

# Global Innovation Index 2023

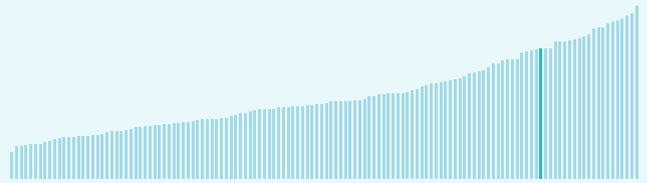


The Global Innovation Index (GII) **ranks world economies according to their innovation capabilities.**

Consisting of **roughly 80 indicators**, grouped into innovation inputs and outputs, the GII **aims to capture the multi-dimensional facets of innovation.**

## Luxembourg ranking in the Global Innovation Index 2023

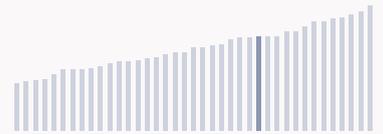
> Luxembourg ranks **21st** among the 132 economies featured in the GII 2023.



> Luxembourg ranks **20th** among the 50 high-income group economies.



> Luxembourg ranks **13th** among the 39 economies in Europe.



### > Luxembourg GII Ranking (2020-2023)

The table shows the rankings of Luxembourg over the past four years. Data availability and changes to the GII model framework influence year-on-year comparisons of the GII rankings. The statistical confidence interval for the ranking of Luxembourg in the GII 2023 is between ranks 18 and 24.

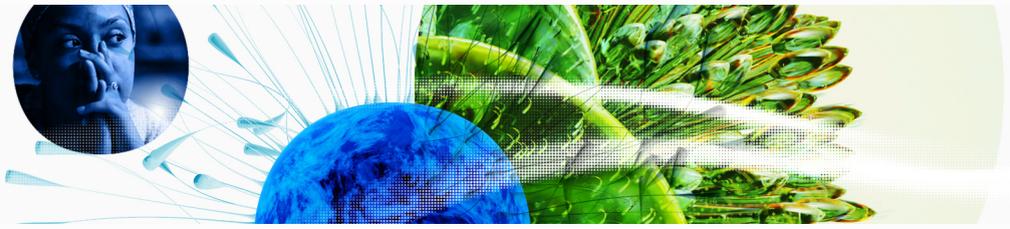
|      | GII Position | Innovation Inputs | Innovation Outputs |
|------|--------------|-------------------|--------------------|
| 2020 | 18th         | 24th              | 14th               |
| 2021 | 23rd         | 26th              | 18th               |
| 2022 | 19th         | 20th              | 18th               |
| 2023 | 21st         | 22nd              | 23rd               |

Luxembourg performs worse in innovation outputs than innovation inputs in 2023.

This year Luxembourg ranks 22nd in innovation inputs. This position is lower than last year.

Luxembourg ranks 23rd in innovation outputs. This position is lower than last year.

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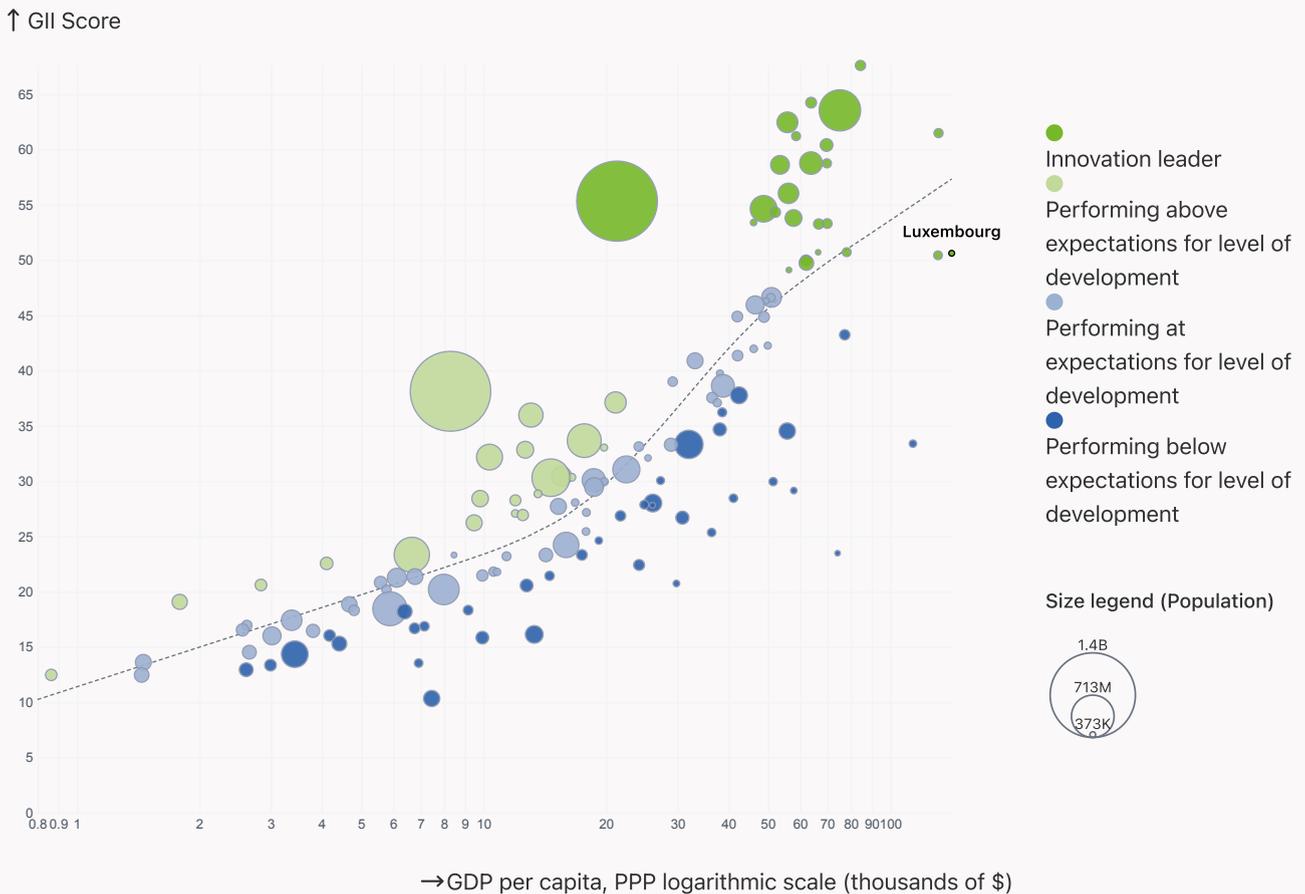
## → Expected vs. observed innovation performance

The bubble chart below shows the relationship between income levels (GDP per capita) and innovation performance (GII score). The trend line gives an indication of the expected innovation performance according to income level. Economies appearing above the trend line are performing better than expected and those below are performing below expectations.



