rev. 2 activity and size class [inn_cis9_bas]:
        - INDIC_INN: Total number of employees in 2014
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: Total
        - TYPE_INN: Total
        - UNIT: Number
    - Purchasing Power Standards (PPPs): GDP and main components (output, expenditure and income) [nama_10_gdp]:
        - NA_ITEM: Gross domestic product at market prices
        - UNIT: Current prices, million purchasing power standards (PPS, EU27 from 2020); Current prices, million euro

      PPPs are calculated as the ratio between Current prices, million purchasing power standards (PPS, EU27 from 2020) and Current prices, million euro.
    - The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by the value for PPP.
    - The EU aggregate is calculated using only data for those Member States for which both numerator and denominator data are available.

In addition, the following data have been used/extracted:

- Data for Moldova have been made available by the National Bureau of Statistics of the Republic of Moldova. Data are available for 2016-2022.
- Data for Bosnia and Herzegovina, Montenegro, North Macedonia, Serbia, UK from EIS 2023? Absent in raw_score, present in final_score

Data are not available for Albania, Switzerland and Ukraine.

2.3.1 Enterprises providing training to develop or upgrade ICT skills of their personnel

Data for EU Member States and other European countries are extracted from Eurostat:

- Dataset: Enterprises that provided training to develop/upgrade ICT skills of their personnel [isoc_ske_ittn2]:

    - INDIC_IS: Enterprise provided training to their personnel to develop their ICT skills
    - NACE_R2: All activities (except agriculture, forestry and fishing, and mining and quarrying), without financial sector
    - UNIT: Percentage of enterprises
- Data are available for 2012-2020 and 2022.

Data for Albania have been made available by the Institute of Statistics of Albania (INSTAT). Data are available for 2023.

Data for Ukraine from EIS 2023? Absent in raw_score, present in final_score

Data are not available for Iceland, Moldova and Switzerland.

2.3.2 ICT specialists (percentage of total employment)

Data for EU Member States and other European countries are extracted from Eurostat:

- Dataset: Employed ICT specialists - total [isoc_sks_itspt]:
    - UNIT: Percentage of total employment
- Data are available for 2004-2023.
- For all EU Member States and other European countries for which data are available for 2021, these data are flagged by Eurostat as a break in time series. None of the data before 2021 is used and all values for the years before 2021 are replaced by the value for 2021
- For EU Member States and other European countries for which 2020 is the most recent year for which data are available, none of the data before 2020 is used and all values for the years before 2020 are replaced by the value for 2020.

Data for Albania have been made available by the Institute of Statistics of Albania (INSTAT). Data are available for 2018-2022.

Data for Moldova have been made available by the National Bureau of Statistics of the Republic of Moldova. Data are available for 2015-2022.

Data are not available for Ukraine.

3.1.1 SMEs introducing product innovation (percentage of SMEs)

Data for EU Member States and other European countries are extracted from Eurostat:

- Data from the Community Innovation Survey CIS 2022- Fast track:
    - Numerator:
        - TYPE_ENT: INNO_PRD
        - INDICATOR: ENT
        - ACTIVITY: _T
        - NUMBER_EMPL: E10T49 + E50T249
    - Denominator:
        - TYPE_ENT: _T
        - INDICATOR: ENT
        - ACTIVITY: _T
        - NUMBER_EMPL: E10T49 + E50T249
    - The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by 100.
    - The CIS 2022 data was available for Bulgaria, Czechia, Germany, Estonia, Greece, Spain, Finland, France, Hungary, Ireland, Italy, Latvia, Lithuania, Montenegro, Malta, Portugal, Romania, Serbia, Slovenia, Slovakia, Sweden and Türkiye. For all other countries, data was imputed using 2020 data, where possible.

- Data from the Community Innovation Survey CIS 2020 for 2020:

- Numerator: Enterprises, employed persons and turnover by type of enterprise, NACE Rev. 2 activity and size class (inn_cis12_bas). Sum of the following 2 data extractions:
  - ENTERPR: Product innovative enterprises (regardless of any other type of innovation)
  - INDIC_INN: Enterprises in the population in 2020
  - NACE_R2 Innovation core activities (Com.Reg. 995/2012)
  - SIZECLAS: From 10 to 49 employees
  - UNIT: Number

  - ENTERPR: Product innovative enterprises (regardless of any other type of innovation)
  - INDIC_INN: Enterprises in the population in 2020
  - NACE_R2 Innovation core activities (Com.Reg. 995/2012)
  - SIZECLAS: From 50 to 249 employees
  - UNIT: Number
- Denominator: Enterprises, employed persons and turnover by type of enterprise, NACE Rev. 2 activity and size class (inn_cis12_bas). Sum of the following 2 data extractions:
  - ENTERPR: Total
  - INDIC_INN: Enterprises in the population in 2020
  - NACE_R2 Innovation core activities (Com.Reg. 995/2012)
  - SIZECLAS: From 10 to 49 employees
  - UNIT: Number

  - ENTERPR: Total
  - INDIC_INN: Enterprises in the population in 2020
  - NACE_R2 Innovation core activities (Com.Reg. 995/2012)
  - SIZECLAS: From 50 to 249 employees
  - UNIT: Number
- The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by 100.
- The EU aggregate is calculated using only data for those Member States for which both numerator and denominator data are available.

