

Research and innovation in *Portugal and Spain*



Credits

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The covid-19 pandemic is providing a unique opportunity to understand how the science and technology system can provide answers to difficulties faced by humanity. Improving knowledge promotes competitiveness, economic growth and wellbeing.

Although knowledge generation is a key tool for progress, the research and innovation ecosystem presents numerous challenges. The most significant are related with training, with science-business links, and with funding. In a global reality where human capital drives the development agenda, it is important to provide training and employment opportunities for scientists.

In coming years, science-business collaboration, along with the coordination and joint work of public-private organisations, will be crucial for Portugal and Spain to be able to efficiently absorb the new funding lines from the European Union's Recovery Plan. According to the expert analyses included in this *Dossier*, Portugal and Spain could obtain major social benefits if they put the focus more clearly on people and networks, promoting opportunities for dialogue and communication. Ultimately, the driving forces behind collaboration and progress are not just the institutions, but people themselves.

The "la Caixa" Foundation is especially sensitive to the importance of research for society. For this reason, this *Dossier* is taking an in-depth look at research dynamics in general, while offering a broad overview to enable readers to gain a snapshot of the situation in Portugal and Spain alike.

Overview

Research and innovation in Portugal and Spain have developed following parallel pathways, although with characteristics that differentiate them. This *Dossier* presents an analysis of the R&D systems of the two countries, comparing them with the European context and focusing on some of their many component variables.

The first article presented, authored by Laura Cruz Castro, Luis Sanz Menéndez, Tiago Santos Pereira and Cláudia Sarrico, explores one of the pillars of research systems: the people who work within them. It analyses the employment conditions of research staff in science and technology and explains the main challenges that are faced.

The second article, authored by Manuel M. Godinho, José Guimón, Catalina Martínez and Joana Mendonça, studies the links between science and business based on the main indicators available. Despite their similar trajectories, the two countries have approached the challenge of intensifying the science-business relationship through very different policies, which provides opportunities for mutual learning.

The interview, with the OECD's director for Science, Technology and Innovation, enables the focus to be expanded beyond the Iberian peninsula to obtain an international perspective. Andy Wyckoff talks about the lessons that we are learning and the difficult task of aligning efforts to tackle the major questions of our time, as well as those related with global policy, ethics, and convergent technologies.

The reviews, by Leoncio López-Ocón and Tiago Brandão, provide us with another dimension of science: historiography, appealing to the past to help us to understand the present. They look at two recent books, one from each country, that study the development of science through history, its relationship with other disciplines, and how it has influenced the building of the Iberian nations.

Finally, the selection of best practices presents a range of initiatives that tell us how research may look in the future, not so much with respect to the subjects or fields that it will tackle, but rather in relation to how it could be conducted so that it fulfils its ultimate mission, which is improving people's quality of life.

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General context indicators

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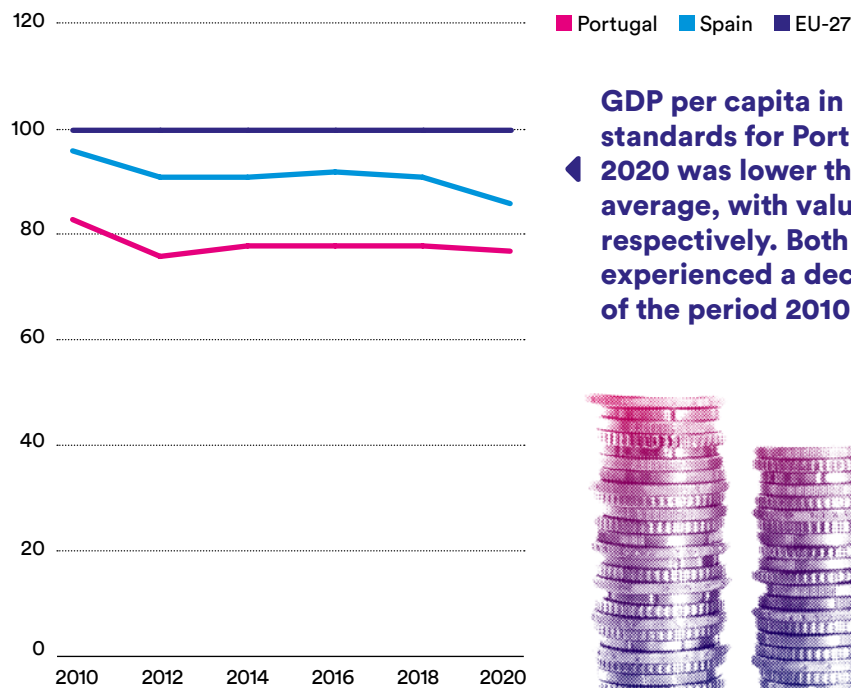
This section provides a general context for the rest of the data and indicators presented in the Barometer. Thus, from a series of basic indicators and synthetic indexes on social, demographic and economic issues, the section offers a global and time-series view of the situation of Portugal and Spain within the European context.