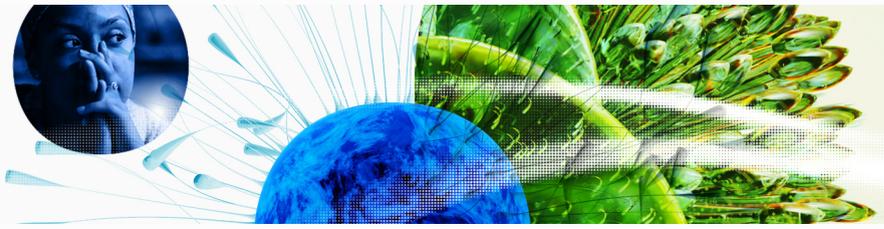
> Luxembourg is an innovation leader, ranking in the top 25 of the GII.

## > Innovation overperformers relative to their economic development



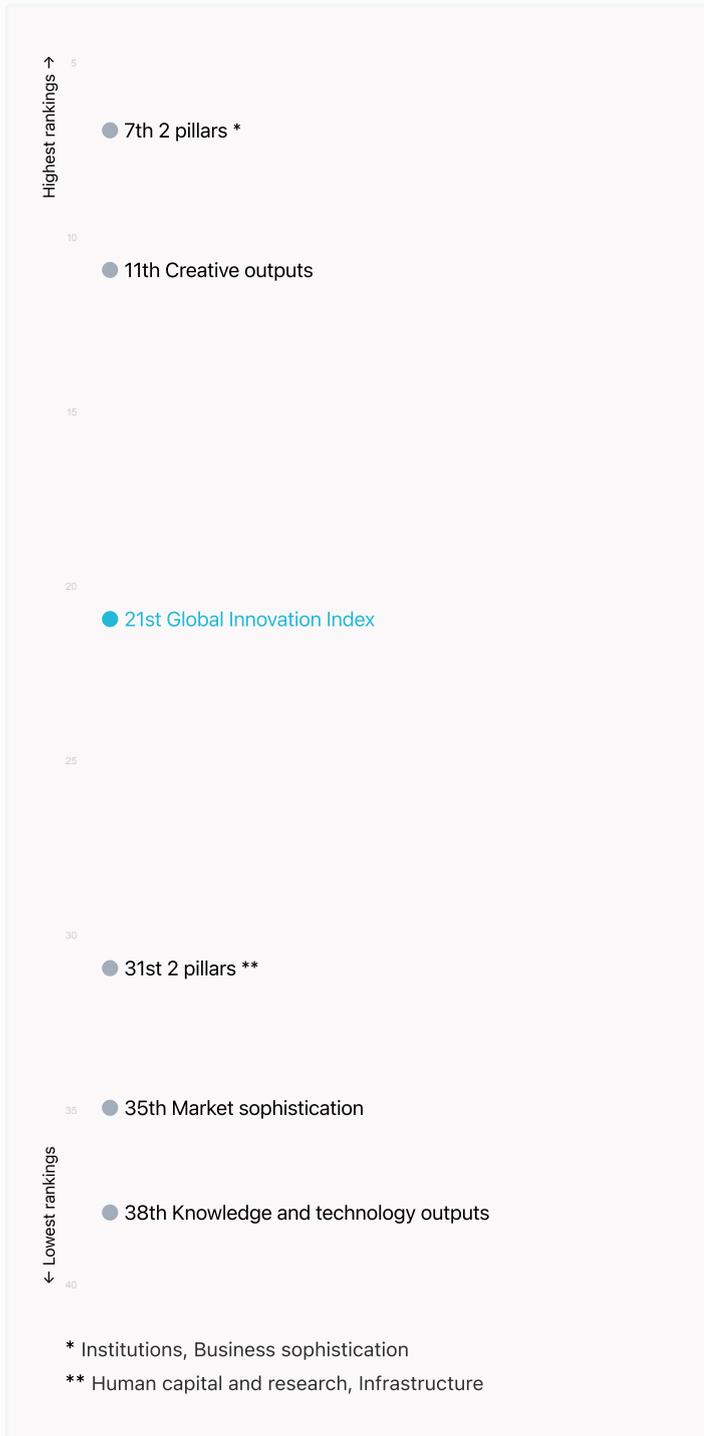


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## → Overview of Luxembourg's rankings in the seven areas of the GII in 2023

The chart shows the ranking for each of the seven areas that the GII comprises. The strongest areas for Luxembourg are those that rank above the GII (shown in blue) and the weakest are those that rank below.



### > Highest rankings



Luxembourg ranks highest in Institutions, Business sophistication (7th) and Creative outputs (11th).

### > Lowest rankings



Luxembourg ranks lowest in Knowledge and technology outputs (38th), Market sophistication (35th) and Human capital and research, Infrastructure (31st).

The full WIPO Intellectual Property Statistics profile for Luxembourg can be found on [this link](#).

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## → Benchmark of Luxembourg against other country groupings for each of the seven areas of the GII Index

The charts show the relative position of Luxembourg (blue bar) against other country groupings (grey bars), for each of the seven areas of the GII Index.

### > High-Income economies

Luxembourg performs above the high-income group average in Creative outputs, Business sophistication, Institutions.

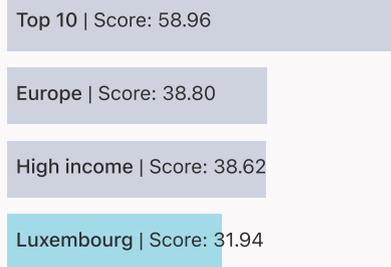


### > Europe

Luxembourg performs above the regional average in Creative outputs, Business sophistication, Market sophistication, Human capital and research, Infrastructure, Institutions.



### Knowledge and technology outputs



### Creative outputs



### Business sophistication



### Market sophistication



### Human capital and research



### Infrastructure



### Institutions



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## → Innovation strengths and weaknesses in Luxembourg

The table below gives an overview of the indicator strengths and weaknesses of Luxembourg in the GII 2023.



> Luxembourg's main innovation strengths are **Cultural and creative services exports, % total trade (rank 1)**, **ICT services imports, % total trade (rank 1)** and **Intellectual property payments, % total trade (rank 1)**.