- Data from the Community Innovation Survey CIS 2018 for 2018:
  - Numerator: Product innovative enterprises that have introduced at least one new or significantly improved product by type of innovation, NACE Rev. 2 activity and size class [inn_cis11_prodn]. Sum of the following 2 data extractions:
    - INNOVAT: Product innovation
    - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
    - SIZECLAS: From 10 to 49 employees
    - UNIT: Number

    - INNOVAT: Product innovation
    - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
    - SIZECLAS: From 50 to 249 employees
    - UNIT: Number
  - Denominator: Enterprises, employed persons and turnover by type of enterprise, NACE Rev. 2 activity and size class [inn_cis11_bas]. Sum of the following 2 data extractions:
    - ENTERPR: Total

        - INDIC_INN: Number of enterprises in the population in 2018
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 10 to 49 employees
        - UNIT: Number

        - ENTERPR: Total
        - INDIC_INN: Number of enterprises in the population in 2018
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 50 to 249 employees
        - UNIT: Number
    - The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by 100.
    - The EU aggregate is calculated using only data for those Member States for which both numerator and denominator data are available.

- Data from the Community Innovation Survey CIS 2016 for 2016:
    - Numerator: Enterprises by NACE Rev. 2 activity and size class [inn_cis10_type]. Sum of the following 4 data extractions:
        - ENTERPR: Product innovative enterprises only
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 10 to 49 employees
        - UNIT: Number

        - ENTERPR: Product innovative enterprises only
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 50 to 249 employees
        - UNIT: Number

        - ENTERPR: Product and process innovative enterprises only
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 10 to 49 employees
        - UNIT: Number

        - ENTERPR: Product and process innovative enterprises only
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 50 to 249 employees
        - UNIT: Number
    - Denominator: Enterprises, employed persons and turnover by type of enterprise, NACE Rev. 2 activity and size class [inn_cis10_bas]. Sum of the following 4 data extractions:
        - ENTERPR: Innovative enterprises
        - INDIC_INN: Number of enterprises in the population in 2016
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 10 to 49 employees
        - UNIT: Number

        - ENTERPR: Innovative enterprises

        - INDIC_INN: Number of enterprises in the population in 2016
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 50 to 249 employees
        - UNIT: Number

        - ENTERPR: Non innovative enterprises
        - INDIC_INN: Number of enterprises in the population in 2016
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 10 to 49 employees
        - UNIT: Number

        - ENTERPR: Non innovative enterprises
        - INDIC_INN: Number of enterprises in the population in 2016
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 50 to 249 employees
        - UNIT: Number
    - The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by 100.
    - The EU aggregate is calculated using only data for those Member States for which both numerator and denominator data are available.

- Data from the Community Innovation Survey CIS 2014 for 2014:
    - Numerator: Enterprises by main types of innovation, NACE Rev. 2 activity and size class [inn_cis9_type]. Sum of the following 4 data extractions:
        - INDIC_IN: Number of enterprises in the population in 2014
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 10 to 49 employees
        - TYPE_INN: Product innovative enterprises only
        - UNIT: Number

        - INDIC_IN: Number of enterprises in the population in 2014
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 50 to 249 employees
        - TYPE_INN: Product innovative enterprises only
        - UNIT: Number

        - INDIC_IN: Number of enterprises in the population in 2014
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 10 to 49 employees
        - TYPE_INN: Product and process innovative enterprises only
        - UNIT: Number

        - INDIC_IN: Number of enterprises in the population in 2014
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 50 to 249 employees

        - TYPE_INN: Product and process innovative enterprises only
        - UNIT: Number
    - Denominator: Enterprises by main types of innovation, NACE Rev. 2 activity and size class [inn_cis9_type]. Sum of the following 2 data extractions:
        - INDIC_IN: Number of enterprises in the population in 2014
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 10 to 49 employees
        - TYPE_INN: Total
        - UNIT: Number

        - INDIC_IN: Number of enterprises in the population in 2014
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 50 to 249 employees
        - TYPE_INN: Total
        - UNIT: Number
    - The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by 100.
    - The EU aggregate is calculated using only data for those Member States for which both numerator and denominator data are available.

In addition, the following data have been used/extracted:

- Data for Moldova have been made available by the National Bureau of Statistics of the Republic of Moldova. Data are available for 2016-2022.
- Data for Albania, Bosnia and Herzegovina, Montenegro, UK, Ukraine from EIS 2023? Absent in raw_score, present in final_score

3.1.2 SMEs introducing business process innovations (percentage of SMEs)

Data for EU Member States and other European countries are extracted from Eurostat:

- Data from the Community Innovation Survey CIS 2022- Fast track:
    - Numerator:
        - TYPE_ENT: INNO_BPCS
        - ACTIVITY: _T
        - NUMBER_EMPL: E10T49 + E50T249
    - Denominator:
        - TYPE_ENT: _T
        - INDICATOR: ENT
        - ACTIVITY: _T
        - NUMBER_EMPL: E10T49 + E50T249
    - The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by 100.
    - The CIS 2022 data was available for Bulgaria, Czechia, Germany, Estonia, Greece, Spain, Finland, France, Hungary, Ireland, Italy, Latvia, Lithuania, Montenegro, Malta, Portugal, Romania, Serbia, Slovenia, Slovakia, Sweden and Türkiye. For all other countries, data was imputed using 2020 data, where possible.