Global view



1. Level of economic development

Gross domestic product per capita in purchasing power standards
Portugal, Spain and EU-27 (since 2020) = 100



GDP per capita in purchasing power standards for Portugal and Spain in 2020 was lower than the European average, with values of 77 and 86, respectively. Both countries experienced a decline over the course of the period 2010-2020



Source: Eurostat, 2021.

The figures are expressed in purchasing power standards, which enables the elimination of differences in price levels between countries and therefore allows a comparison of GDP that affords a more accurate reflection of the economic capacity of the citizens of each country. The volume

of GDP per capita in purchasing power standards is expressed in relation to the Europe of the Twenty-Seven (EU-27) average, which takes the value 100. Therefore, if the index of a country is higher than 100, the level of per capita GDP of that country is higher than the EU-27 average and vice versa.

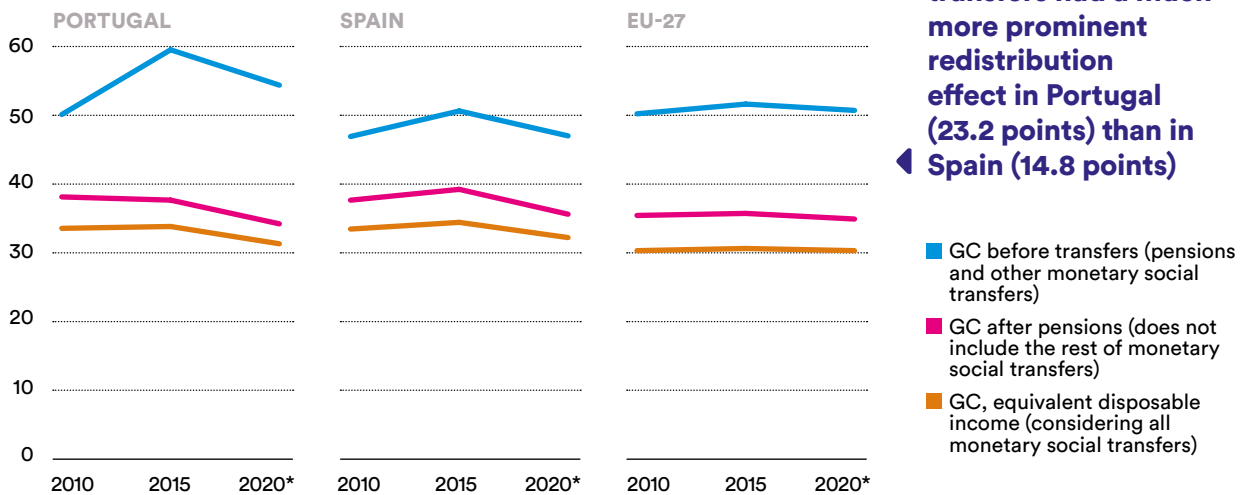


The **Gini coefficient** measures inequality in income distribution. To make it easier to interpret, its values (between 0 and 1) are multiplied by 100, thus ranging from 0 to 100. The closer the coefficient is to 0, the more equal the distribution, while a coefficient close to 100 implies a high concentration of income among a small number of individuals and, therefore, greater inequality.