### Strengths

### Weaknesses

| Rank | Code  | Indicator name  | Rank | Code  | Indicator name                          |
|------|-------|---|------|-------|---|
| 1    | 7.2.1 | Cultural and creative services exports, % total trade | 132  | 5.3.2 | High-tech imports, % total trade        |
| 1    | 5.3.3 | ICT services imports, % total trade                   | 119  | 6.2.1 | Labor productivity growth, %            |
| 1    | 5.3.1 | Intellectual property payments, % total trade         | 106  | 3.2.3 | Gross capital formation, % GDP          |
| 1    | 5.1.1 | Knowledge-intensive employment, %                     | 101  | 2.2.1 | Tertiary enrolment, % gross             |
| 1    | 2.2.3 | Tertiary inbound mobility, %                          | 97   | 7.2.4 | Creative goods exports, % total trade   |
| 2    | 5.3.4 | FDI net inflows, % GDP                                | 95   | 1.2.3 | Cost of redundancy dismissal            |
| 2    | 3.1.1 | ICT access  | 89   | 4.3.3 | Domestic market scale, bn PPP\$         |
| 2    | 1.2.1 | Regulatory quality                                    | 88   | 6.3.3 | High-tech exports, % total trade        |
| 2    | 4.2.2 | Venture capital (VC) investors, deals/bn PPP\$ GDP    | 81   | 2.2.2 | Graduates in science and engineering, % |
| 3    | 1.3.1 | Policies for doing business                           | 71   | 2.3.4 | QS university ranking, top 3            |
| 4    | 7.3.1 | Generic top-level domains (TLDs)/th pop. 15-69        |      |       |   |

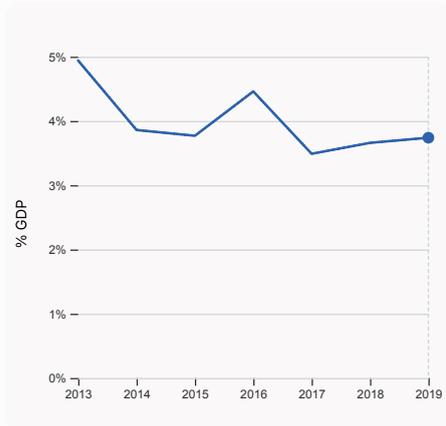
# Global Innovation Index 2023



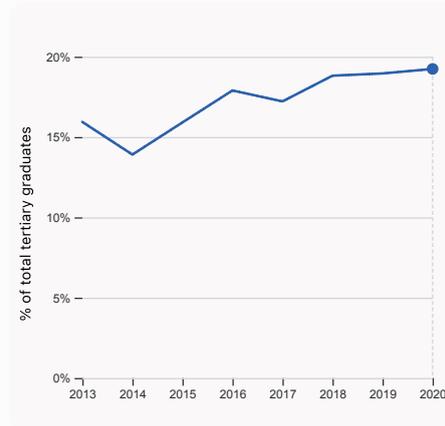
## → Luxembourg's innovation system

As far as practicable, the plots below present unscaled indicator data.

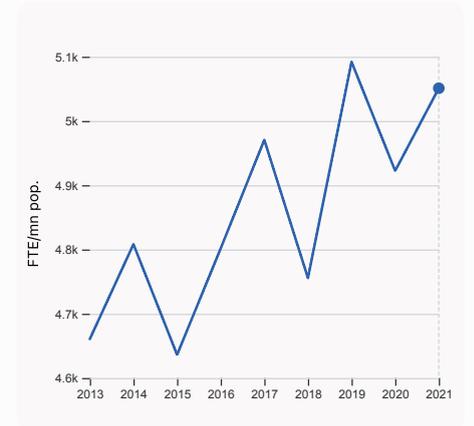
### > Innovation inputs in Luxembourg



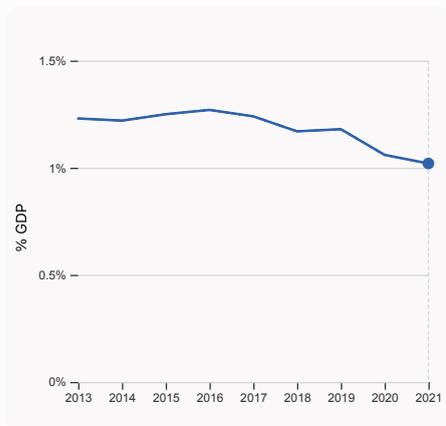
**2.1.1 Expenditure on education, % GDP**  
was equal to 3.74% GDP in 2019, up by 0.08 percentage points from the year prior – and equivalent to an indicator rank of 81.



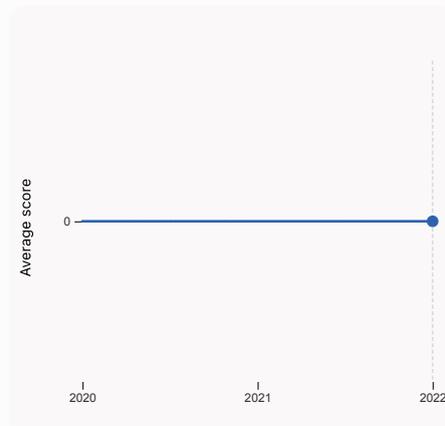
**2.2.2 Graduates in science and engineering, %**  
was equal to 19.24% of total tertiary graduates in 2020, up by 0.28 percentage points from the year prior – and equivalent to an indicator rank of 81.



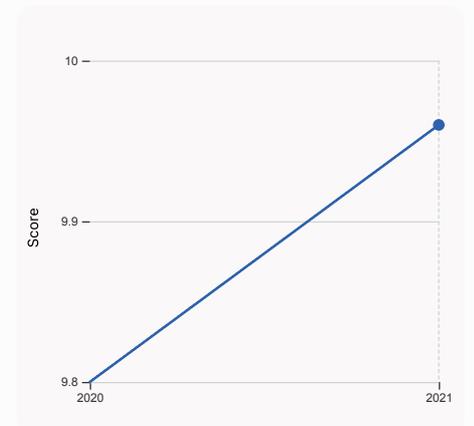
**2.3.1 Researchers, FTE/mn pop.**  
was equal to 5,050.97 FTE/mn pop. in 2021, up by 2.61% from the year prior – and equivalent to an indicator rank of 17.



**2.3.2 Gross expenditure on R&D, % GDP**  
was equal to 1.02% GDP in 2021, down by 0.04 percentage points from the year prior – and equivalent to an indicator rank of 39.

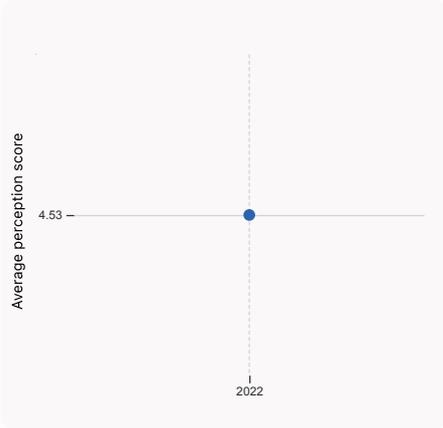


**2.3.4 QS university ranking, top 3**  
was equal to an average score of 0 for the top 3 universities in 2022, equivalent to an indicator rank of 71.