- Data from the Community Innovation Survey CIS 2020 for 2020:
    - Numerator: Enterprises that introduced new or improved processes by type of innovation, NACE Rev. 2 activity and size class [inn_cis12_spec]. Sum of the following 2 data extractions:

        - INNOVAT: Business process innovation
        - NACE_R2 Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 10 to 49 employees
        - UNIT: Number

        - INNOVAT: Business process innovation
        - NACE_R2 Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 50 to 249 employees
        - UNIT: Number
    - Denominator: Enterprises, employed persons and turnover by type of enterprise, NACE Rev. 2 activity and size class (inn_cis12_bas). Sum of the following 2 data extractions:
        - ENTERPR: Total
        - INDIC_INN: Enterprises in the population in 2020
        - NACE_R2 Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 10 to 49 employees
        - UNIT: Number

        - ENTERPR: Total
        - INDIC_INN: Enterprises in the population in 2020
        - NACE_R2 Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 50 to 249 employees
        - UNIT: Number
    - The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by 100.
    - The EU aggregate is calculated using only data for those Member States for which both numerator and denominator data are available.

- Data from the Community Innovation Survey CIS 2018 for 2018:
    - Numerator: Enterprises that introduced new or improved processes by type of innovation, NACE Rev. 2 activity and size class [inn_cis11_spec]. Sum of the following 2 data extractions:
        - INNOVAT: Business process innovation
        - NACE_R2 Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 10 to 49 employees
        - UNIT: Number

        - INNOVAT: Business process innovation
        - NACE_R2 Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 50 to 249 employees
        - UNIT: Number
    - Denominator: Enterprises, employed persons and turnover by type of enterprise, NACE Rev. 2 activity and size class [inn_cis11_bas]. Sum of the following 2 data extractions:
        - ENTERPR: Total
        - INDIC_INN: Number of enterprises in the population in 2018
        - NACE_R2 : Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 10 to 49 employees
        - UNIT: Number

        - ENTERPR: Total
        - INDIC_INN: Number of enterprises in the population in 2018
        - NACE_R2 : Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 50 to 249 employees
        - UNIT: Number
    - The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by 100.
    - The EU aggregate is calculated using only data for those Member States for which both numerator and denominator data are available.

The concept of business process innovators was introduced in the CIS 2018 following the recommendations in the latest 2018 edition of the Oslo annual. Earlier versions of the CIS survey did not provide results for business process innovators. Results for the CIS 2014 and CIS 2016 have been copied from the EIS 2021 database.

In addition, the following data have been used/extracted:

- Data for Moldova have been made available by the National Bureau of Statistics of the Republic of Moldova. Data are available for 2016-2022.
- Data for Albania, Bosnia and Herzegovina, Montenegro, UK, Ukraine from EIS 2023? Absent in raw_score, present in final_score

3.2.1 Innovative SMEs collaborating with others (percentage of SMEs)

Data for EU Member States and other European countries are extracted from Eurostat:

- Data from the Community Innovation Survey CIS 2022- Fast track:
    - Numerator:
        - TYPE_ENT: INN
        - CIS_INDICATOR: COOP_RNDINN
        - ACTIVITY: _T
        - NUMBER_EMPL: E10T49 + E50T249
        - INDICATOR: ENT
    - Denominator:
        - TYPE_ENT: _T
        - INDICATOR: ENT
        - ACTIVITY: _T
        - NUMBER_EMPL: E10T49 + E50T249
    - The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by 100.
    - The CIS 2022 data was available for Bulgaria, Czechia, Germany, Estonia, Greece, Spain, Finland, France, Hungary, Ireland, Italy, Latvia, Lithuania, Montenegro, Malta, Portugal, Romania, Serbia, Slovenia, Slovakia, Sweden and Türkiye. For all other countries, data was imputed using 2020 data, where possible.

- Data from the Community Innovation Survey CIS 2020 for 2020:
    - Numerator: Enterprises that co-operated on business activities with other enterprises or organisations by field of activities, NACE Rev. 2 activity and size class [inn_cis12_co]. Sum of the following 2 data extractions:
        - ENTERPR: Innovation active enterprises
        - INN_ACT: Research and development (R&D) or other innovation activities
        - NACE_R2 Innovation core activities (Com.Reg. 995/2012)

        - SIZECLAS: From 10 to 49 employees
        - UNIT: Number

        - ENTERPR: Innovation active enterprises
        - INN_ACT: Research and development (R&D) or other innovation activities
        - NACE_R2 Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 50 to 249 employees
        - UNIT: Number
    - Denominator: Enterprises, employed persons and turnover by type of enterprise, NACE Rev. 2 activity and size class [inn_cis12_bas]. Sum of the following 2 data extractions:
        - ENTERPR: Total
        - INDIC_INN: Enterprises in the population in 2020
        - NACE_R2 Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 10 to 49 employees
        - UNIT: Number

        - ENTERPR: Total
        - INDIC_INN: Enterprises in the population in 2020
        - NACE_R2 Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 50 to 249 employees
        - UNIT: Number
    - The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by 100.
    - The EU aggregate is calculated using only data for those Member States for which both numerator and denominator data are available.

- Data from the Community Innovation Survey CIS 2018 for 2018:
    - Numerator: Enterprises that co-operated on business activities with other enterprises or organisations by field of activities, NACE Rev. 2 activity and size class [inn_cis11_co]. Sum of the following 2 data extractions:
        - ENTERPR: Innovation active enterprises
        - INN_ACT: Research and development (R&D) or other innovation activities
        - NACE_R2 Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 10 to 49 employees
        - UNIT: Number

        - ENTERPR: Innovation active enterprises
        - INN_ACT: Research and development (R&D) or other innovation activities
        - NACE_R2 Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 50 to 249 employees
        - UNIT: Number
    - Denominator: Enterprises, employed persons and turnover by type of enterprise, NACE Rev. 2 activity and size class [inn_cis11_bas]. Sum of the following 2 data extractions:
        - ENTERPR: Total
        - INDIC_INN: Number of enterprises in the population in 2018
        - NACE_R2 : Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 10 to 49 employees

        - UNIT: Number

        - ENTERPR: Total
        - INDIC_INN: Number of enterprises in the population in 2018
        - NACE_R2 : Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 50 to 249 employees
        - UNIT: Number
    - The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by 100.
    - The EU aggregate is calculated using only data for those Member States for which both numerator and denominator data are available.