The **AROPE indicator** of risk of poverty and social exclusion affords a multidimensional view of poverty and social exclusion, taking into account the population that finds itself in at least one of the following three situations: 1) below the risk-of-poverty threshold; 2) severe material deprivation, and 3) living in a household with zero or very low work intensity.

2. Inequality of income distribution

Gini coefficient (GC)

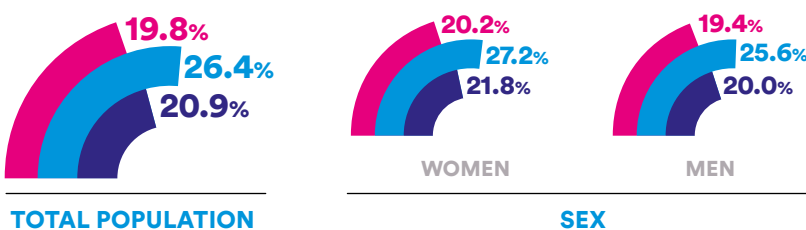


In 2020, social transfers had a much more prominent redistribution effect in Portugal (23.2 points) than in Spain (14.8 points)

Source: Eurostat, 2021. / * The 2020 data refer to the year 2019.

3. People at risk of poverty and social exclusion

AROPE indicator of risk of poverty and social exclusion by sex, Portugal, Spain and EU-27*, 2020



While in Portugal the percentage of women at risk of poverty and social exclusion stands below the European average, in Spain it stands significantly higher

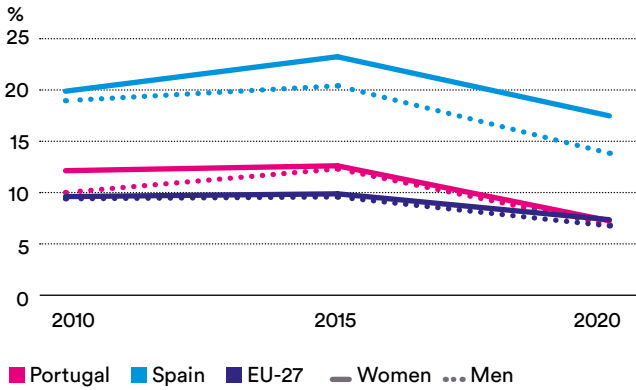
■ Portugal ■ Spain ■ EU-27

Source: Eurostat, 2021. / * The 2020 data refer to the year 2019.

Global view

4. Social exclusion from the labour market

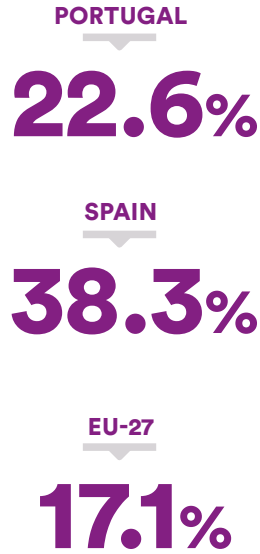
Unemployment rates by sex
Annual average for the total labour force
Portugal, Spain and EU-27, 2020



In 2020, the unemployment rate for women in Portugal (7.1%) was close to the European average (7.2%) and a long way from Spain's rate (17.2%)

Source: Eurostat, 2021.