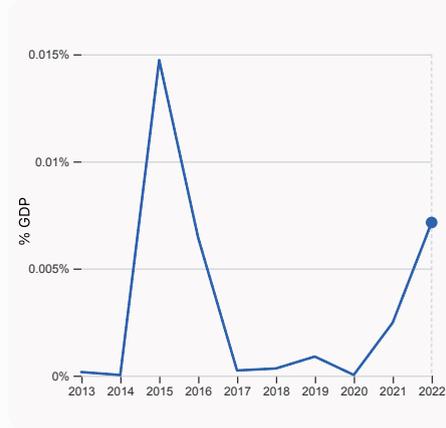


**3.1.1 ICT access**  
was equal to a score of 9.96 in 2021, up by 1.63% from the year prior – and equivalent to an indicator rank of 2.

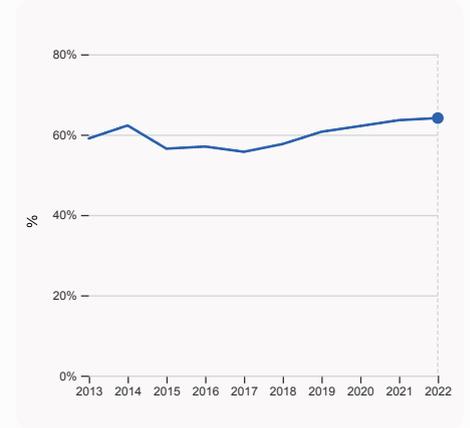
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**4.1.1 Finance for startups and scaleups** was equal to an average perception score of 4.53 in 2022, equivalent to an indicator rank of 48.



**4.2.4 VC received, value, % GDP** was equal to 0.00715% GDP in 2022, up by 0.0047 percentage points from the year prior – and equivalent to an indicator rank of 21.

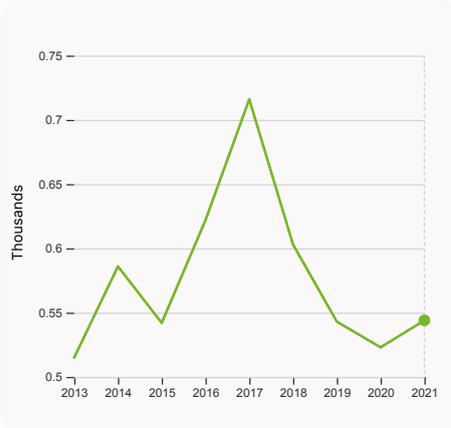


**5.1.1 Knowledge-intensive employment, %** was equal to 64.13% in 2022, up by 0.52 percentage points from the year prior – and equivalent to an indicator rank of 1.

# Global Innovation Index 2023

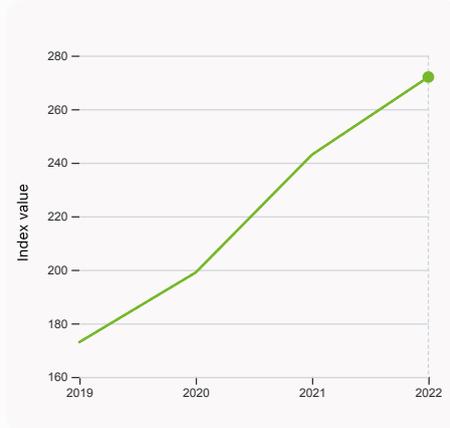


## > Innovation outputs in Luxembourg



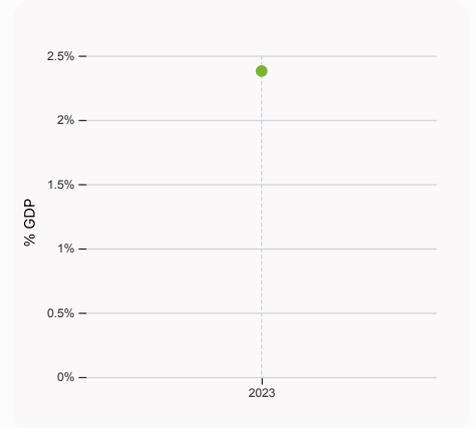
### 6.1.1 Patents by origin

was equal to 0.54 Thousands in 2021, up by 4.015% from the year prior – and equivalent to an indicator rank of 14.



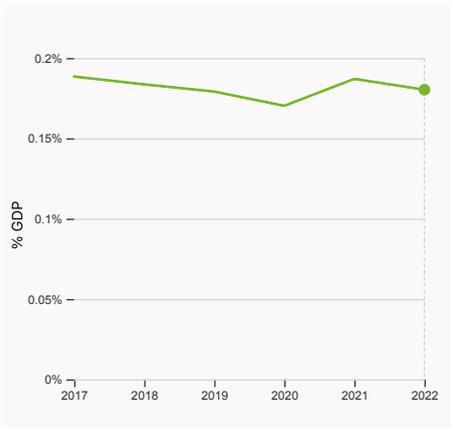
### 6.1.5 Citable documents H-index

was equal to an index value of 272 in 2022, up by 11.93% from the year prior – and equivalent to an indicator rank of 65.



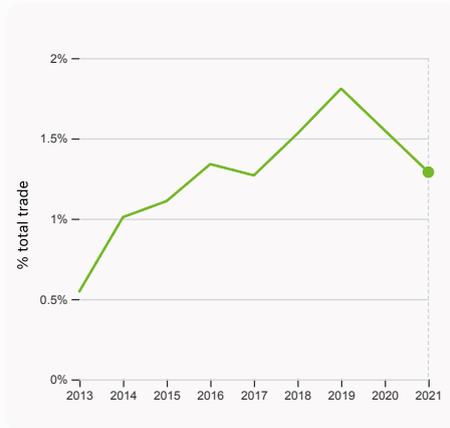
### 6.2.2 Unicorn valuation, % GDP

was equal to 2.38 % GDP in 2023 – and equivalent to an indicator rank of 15.