- Data from the Community Innovation Survey CIS 2016 for 2016:
    - Numerator: Product and/or process innovative enterprises engaged in co-operation by cooperation partner, NACE Rev. 2 activity and size class [inn_cis10_coop]. Sum of the following 2 data extractions:
        - COOP_PTN: Total
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 10 to 49 employees
        - UNIT: Number

        - COOP_PTN: Total
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 50 to 249 employees
        - UNIT: Number
    - Denominator: Enterprises, employed persons and turnover by type of enterprise, NACE Rev. 2 activity and size class [inn_cis11_bas]. Sum of the following 2 data extractions:
        - ENTERPR: Total
        - INDIC_INN: Number of enterprises in the population in 2016
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 10 to 49 employees
        - UNIT: Number

        - ENTERPR: Total
        - INDIC_INN: Number of enterprises in the population in 2016
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 50 to 249 employees
        - UNIT: Number
    - The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by 100.
    - The EU aggregate is calculated using only data for those Member States for which both numerator and denominator data are available.

- Data from the Community Innovation Survey CIS 2014 for 2014:
    - Numerator: Types of co-operation of the enterprises by NACE Rev. 2 activity and size class [inn_cis9_coop]. Sum of the following 2 data extractions:
        - INDIC_IN: Entreprises engaged in any type of co-operation

        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 10 to 49 employees
        - UNIT: Number

        - INDIC_IN: Entreprises engaged in any type of co-operation
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 50 to 249 employees
        - UNIT: Number
    - Denominator: Enterprises, employed persons and turnover by type of enterprise, NACE Rev. 2 activity and size class [inn_cis11_bas]. Sum of the following 2 data extractions:
        - INDIC_INN: Number of enterprises in the population in 2014
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 10 to 49 employees
        - TYPE_INN: Total entreprises
        - UNIT: Number

        - INDIC_INN: Number of enterprises in the population in 2014
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 50 to 249 employees
        - TYPE_INN: Total entreprises
        - UNIT: Number
    - The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by 100.
    - The EU aggregate is calculated using only data for those Member States for which both numerator and denominator data are available.

In addition, the following data have been used/extracted:

- Data for Moldova have been made available by the National Bureau of Statistics of the Republic of Moldova. Data are available for 2016-2022.
- Data for Ukraine have been made available by the State Statistics Service of Ukraine. Data are available for 2018-2020.
- Data for the United Kingdom have been made available by the Department for Business & Trade of the United Kingdom. Data are available for 2020.
- Data for Albania was taken from EIS 2023, for which it was provided by the Institute of Statistics (INSTAT) of Albania

Data are not available for Bosnia and Herzegovina.

3.2.2 Public-private publications per million population

Data on number of public-private co-publications for all countries are calculated and made available by Science-Metrix for the years 2010-2023. Data have been calculated using full counting and have been extracted from Scopus.

Population data for EU Member States and other European countries are extracted from Eurostat:

- Dataset: Population on 1 January by age and sex [demo_pjan]:
    - AGE: Total
    - SEX: Total
    - UNIT: Number

Population data for all years for Bosnia and Herzegovina and from 2021 onwards for the United Kingdom are extracted from the World Development Indicators of the World Bank:

- Dataset: Population, total – SP.POP.TOTL

The indicator is calculated by dividing the number of public-private co-publications by the population size in millions.

Data are available for 2010-2023.

3.2.3 Job-to-job mobility of Human Resources in Science & Technology

Data for EU Member States and other European countries are extracted from Eurostat:

- Dataset: Job-to-job mobility of HRST by sex [hrst_fl_mobsex]:
  - AGE: From 25 to 64 years
  - SEX: Total
  - UNIT: Percentage
- Data are available for 2010-2020
- For several countries there are breaks in series in 2015-2020 and for all EU Member States and other European countries for which data are available for 2014, these data are flagged by Eurostat as a break in time series. None of the data before 2014 is used and all values for the years before 2014 are replaced by the value for 2014. For breaks in series after 2014 all data from before the break are not used and replace by the value of the year in which the break in series take place (Belgium in 2017, Czechia in 2017, Germany in 2020, Iceland in 2020, Luxembourg in 2016, Netherlands in 2019, Sweden in 2018).
- For EU Member States and other European countries for which 2020 is the most recent year for which data are available, none of the data before 2020 is used and all values for the years before 2020 are replaced by the value for 2020.

Data are not available for Albania, Bosnia and Herzegovina, Ireland, Moldova, and Ukraine.

3.3.1 PCT patent applications per billion GDP (in PPS)

Data on patents for all countries are extracted from the OECD:

- Dataset: Patents by technology
  - Patents Office & Patents Families: Patent applications filed under the PCT
  - Reference country: Inventor(s)'s country(ies) of residence
  - Reference date: Priority date
  - Technology domains & IPC: Total Patents
- Data are available for 2010-2020.