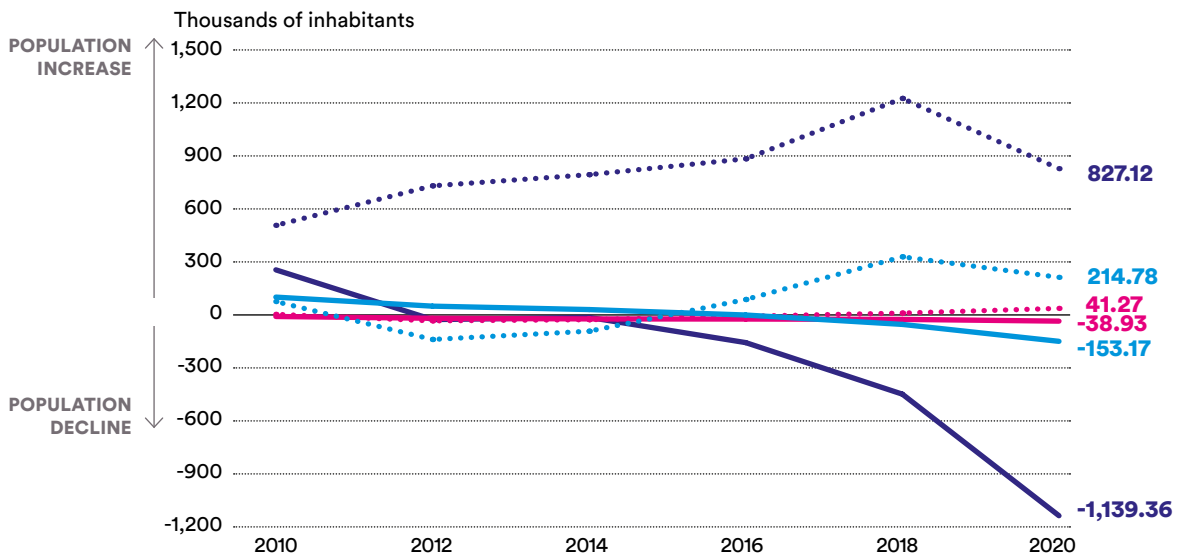
Youth unemployment rate (under 25s), 2020



Source: Eurostat, 2021.

5. Population growth or decline

Population change due to natural causes (births and deaths) and due to migratory movements (arrivals and departures). Portugal, Spain and EU-27, 2020



In 2020, the Portuguese population increased by 2,343 people and the Spanish population by 61,609 people. Without taking into account migratory flows, the population would have decreased by 38,931 and 153,167 people, respectively

Portugal Spain EU-27
Population change due to natural causes Population change due to migratory movements

Source: Eurostat, 2021.

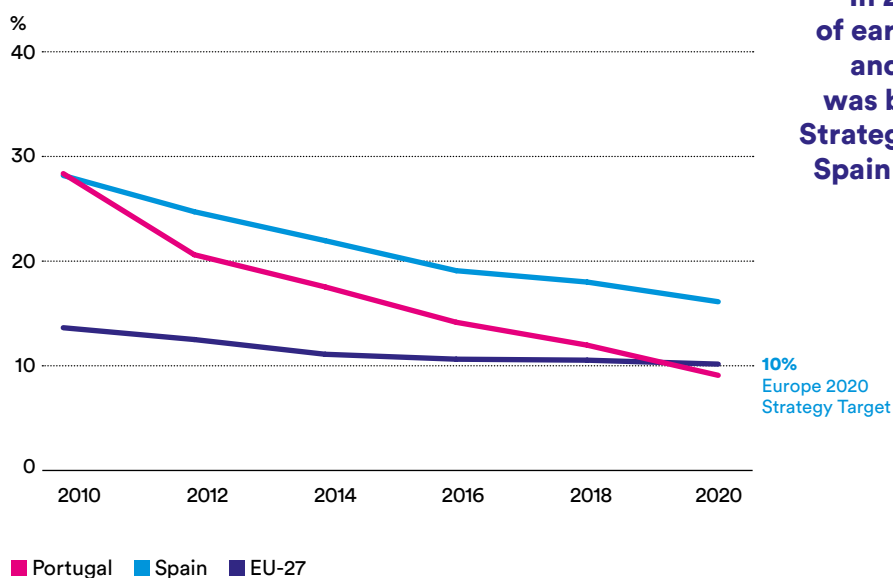


The **rate of early leavers from education and training** reflects the percentage of people aged 18 to 24 whose maximum education

level is the first phase of secondary education and who are not following any kind of education or training.