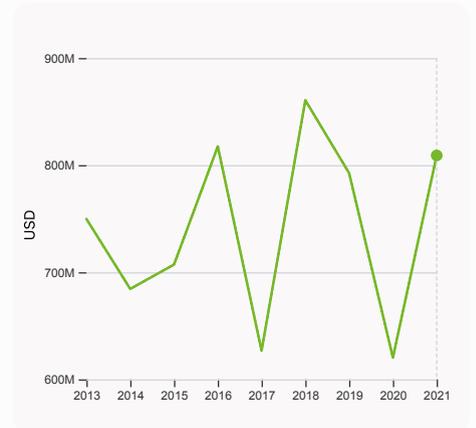
### 6.2.3 Software spending, % GDP

was equal to 0.18% GDP in 2022, down by 0.0067 percentage points from the year prior – and equivalent to an indicator rank of 78.



### 6.3.1 Intellectual property receipts, % total trade

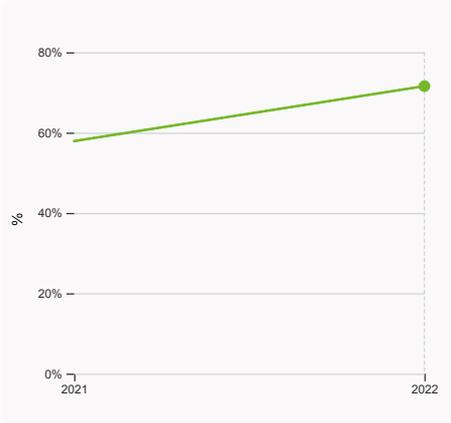
was equal to 1.29% total trade in 2021, down by 0.26 percentage points from the year prior – and equivalent to an indicator rank of 17.



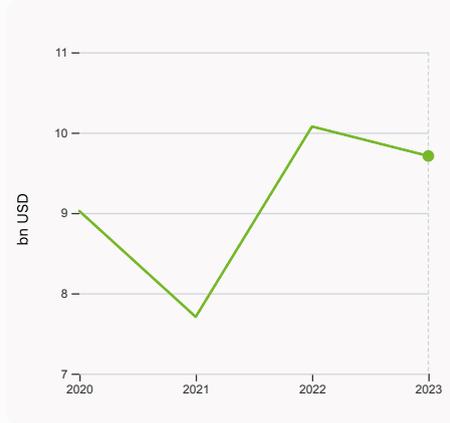
### 6.3.3 High-tech exports

was equal to 809,095,343 USD in 2021, up by 30.42% from the year prior – and equivalent to an indicator rank of 88.

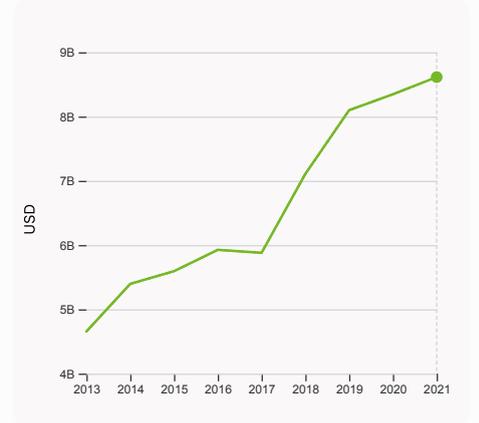
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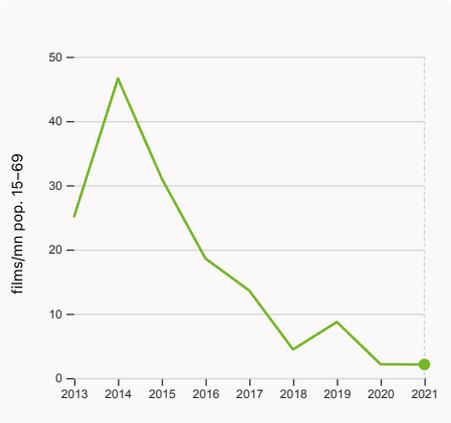
**7.1.1 Intangible asset intensity, top 15, %** was equal to 71.58% in 2022, up by 13.68 percentage points from the year prior – and equivalent to an indicator rank of 18.



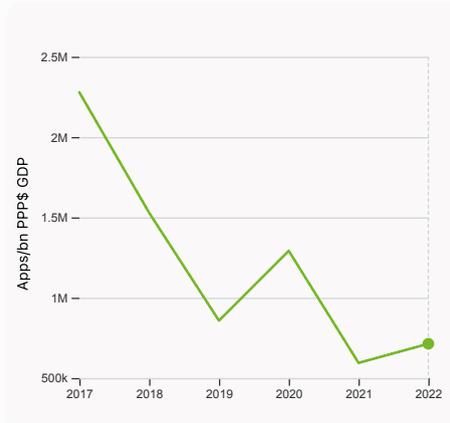
**7.1.3 Global brand value, top 5,000** was equal to 9.71 bn USD in 2023, down by 3.64% from the year prior – and equivalent to an indicator rank of 14.



**7.2.1 Cultural and creative services exports** was equal to 8,614,481,000 USD in 2021, up by 3.2% from the year prior – and equivalent to an indicator rank of 1.

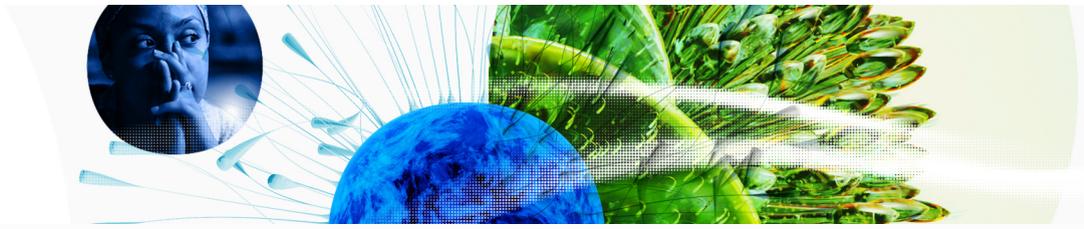


**7.2.2 National feature films/mn pop. 15-69** was equal to 2.12 films/mn pop. 15-69 in 2021, down by 1.4% from the year prior – and equivalent to an indicator rank of 45.



**7.3.4 Mobile app creation/bn PPP\$ GDP** was equal to 713,804.23 Apps/bn PPP\$ GDP in 2022, up by 20.041% from the year prior – and equivalent to an indicator rank of 35.

# Global Innovation Index 2023



## → Luxembourg's innovation top performers

### > 2.3.3 Global corporate R&D investors from Luxembourg

| Rank | Firm          | Industry                     | R&D      | R&D Growth | R&D Intensity |
|------|---------------|------------------------------|----------|------------|---------------|
|      |               |                              | [mn EUR] | [%]        | [%]           |
| 224  | SPOTIFY       | Software & Computer Services | 887      | 8          | 9             |
| 607  | ARCELORMITTAL | Industrial Metals & Mining   | 275      | 27         | 0             |
| 1550 | SUSE          | Software & Computer Services | 89       | 23         | 18            |

Source: European Commission's Joint Research Centre (<https://iri.jrc.ec.europa.eu/scoreboard/2022-eu-industrial-rd-investment-scoreboard>).  
 Note: European Commission's Joint Research Centre ranks the top 2,500 firms by R&D investment annually.