Data on Gross Domestic Product (GDP) in Purchasing Power Standards (PPS) for EU Member States and other European countries are extracted from Eurostat:

- Dataset: GDP and main components (output, expenditure and income) [nama_10_gdp]:
  - NA_ITEM: Gross domestic product at market prices
  - UNIT Current prices, million purchasing power standards (PPS, EU27 from 2020)

Data on Gross Domestic Product (GDP) for countries not covered by Eurostat are extracted from the World Bank Development Indicators:

- Dataset: GDP, PPP (current international $) NY.GDP.MKTP.PP.CD
- Data are converted into PPPs by dividing the GDP in PPPs for one of the Eurozone countries with the ratio of GDP, PPP (current international $) for one of the Eurozone countries and GDP, PPP (current international $) for the respective country.

The indicator is calculated by dividing the number of PCT patent applications by GDP in PPPs.

3.3.2 Trademark applications per billion GDP (in PPS)

Data on trademark applications for all countries are extracted from the individual "Statistics per country or territory" reports from the European Union Intellectual Property Office (EUIPO). Data can be copied from each of the reports in pdf format:

- Table: EUTMs Received by Year

- Data are available for 2010-2023.

Data on Gross Domestic Product (GDP) for countries not covered by Eurostat are extracted from the World Bank Development Indicators:

- Dataset: GDP, PPP (current international $) NY.GDP.MKTP.PP.CD
- Data are converted into PPPs by dividing the GDP in PPPs for one of the Eurozone countries with the ratio of GDP, PPP (current international $) for one of the Eurozone countries and GDP, PPP (current international $) for the respective country.

The indicator is calculated by dividing the number of trademark applications by GDP in PPPs.

For all countries, the indicator is calculated for each country as a 2-year rolling average. The indicator is calculated for each country as a 2-year rolling average. Prior to calculation of the rolling average, missing values are imputed (replacing with the last available value first, then the next available value).

3.3.3 Design applications per billion GDP (in PPS)

Data on individual design applications for all countries are extracted from the individual "Statistics per country or territory" reports from the European Union Intellectual Property Office (EUIPO). Data can be copied from each of the reports in pdf format:

- Table: RCDs Received by Year
- Data are available for 2010-2023.

Data on Gross Domestic Product (GDP) for countries not covered by Eurostat are extracted from the World Bank Development Indicators:

- Dataset: GDP, PPP (current international $) NY.GDP.MKTP.PP.CD
- Data are converted into PPPs by dividing the GDP in PPPs for one of the Eurozone countries with the ratio of GDP, PPP (current international $) for one of the Eurozone countries and GDP, PPP (current international $) for the respective country.

The indicator is calculated by dividing the number of design trademark applications by GDP in PPPs.

For all countries, the indicator is calculated for each country as a 2-year rolling average. The indicator is calculated for each country as a 2-year rolling average. Prior to calculation of the rolling average, missing values are imputed (replacing with the last available value first, then the next available value).

4.1.1 Employment in knowledge-intensive activities (percentage of total employment)

Data for EU Member States and other European countries are extracted from Eurostat:

- Annual data on employment in knowledge-intensive activities at the national level, by sex (from 2008 onwards, NACE Rev. 2) [htec_kia_emp2]:
    - NACE_R2: Knowledge-intensive activities - business industries
    - SEX: Total
    - UNIT: Percentage of total employment
- Data are available for 2010-2023.
- For all EU Member States and other European countries for which data are available for 2021, these data are flagged by Eurostat as a break in time series. None of the data before 2021 is used and all values for the years before 2021 are replaced by the value for 2021.
- For EU Member States and other European countries for which 2020 is the most recent year for which data are available, none of the data before 2020 is used and all values for the years before 2020 are replaced by the value for 2020.

Data for Moldova have been made available by the National Bureau of Statistics of the Republic of Moldova. Data are available for 2015-2022.

Data for Ukraine have been made available by the State Statistics Service of Ukraine. Data are available for 2022.

Data for the United Kingdom for the year 2020 onwards was extracted from:

- Bello, M., Ravanos, P. and Smallenbroek, O., Tracking country innovation performance: The Innovation Output Indicator 2023, Publications Office of the European Union, Luxembourg, 2024, doi:10.2760/27979, JRC137117.
    - KIABI: Share of employment in knowledge-intensive activities in business industries (%)

Data for Albania was taken from EIS 2023, for which it was provided by the Institute of Statistics (INSTAT) of Albania

was taken

4.1.2 Employment in innovative enterprises

Data for EU Member States and other European countries are extracted from Eurostat:

- Data from the Community Innovation Survey CIS 2020 for 2020:
  - Numerator: Enterprises, employed persons and turnover by type of enterprise, NACE Rev. 2 activity and size class [inn_cis12_bas]. Sum of the following 2 data extractions:
    - ENTERPR: Innovative enterprises
    - INDIC_INN: Employed persons in 2020
    - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
    - SIZECLAS: From 10 to 49 employees
    - UNIT: Number

    - ENTERPR: Innovative enterprises
    - INDIC_INN: Employed persons in 2020
    - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
    - SIZECLAS: From 50 to 249 employees
    - UNIT: Number
  - Denominator: Enterprises, employed persons and turnover by type of enterprise, NACE Rev. 2 activity and size class [inn_cis12_bas]. Sum of the following 2 data extractions:
    - ENTERPR: Total
    - INDIC_INN: Employed persons in 2020
    - NACE_R2 Innovation core activities (Com.Reg. 995/2012)
    - SIZECLAS: From 10 to 49 employees
    - UNIT: Number

    - ENTERPR: Total
    - INDIC_INN: Employed persons in 2020
    - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
    - SIZECLAS: From 50 to 249 employees
    - UNIT: Number
  - The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by 100.
  - The EU aggregate is calculated using only data for those Member States for which both numerator and denominator data are available.