6. Limitations to human capital formation

Rate of early leavers from education and training
Portugal, Spain and EU-27, 2020

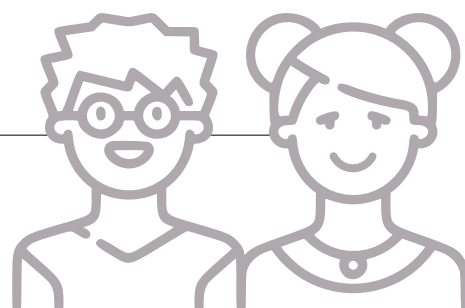
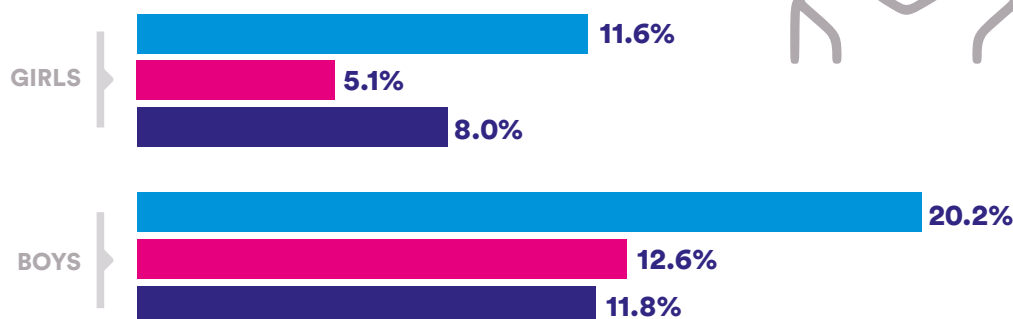


In 2020, the percentage of early leaving of education and training in Portugal was below the Europe 2020 Strategy target (10%), whereas Spain positioned itself above the set target

Source: Eurostat, 2021.

7. Early leavers from education and training (18-24 years)

By sex, 2020



In the EU-27, the disparity between percentages of early leaving from education and training for the two sexes is much lower than in Portugal and in Spain

Legend: Portugal (pink), Spain (blue), EU-27 (dark blue)

Source: Eurostat, 2021.

Indicators on research and development

This section presents a series of key indicators on research and development (R&D) in Portugal and Spain. These indicators originate from European and international databases (European Commission, Elsevier, Eurostat and OECD).

For the purposes of the indicators included in this barometer, it should be indicated that the term research and development refers, according to the OECD's *Manual de Frascati 2015* (Spanish Foundation for Science and Technology, 2018), to the creative and systemic work conducted to increase the stock of knowledge, including knowledge of humanity, culture, and society, as well as the design of new applications of the knowledge available.

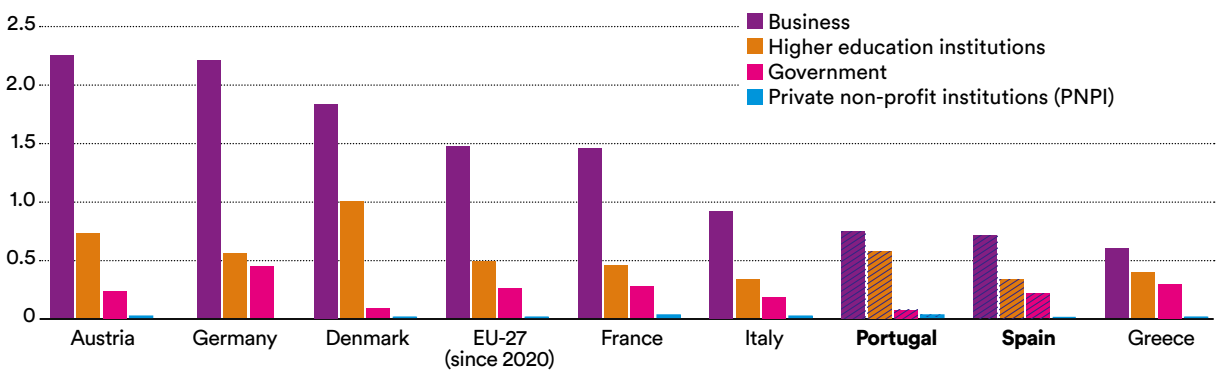
Selection made by
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Universitat de Barcelona

Which sectors of performance spend most in R&D?



1. Expenditure on R&D by sectors

As a % of GDP, 2019



By sectors, businesses represent the largest percentage of spending on R&D. Portugal and Spain, far below the EU-27 average, experienced a similar tendency over the period 2009-2019: investment from the business sector remained stable and the effort of the governmental and the non-business private sector decreased

Source: Eurostat, 2021.