### > 6.2.2 Top Unicorn Companies in Luxembourg

| Rank | Unicorn Company | Industry | City       | Valuation, bn USD |
|------|-----------------|----------|------------|-------------------|
| 1    | OCSIAL          | Other    | Leudelange | 2                 |

Source: CBInsights, Tracker – The Complete List of Unicorn Companies: <https://www.cbinsights.com/research-unicorn-companies>

### > 7.1.1 Top 15 intangible-asset intensive companies in Luxembourg

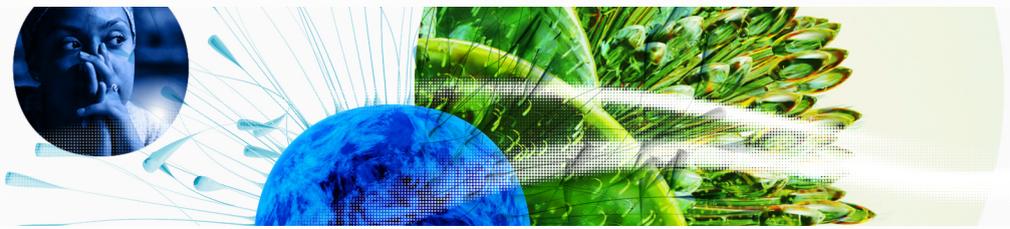
| Rank | Firm                   | Intensity, % |
|------|------------------------|--------------|
| 1    | EUROFINS SCIENTIFIC SE | 88.46        |
| 2    | TENARIS SA             | 41.62        |
| 3    | GLOBANT SA             | 89.51        |

Source: Brand Finance (<https://brandirectory.com/reports/gift-2022>).  
 Note: Brand Finance only provides within economy ranks.

### > 7.1.3 Top 5,000 companies in Luxembourg with highest global brand value

| Rank | Brand               | Industry              | Brand Value, mn USD |
|------|---------------------|-----------------------|---------------------|
| 1    | ARCELORMITTAL       | Mining, Iron & Steel  | 3,387.1             |
| 2    | EUROFINS SCIENTIFIC | Healthcare Facilities | 1,972.7             |
| 3    | RTL                 | Media                 | 1,289.2             |

Source: Brand Finance (<https://brandirectory.com>).  
 Note: Rank corresponds to within economy ranks.