- Data from the Community Innovation Survey CIS 2018 for 2018:
  - Numerator: Enterprises, employed persons and turnover by type of enterprise, NACE Rev. 2 activity and size class [inn_cis11_bas]. Sum of the following 2 data extractions:
    - ENTERPR: Innovative enterprises
    - INDIC_INN: Employed persons in 2018
    - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
    - SIZECLAS: From 10 to 49 employees
    - UNIT: Number

    - ENTERPR: Innovative enterprises

        - INDIC_INN: Employed persons in 2018
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 50 to 249 employees
        - UNIT: Number
    - Denominator: Enterprises, employed persons and turnover by type of enterprise, NACE Rev. 2 activity and size class [inn_cis11_bas]. Sum of the following 2 data extractions:
        - ENTERPR: Total
        - INDIC_INN: Employed persons in 2018
        - NACE_R2 Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 10 to 49 employees
        - UNIT: Number

        - ENTERPR: Total
        - INDIC_INN: Employed persons in 2018
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 50 to 249 employees
        - UNIT: Number
    - The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by 100.
    - The EU aggregate is calculated using only data for those Member States for which both numerator and denominator data are available.

- Data from the Community Innovation Survey CIS 2016 for 2016:
    - Numerator: Basic economic information on the enterprises by NACE Rev. 2 activity and size class [inn_cis10_bas]. Sum of the following 2 data extractions:
        - ENTERPR: Innovative enterprises
        - INDIC_INN: Number of employees in 2016
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 10 to 49 employees
        - UNIT: Number

        - ENTERPR: Innovative enterprises
        - INDIC_INN: Number of employees in 2016
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 50 to 249 employees
        - UNIT: Number
    - Denominator: Basic economic information on the enterprises by NACE Rev. 2 activity and size class [inn_cis10_bas]. Sum of the following 2 data extractions:
        - ENTERPR: Total
        - INDIC_INN: Number of employees in 2016
        - NACE_R2 Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 10 to 49 employees
        - UNIT: Number

        - ENTERPR: Total
        - INDIC_INN: Number of employees in 2016

        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 50 to 249 employees
        - UNIT: Number
    - The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by 100.
    - The EU aggregate is calculated using only data for those Member States for which both numerator and denominator data are available.

- Data from the Community Innovation Survey CIS 2014 for 2014:
    - Numerator: Basic economic information on the enterprises by NACE Rev. 2 activity and size class [inn_cis9_bas]. Sum of the following 2 data extractions:
        - ENTERPR: Innovative enterprises
        - INDIC_INN: Number of employees in 2014
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 10 to 49 employees
        - UNIT: Number

        - ENTERPR: Innovative enterprises
        - INDIC_INN: Number of employees in 2014
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 50 to 249 employees
        - UNIT: Number
    - Denominator: Basic economic information on the enterprises by NACE Rev. 2 activity and size class [inn_cis9_bas]. Sum of the following 2 data extractions:
        - ENTERPR: Total
        - INDIC_INN: Number of employees in 2014
        - NACE_R2 Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 10 to 49 employees
        - UNIT: Number

        - ENTERPR: Total
        - INDIC_INN: Number of employees in 2014
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: From 50 to 249 employees
        - UNIT: Number
    - The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by 100.
    - The EU aggregate is calculated using only data for those Member States for which both numerator and denominator data are available.

In addition, the following data have been used/extracted:

- Data for Moldova have been made available by the National Bureau of Statistics of the Republic of Moldova. Data are available for 2016-2022.
- Data for the United Kingdom have been made available by the Department for Business & Trade of the United Kingdom. Data are available for 2020.
- Data for Albania, Bosnia and Herzegovina and Montenegro were taken from EIS 2023, for which they were provided by the national statistics institutes of these countries.

Data are not available for Ukraine.

4.2.1 Exports of medium and high technology products as a share of total products exports

Medium and high technology products have been defined to include the following Standard International Trade Classification, Rev. 4 items:

- 266 Synthetic fibres suitable for spinning
- 267 Other man-made fibres suitable for spinning; waste of man-made fibres
- 512 Alcohols, phenols, phenol-alcohols, and their halogenated, sulphonated, nitrated or nitrosated derivatives
- 513 Carboxylic acids and their anhydrides, halides, peroxides and peroxyacids; their halogenated, sulphonated, nitrated or nitrosated derivatives
- 525 Radioactive and associated materials
- 533 Pigments, paints, varnishes and related materials
- 54 Medicinal and pharmaceutical products
- 553 Perfumery, cosmetic or toilet preparations (excluding soaps)
- 554 Soap, cleansing and polishing preparations
- 562 Fertilizers (other than those of group 272)
- 57 Plastics in primary forms
- 58 Plastics in non-primary forms
- 591 Insecticides, rodenticides, fungicides, herbicides, anti-sprouting products and plant-growth regulators, disinfectants and similar products, put up in forms or packings for retail sale or as preparations or articles (e.g., sulphur-treated bands, wicks and candles, and fly-papers)
- 593 Explosives and pyrotechnic products
- 597 Prepared additives for mineral oils and the like; prepared liquids for hydraulic transmission; anti-freezing preparations and prepared de-icing fluids; lubricating preparations
- 598 Miscellaneous chemical products, n.e.s.
- 629 Articles of rubber, n.e.s.
- 653 Fabrics, woven, of man-made textile materials (not including narrow or special fabrics)
- 671 Pig-iron, spiegeleisen, sponge iron, iron or steel granules and powders and ferro-alloys
- 672 Ingots and other primary forms of iron or steel; semi-finished products of iron or steel
- 679 Tubes, pipes and hollow profiles, and tube or pipe fittings, of iron or steel
- 71 Power-generating machinery and equipment
- 72 Machinery specialized for particular industries
- 731 Machine tools working by removing metal or other material
- 733 Machine tools for working metal, sintered metal carbides or cermets, without removing material
- 737 Metalworking machinery (other than machine tools) and parts thereof, n.e.s.
- 74 General industrial machinery and equipment, n.e.s., and machine parts, n.e.s.
- 75 Office machines and automatic data-processing machines
- 76 Telecommunications and sound-recording and reproducing apparatus and equipment
- 77 Electrical machinery, apparatus and appliances, n.e.s., and electrical parts thereof (including nonelectrical counterparts, n.e.s., of electrical household-type equipment)
- 78 Road vehicles (including air-cushion vehicles)
- 79 Other transport equipment
- 812 Sanitary, plumbing and heating fixtures and fittings, n.e.s.
- 87 Professional, scientific and controlling instruments and apparatus, n.e.s
- 88 Photographic apparatus, equipment and supplies and optical goods, n.e.s.; watches and clocks
- 891 Arms and ammunition

Data for EU Member States and the United Kingdom are extracted from Eurostat:

- Dataset: EU trade since 1999 by SITC [DS-018995]:
  - Data for the numerator are calculated as:
    - INDICATORS: VALUE_IN_EUROS
    - FLOW: EXPORT
    - FREQ: Annual
    - PARTNER: All countries of the world
    - PRODUCT: 266 + 267 + 512 + 513 + 525 + 533 + 54 + 553 + 554 + 562 + 57 + 58 + 591 + 593 + 597 + 598 + 629 + 653 + 671 + 672 + 679 + 71 + 72 + 731 + 733 + 737 + 74 + 751 + 752 + 759 + 76 + 77 + 78 + 79 + 812 + 87 + 88 + 891
  - Data for the denominator are calculated as:
    - INDICATORS: VALUE_IN_EUROS
    - FLOW: EXPORT
    - FREQ: Annual
    - PARTNER: All countries of the world
    - PRODUCT: Total
- The indicator is calculated as the ratio between the numerator and denominator multiplied by 100.
- Data are available for 2010-2023.

Data for other European countries are extracted from the United Nations Comtrade database (https://comtrade.un.org/).

- Data for the numerator are calculated as the sum of the Trade Value (US$) in SITC Rev. 4 exports for the following commodities: 266 + 267 + 512 + 513 + 525 + 533 + 54 + 553 + 554 + 562 + 57 + 58 + 591 + 593 + 597 + 598 + 629 + 653 + 671 + 672 + 679 + 71 + 72 + 731 + 733 + 737 + 74 + 751 + 752 + 759 + 76 + 77 + 78 + 79 + 812 + 87 + 88 + 891
- Data for the denominator are equal to the Trade Value (US$) of total exports.
- The indicator is calculated as the ratio of the numerator by the denominator multiplied by 100.
- Data are available for 2013-2023.

4.2.2 Knowledge-intensive services exports as a share of total services exports

Knowledge-intensive services exports have been defined to include the following EBOPS 2011 (Extended Balance of Payments Services Classification) items:

- SC1 Sea transport
- SC2 Air transport
- SC3A Space transport
- SF Insurance and pension services
- SG Financial services
- SH Charges for the use of intellectual property
- SI Telecommunications, computer, and services
- SJ Other business services
- SK1 Audio-visual and related services

Data for most EU Member States are extracted from Eurostat:

- Dataset: International trade in services (since 2011) (BPM6) [bop_its6_det]:
  - Data for the numerator are calculated as:

        - BOP_ITEM: SC1 + SC2 + SC3A + SF + SG + SH + SI + SJ + SK1
        - CURRENCY: Million euro
        - PARTNER: Rest of the world
        - STK_FLOW: Credit
    - Data for the denominator are calculated as the sum of:
        - BOP_ITEM: All
        - CURRENCY: Million euro
        - PARTNER: Rest of the world
        - STK_FLOW: Credit
- The indicator is calculated as the ratio of the numerator by the denominator multiplied by 100.
- Data are available for 2010-2022.

Data for other European countries are extracted from the data centre of UN Trade and Development (UNCTAD) (https://unctadstat.unctad.org/datacentre/):

- Dataset: Services (BPM6): Exports and imports by service-category, trade-partner World, annual
- Data are equal to the share of the above listed categories in total exports, in US dollars at current prices.
- Data are available for 2010-2022.

4.2.3 Sales of new-to-market and new-to-enterprise innovations as a percentage of turnover

Data for EU Member States and other European countries are extracted from Eurostat:

- Data from the Community Innovation Survey CIS 2020 for 2020:
    - Numerator: Turnover of enterprises from new or significantly improved products, by NACE Rev.2 activity and size class [inn_cis12_prodt]:
        - INNOVAT: New or significantly improved products
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: Total
        - UNIT: Thousand euro
    - Denominator: Enterprises, employed persons and turnover by type of enterprise, NACE Rev. 2 activity and size class [inn_cis12_bas]:
        - ENTERPR: Total
        - INDIC_INN: Turnover in 2020
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: Total
        - UNIT: Thousand euro
    - The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by 100.
    - The EU aggregate is calculated using only data for those Member States for which both numerator and denominator data are available.