Government budget assigned to R&D

(as a % of total public spending budget, 2019)

Portugal

0.82%

Spain

1.24%

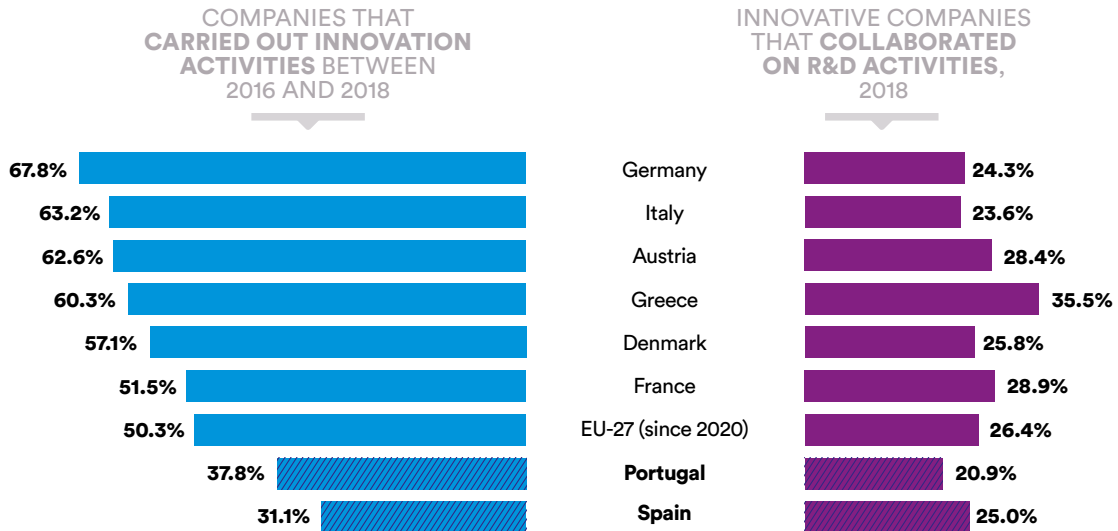
EU-27 (since 2020)

1.43%

Source: Eurostat, 2021.



2. Innovative companies and business cooperation on R&D activities

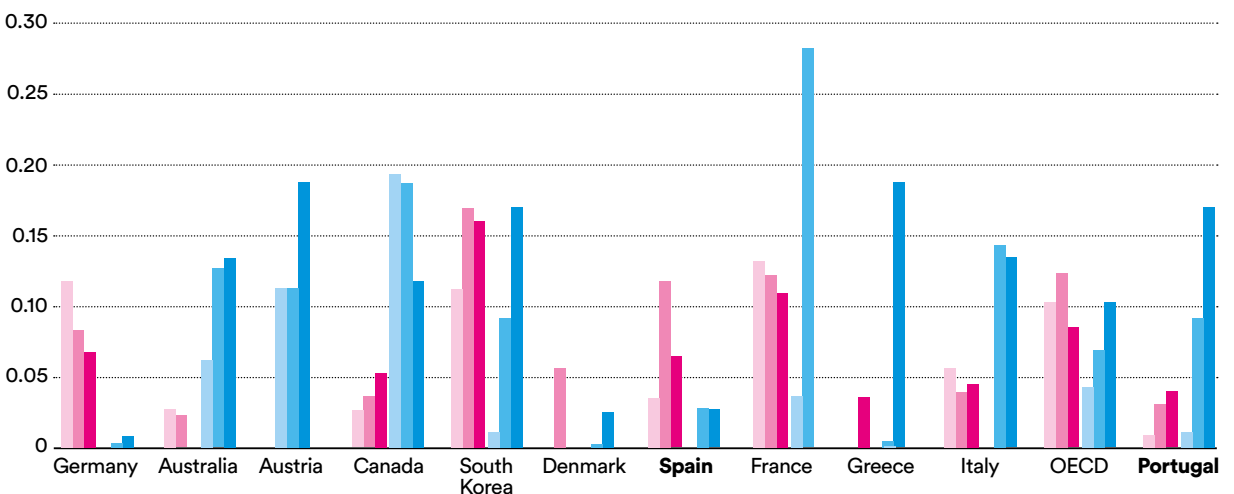


In Portugal and Spain, the proportion of innovative companies, as well as the degree to which these collaborate with other companies and organisations, is lower than the EU-27 average. Furthermore, a large part of collaboration on R&D activities is conducted with companies and organisations from the national sphere

Source: Eurostat, 2021.