## Luxembourg

| Output rank  | Input rank | Income | Region | Population (mn)  | GDP, PPP\$ (bn) | GDP per capita, PPP\$ |
|--|------------|--------|--------|--|-----------------|-----------------------|
| 23   | 22         | High   | EUR    | 0.6  | 91.1            | 141,587.1             |
| Score / Value Rank   |            |        |        | Score / Value Rank   |                 |                       |
| <b>Institutions</b> 81.6 7   |            |        |        | <b>Business sophistication</b> 63.8 7                                |                 |                       |
| <b>1.1 Institutional environment</b> 84.1 7                          |            |        |        | <b>5.1 Knowledge workers</b> 70.2 6                                  |                 |                       |
| 1.1.1 Operational stability for businesses* 84.0 7                   |            |        |        | 5.1.1 Knowledge-intensive employment, % 64.1 1 ●◆                    |                 |                       |
| 1.1.2 Government effectiveness* 84.2 7                               |            |        |        | 5.1.2 Firms offering formal training, % 66.1 4 ◆                     |                 |                       |
| <b>1.2 Regulatory environment</b> 82.4 23                            |            |        |        | 5.1.3 GERD performed by business, % GDP 0.5 40 ◇                     |                 |                       |
| 1.2.1 Regulatory quality* 91.8 2 ●◆                                  |            |        |        | 5.1.4 GERD financed by business, % 51.3 25                           |                 |                       |
| 1.2.2 Rule of law* 92.1 8  |            |        |        | 5.1.5 Females employed w/advanced degrees, % 27.6 11                 |                 |                       |
| 1.2.3 Cost of redundancy dismissal 21.7 95 ○◇                        |            |        |        | <b>5.2 Innovation linkages</b> 54.6 16                               |                 |                       |
| <b>1.3 Business environment</b> 78.3 10                              |            |        |        | 5.2.1 University-industry R&D collaboration+ 76.8 16                 |                 |                       |
| 1.3.1 Policies for doing business* 94.3 3 ●◆                         |            |        |        | 5.2.2 State of cluster development+ 63.9 33                          |                 |                       |
| 1.3.2 Entrepreneurship policies and culture* 62.2 21                 |            |        |        | 5.2.3 GERD financed by abroad, % GDP 0.0 50 ◇                        |                 |                       |
| <b>Human capital and research</b> 44.4 31 ◇                          |            |        |        | 5.2.4 Joint venture/strategic alliance deals/bn PPP\$ GDP 0.1 13     |                 |                       |
| <b>2.1 Education</b> 53.8 60 ◇                                       |            |        |        | 5.2.5 Patent families/bn PPP\$ GDP 3.7 10                            |                 |                       |
| 2.1.1 Expenditure on education, % GDP 3.7 81 ◇                       |            |        |        | <b>5.3 Knowledge absorption</b> 66.7 3 ●◆                            |                 |                       |
| 2.1.2 Government funding/pupil, secondary, % GDP/cap 20.3 50         |            |        |        | 5.3.1 Intellectual property payments, % total trade 4.0 1 ●◆         |                 |                       |
| 2.1.3 School life expectancy, years 14.6 62 ◇                        |            |        |        | 5.3.2 High-tech imports, % total trade 1.7 132 ○◇                    |                 |                       |
| 2.1.4 PISA scales in reading, maths and science 476.7 35 ◇           |            |        |        | 5.3.3 ICT services imports, % total trade 4.9 1 ●◆                   |                 |                       |
| 2.1.5 Pupil-teacher ratio, secondary 7.8 8 ◆                         |            |        |        | 5.3.4 FDI net inflows, % GDP 48.7 2 ●◆                               |                 |                       |
| <b>2.2 Tertiary education</b> 46.6 16                                |            |        |        | 5.3.5 Research talent, % in businesses 31.6 40 ◇                     |                 |                       |
| 2.2.1 Tertiary enrolment, % gross 19.2 101 ○◇                        |            |        |        | <b>Knowledge and technology outputs</b> 31.9 38 ◇                    |                 |                       |
| 2.2.2 Graduates in science and engineering, % 19.2 81 ○              |            |        |        | <b>6.1 Knowledge creation</b> 44.1 19                                |                 |                       |
| 2.2.3 Tertiary inbound mobility, % 48.4 1 ●◆                         |            |        |        | 6.1.1 Patents by origin/bn PPP\$ GDP 6.5 14                          |                 |                       |
| <b>2.3 Research and development (R&amp;D)</b> 32.8 34 ◇              |            |        |        | 6.1.2 PCT patents by origin/bn PPP\$ GDP 3.4 8                       |                 |                       |
| 2.3.1 Researchers, FTE/mn pop. 5,051.0 17                            |            |        |        | 6.1.3 Utility models by origin/bn PPP\$ GDP n/a n/a                  |                 |                       |
| 2.3.2 Gross expenditure on R&D, % GDP 1.0 39 ◇                       |            |        |        | 6.1.4 Scientific and technical articles/bn PPP\$ GDP n/a n/a         |                 |                       |
| 2.3.3 Global corporate R&D investors, top 3, mn US\$ 60.6 22         |            |        |        | 6.1.5 Citable documents H-index 12.7 65 ◇                            |                 |                       |
| 2.3.4 QS university ranking, top 3* 0.0 71 ○◇                        |            |        |        | <b>6.2 Knowledge impact</b> 30.8 54 ◇                                |                 |                       |
| <b>Infrastructure</b> 55.6 31 ◇                                      |            |        |        | 6.2.1 Labor productivity growth, % -1.2 119 ○◇                       |                 |                       |
| <b>3.1 Information and communication technologies (ICTs)</b> 87.0 15 |            |        |        | 6.2.2 Unicorn valuation, % GDP 2.4 15                                |                 |                       |
| 3.1.1 ICT access* 99.7 2 ●◆  |            |        |        | 6.2.3 Software spending, % GDP 0.2 78 ◇                              |                 |                       |
| 3.1.2 ICT use* 92.6 15   |            |        |        | 6.2.4 High-tech manufacturing, % n/a n/a                             |                 |                       |
| 3.1.3 Government's online service* 81.4 29                           |            |        |        | <b>6.3 Knowledge diffusion</b> 20.9 71 ◇                             |                 |                       |
| 3.1.4 E-participation* 74.4 25                                       |            |        |        | 6.3.1 Intellectual property receipts, % total trade 1.5 17           |                 |                       |
| <b>3.2 General infrastructure</b> 29.9 56 ◇                          |            |        |        | 6.3.2 Production and export complexity n/a n/a                       |                 |                       |
| 3.2.1 Electricity output, GWh/mn pop. 2,074.9 80 ◇                   |            |        |        | 6.3.3 High-tech exports, % total trade 0.5 88 ○◇                     |                 |                       |
| 3.2.2 Logistics performance* 68.2 25 ◇                               |            |        |        | 6.3.4 ICT services exports, % total trade 3.3 37                     |                 |                       |
| 3.2.3 Gross capital formation, % GDP 18.6 106 ○◇                     |            |        |        | 6.3.5 ISO 9001 quality/bn PPP\$ GDP 1.9 87 ◇                         |                 |                       |
| <b>3.3 Ecological sustainability</b> 49.8 23                         |            |        |        | <b>Creative outputs</b> 54.2 11                                      |                 |                       |
| 3.3.1 GDP/unit of energy use 20.0 8                                  |            |        |        | <b>7.1 Intangible assets</b> 53.1 17                                 |                 |                       |
| 3.3.2 Environmental performance* 90.5 6                              |            |        |        | 7.1.1 Intangible asset intensity, top 15, % 71.6 18                  |                 |                       |
| 3.3.3 ISO 14001 environment/bn PPP\$ GDP 0.9 68                      |            |        |        | 7.1.2 Trademarks by origin/bn PPP\$ GDP 55.6 42                      |                 |                       |
| <b>Market sophistication</b> 45.2 35 ◇                               |            |        |        | 7.1.3 Global brand value, top 5,000 11.6 14                          |                 |                       |
| <b>4.1 Credit</b> 44.2 38  |            |        |        | 7.1.4 Industrial designs by origin/bn PPP\$ GDP 3.8 26               |                 |                       |
| 4.1.1 Finance for startups and scaleups+ 49.2 48 ◇                   |            |        |        | <b>7.2 Creative goods and services</b> 38.2 15                       |                 |                       |
| 4.1.2 Domestic credit to private sector, % GDP 104.9 27              |            |        |        | 7.2.1 Cultural and creative services exports, % total trade 5.6 1 ●◆ |                 |                       |
| 4.1.3 Loans from microfinance institutions, % GDP n/a n/a            |            |        |        | 7.2.2 National feature films/mn pop. 15-69 2.1 45 ◇                  |                 |                       |
| <b>4.2 Investment</b> 45.3 13  |            |        |        | 7.2.3 Entertainment and media market/th pop. 15-69 n/a n/a           |                 |                       |
| 4.2.1 Market capitalization, % GDP 67.6 25                           |            |        |        | 7.2.4 Creative goods exports, % total trade 0.1 97 ○                 |                 |                       |
| 4.2.2 Venture capital (VC) investors, deals/bn PPP\$ GDP 1.9 2 ●◆    |            |        |        | <b>7.3 Online creativity</b> 72.5 5                                  |                 |                       |
| 4.2.3 VC recipients, deals/bn PPP\$ GDP 0.1 26                       |            |        |        | 7.3.1 Generic top-level domains (TLDs)/th pop. 15-69 97.1 4 ●◆       |                 |                       |
| 4.2.4 VC received, value, % GDP 0.0 21                               |            |        |        | 7.3.2 Country-code TLDs/th pop. 15-69 70.7 8                         |                 |                       |
| <b>4.3 Trade, diversification, and market scale</b> 46.1 95 ○◇       |            |        |        | 7.3.3 GitHub commits/mn pop. 15-69 48.3 21                           |                 |                       |
| 4.3.1 Applied tariff rate, weighted avg., % 1.5 20                   |            |        |        | 7.3.4 Mobile app creation/bn PPP\$ GDP 73.7 35                       |                 |                       |
| 4.3.2 Domestic industry diversification n/a n/a                      |            |        |        |  |                 |                       |
| 4.3.3 Domestic market scale, bn PPP\$ 91.1 89 ○                      |            |        |        |  |                 |                       |

NOTES: ● indicates a strength; ○ a weakness; ◆ an income group strength; ◇ an income group weakness; \* an index; + a survey question, ● indicates that the economy's data are older than the base year; see appendices for details, including the year of the data, at <https://www.wipo.int/gii-ranking>. Square brackets [ ] indicate that the data minimum coverage (DMC) requirements were not met at the sub-pillar or pillar level.