- Data from the Community Innovation Survey CIS 2018 for 2018:
    - Numerator: Turnover of enterprises from new or significantly improved products, by NACE Rev.2 activity and size class [inn_cis11_prodt]:
        - INNOVAT: New or significantly improved products
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: Total
        - UNIT: Thousand euro
    - Denominator: Enterprises, employed persons and turnover by type of enterprise, NACE Rev. 2 activity and size class [inn_cis11_bas]:

        - ENTERPR: Total
        - INDIC_INN: Turnover in 2018
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: Total
        - UNIT: Thousand euro
    - The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by 100.
    - The EU aggregate is calculated using only data for those Member States for which both numerator and denominator data are available.

- Data from the Community Innovation Survey CIS 2016 for 2016:
    - Numerator: Turnover of enterprises from new or significantly improved products, by NACE Rev.2 activity and size class [inn_cis10_prodt]. Sum of the following 2 data extractions:
        - INNOVAT: New or significantly improved products that were new to the firm
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: Total
        - UNIT: Thousand euro

        - INNOVAT: New or significantly improved products that were new to the market
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: Total
        - UNIT: Thousand euro
    - Denominator: Basic economic information on the enterprises by NACE Rev. 2 activity and size class [inn_cis10_bas]:
        - ENTERPR: Total
        - INDIC_INN: Turnover in 2016
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: Total
        - UNIT: Thousand euro
    - The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by 100.
    - The EU aggregate is calculated using only data for those Member States for which both numerator and denominator data are available.

- Data from the Community Innovation Survey CIS 2014 for 2014:
    - Numerator: Turnover of enterprises from new or significantly improved products, by NACE Rev.2 activity and size class [inn_cis9_prodt]. Sum of the following 2 data extractions:
        - INNOVAT: New or significantly improved products that were new to the firm
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: Total
        - UNIT: Thousand euro

        - INNOVAT: New or significantly improved products that were new to the market
        - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
        - SIZECLAS: Total
        - UNIT: Thousand euro

- Denominator: Basic economic information on the enterprises by NACE Rev. 2 activity and size class [inn_cis9_bas]:
  - INDIC_INN: Turnover in 2014
  - NACE_R2: Innovation core activities (Com.Reg. 995/2012)
  - SIZECLAS: Total
  - TYPE_INN: Total
  - UNIT: Thousand euro
- The indicator is calculated by dividing the data for the numerator by the data for the denominator and multiplying by 100.
- The EU aggregate is calculated using only data for those Member States for which both numerator and denominator data are available.

In addition, the following data have been used/extracted:

- Data for Moldova have been made available by the National Bureau of Statistics of the Republic of Moldova. Data are available for 2016-2022.
- Data for the United Kingdom have been made available by the Department for Business & Trade of the United Kingdom. Data are available for 2020.
- Data for Albania, Bosnia and Herzegovina, Montenegro, and Ukraine were taken directly from EIS 2023, for which they were provided by the national statistics institutes of these countries.

4.3.1 Resource productivity

Data for EU Member States and other European countries are extracted from Eurostat:

- Dataset: Resource productivity [env_ac_rp]:
  - UNIT: Purchasing power standard (PPS) per kilogram
- Data are available for 2000-2022.

Data are not available for Moldova, Montenegro and Ukraine.

4.3.2 Air emissions by fine particulate matter (PM2.5) in industry

Data for EU Member States and other European countries are extracted from Eurostat:

- For the numerator, data are extracted from:
  - Dataset: Air emissions accounts by NACE Rev. 2 activity [env_ac_ainah_r2]:
    - AIRPOL: Particulates < 2.5µm
    - NACE_R2: Manufacturing
    - UNIT: Tonne
  - Data are available for 2008-2021.
- For the denominator, data are extracted from:
  - Dataset: National accounts aggregates by industry (up to NACE A*64) [nama_10_a64]:
    - NA_ITEM: Value added, gross
    - NACE_R2: Manufacturing
    - UNIT: Chain linked volumes (2010), million euro
  - Data are available for 2000-2022.
- The indicator is calculated as the ratio of the denominator and numerator and multiplied by 1,000.

Data for Albania have been made available by the Institute of Statistics of Albania (INSTAT). Data are available for 2020-2021.

Data are not available for Bosnia and Herzegovina, Moldova, Montenegro, North Macedonia, and Ukraine.

4.3.3 Development of environment-related technologies, percentage of all technologies

Data on patents for all countries are extracted from the OECD:

- Dataset: Green Growth database
  - Economic activity: Total – all activities
  - Measure: Development of environment-related technologies
  - Unit: Percentage of domestic inventions
- Data are available for 2011-2019.

Results for the EU have been calculated by first aggregating the volumes of environment-related patents for the 27 Member States for the numerator and total patents for the 27 Member States for the denominator, and then dividing these two and multiplying by 100.

For all countries, the indicator is calculated for each country as a 2-year rolling average. The indicator is calculated for each country as a 2-year rolling average. Prior to calculation of the rolling average, missing values are imputed (replacing with the last available value first, then the next available value).

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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 EIS Methodology Report provides more detail on the methodology used for the EIS and the construction of the Summary Innovation Index (SII). The Methodology Report also provides detailed methodological information on the indicators used for both the SII and the Structural indicators that aim to provide a better understanding of the impact of structural differences on innovation performance scores.

Studies and reports