3. Direct (grants) and indirect (tax incentives) government support for business R&D

As a % of GDP, 2000-2018



The model of governmental support for business R&D differs between Portugal and Spain, with a predominance of indirect support in Portugal's case and direct support in that of Spain

DIRECT SUPPORT
 2000 2010 2018
INDIRECT SUPPORT
 2000 2010 2018

Source: OECD, 2021.

The human capital of R&D

4. PhD qualifications by different branches of knowledge and by sex

In %, 2019

■ % men
■ % women



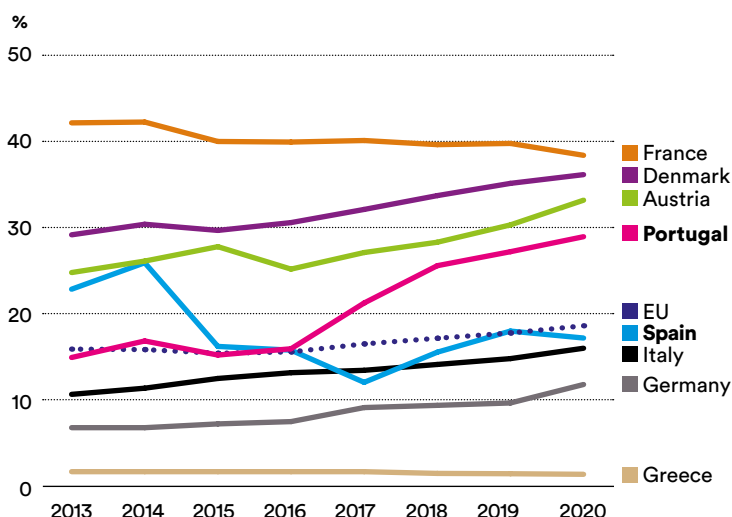
| | ART AND HUMANITIES | SOCIAL SCIENCES, JOURNALISM AND INFORMATION | NATURAL SCIENCES, MATHEMATICS AND STATISTICS | ENGINEERING | HEALTH AND WELFARE |
|--------------------|--------------------|---|--|-------------|--------------------|
| Portugal | 40.9 / 59.1 | 42.0 / 58.0 | 37.9 / 62.1 | 63.2 / 36.8 | 30.5 / 69.5 |
| Italy | 41.4 / 58.6 | 39.4 / 60.6 | 52.2 / 47.8 | 64.7 / 35.3 | 34.1 / 65.9 |
| France | 42.2 / 57.8 | 50.9 / 49.1 | 60.8 / 39.3 | 69.0 / 31.0 | 44.0 / 56.0 |
| Germany | 44.2 / 55.8 | 45.5 / 54.5 | 59.1 / 41.0 | 79.8 / 20.2 | 41.5 / 58.6 |
| EU-27 (since 2020) | 44.5 / 55.5 | 44.0 / 56.0 | 55.1 / 44.9 | 70.6 / 29.4 | 39.7 / 60.3 |
| Greece | 46.0 / 54.0 | 50.5 / 49.6 | 51.5 / 48.5 | 64.1 / 35.9 | 49.5 / 50.5 |
| Spain | 46.6 / 53.5 | 44.8 / 55.2 | 48.1 / 51.9 | 62.3 / 37.7 | 35.8 / 64.2 |
| Austria | 47.2 / 52.8 | 45.8 / 54.2 | 61.1 / 38.9 | 73.7 / 26.3 | 46.3 / 53.7 |
| Denmark | 48.9 / 51.2 | 42.5 / 57.5 | 59.8 / 40.2 | 69.7 / 30.3 | 36.7 / 63.3 |

While the percentage of women with a PhD in Portugal is situated above the EU-27 average in all knowledge sectors considered, in Spain, the participation of women with a PhD is situated below the European average in the fields of art, humanities and social sciences

Source: Eurostat, 2021.