## → Data availability

The following tables list indicators that are either missing or outdated for Luxembourg.



> Luxembourg has missing data for six indicators and outdated data for three indicators.

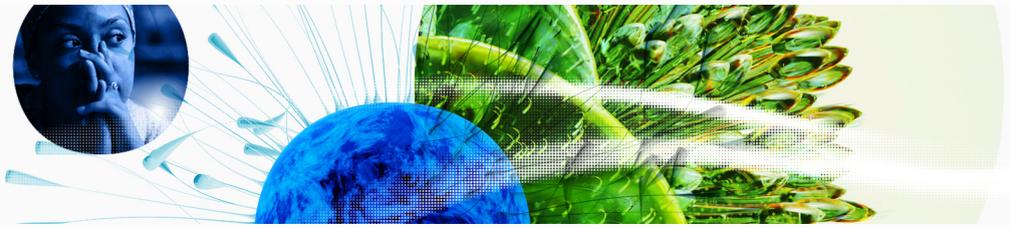
## > Missing data for Luxembourg

| Code  | Indicator name                               | Economy Year | Model Year | Source   |
|-------|--|--------------|------------|--|
| 4.1.3 | Loans from microfinance institutions, % GDP  | n/a          | 2021       | International Monetary Fund, Financial Access Survey (FAS)                         |
| 4.3.2 | Domestic industry diversification            | n/a          | 2020       | United Nations Industrial Development Organization                                 |
| 6.1.3 | Utility models by origin/bn PPP\$ GDP        | n/a          | 2021       | World Intellectual Property Organization; International Monetary Fund              |
| 6.2.4 | High-tech manufacturing, %                   | n/a          | 2020       | United Nations Industrial Development Organization                                 |
| 6.3.2 | Production and export complexity             | n/a          | 2020       | Harvard University, Growth Lab   |
| 7.2.3 | Entertainment and media market/th pop. 15-69 | n/a          | 2022       | PwC, GEMO; United Nations, World Population Prospects; International Monetary Fund |

## > Outdated data for Luxembourg

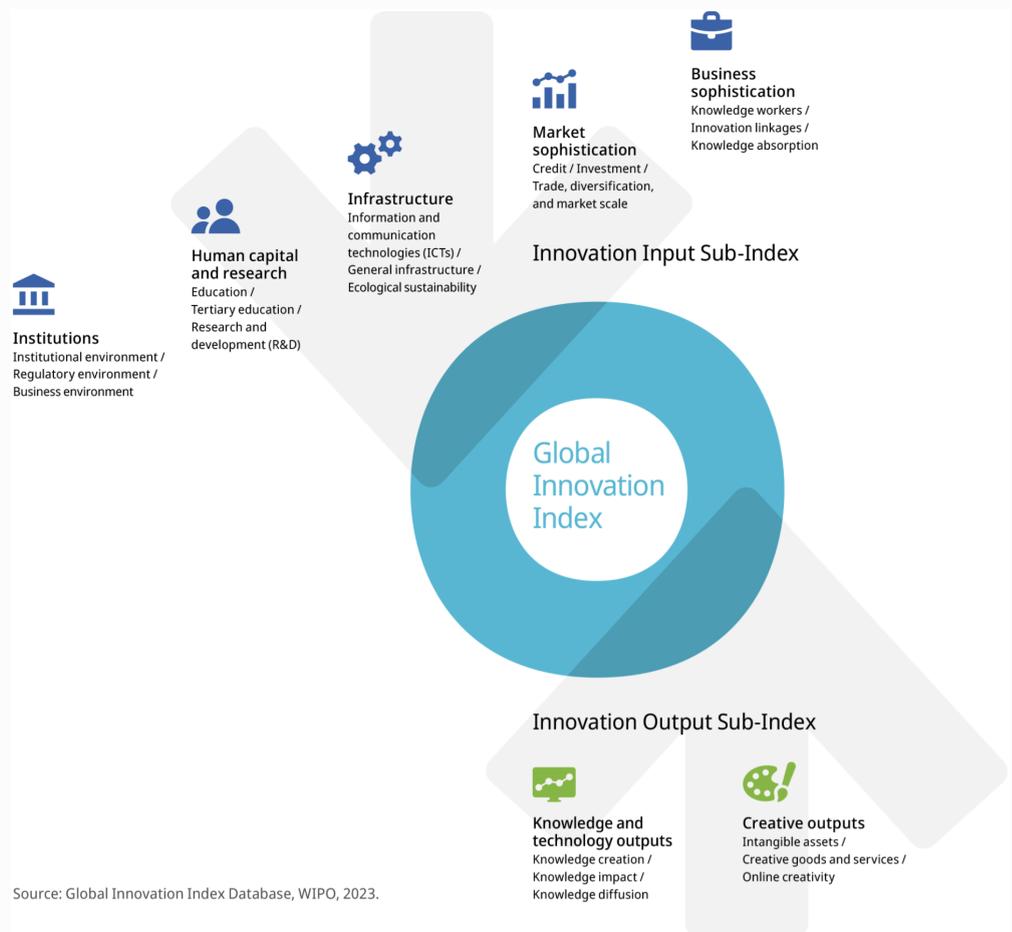
| Code  | Indicator name                  | Economy Year | Model Year | Source   |
|-------|---------------------------------|--------------|------------|--|
| 2.1.1 | Expenditure on education, % GDP | 2019         | 2021       | UNESCO Institute for Statistics                        |
| 5.1.4 | GERD financed by business, %    | 2019         | 2020       | UNESCO Institute for Statistics; Eurostat; OECD; RICYT |
| 5.2.3 | GERD financed by abroad, % GDP  | 2019         | 2020       | UNESCO Institute for Statistics; Eurostat; OECD; RICYT |

# Global Innovation Index 2023



## → About the Global Innovation Index

- The Global Innovation Index (GII) is published by the World Intellectual Property Organization (WIPO), a specialized agency of the United Nations.
- Recognizing that innovation is a key driver of economic development, the GII aims to provide an innovation ranking and rich analysis referencing around 130 economies. Over the last decade, the GII has established itself as both a leading reference on innovation and a “tool for action” for economies that incorporate the GII into their innovation agendas.



The Index is a ranking of the innovation capabilities and results of world economies. It measures innovation based on criteria that include institutions, human capital and research, infrastructure, credit, investment, linkages; the creation, absorption and diffusion of knowledge; and creative outputs.

The GII has two sub-indices: the Innovation Input Sub-Index and the Innovation Output Sub-Index, and seven pillars, each consisting of three sub-pillars.