5. Capacity for attracting international talent

Foreign PhD students as a % total of PhD students



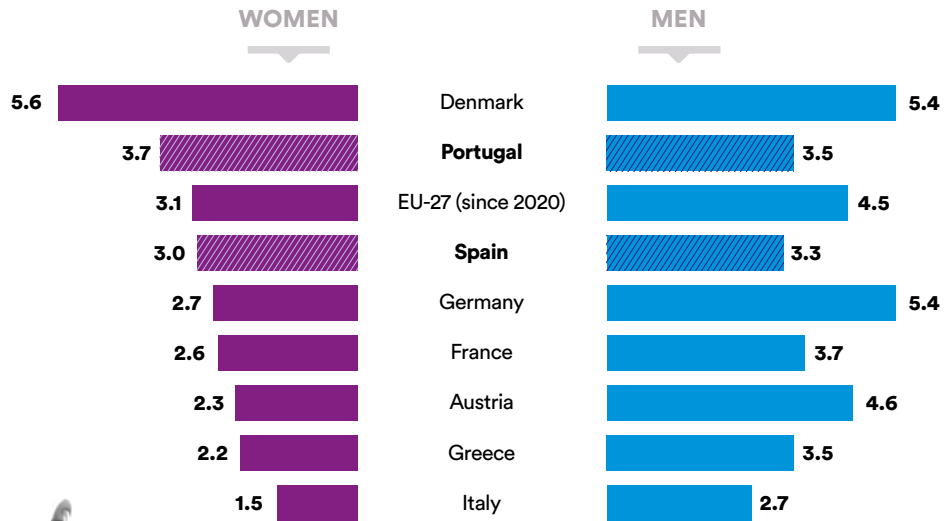
In 2020, the attraction of international talent was situated above the European average (18.7%) in the case of Portugal (29.1%) and below the average (17.2%) in the case of Spain. In recent years, the capacity to attract talent in Portugal has increased and in Spain has stabilized

Source: European Innovation Scoreboard 2021.



6. Scientists and engineers by sex

As a % of the total labour force, 2017



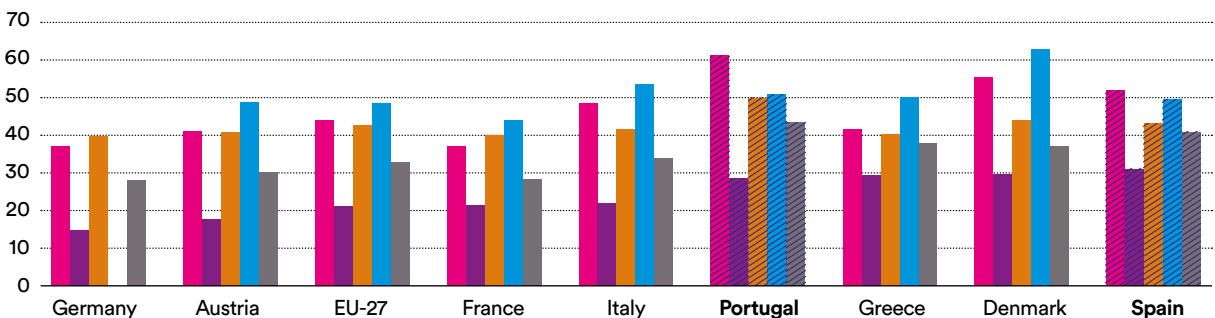
In the majority of EU-27 countries, there is a lower proportion of women employed as scientists and engineers than men in the same situation. Portugal and Denmark are the exception, with percentages of women scientists and engineers that exceed the European average

Source: *She Figures 2018*, European Commission, 2019.



7. Women researchers by sectors

As a % of total research staff, 2018



Portugal and Spain stand above the European average in percentage of female researchers in all sectors considered, although the lowest participation corresponds to the business sector and the highest to the governmental sector

- Government**
- Business*
- Higher education institutions**
- Private non-profit institutions (PNPI)*
- Total

*The data for Germany, Austria, Denmark, France, Greece and the EU-27 refer to 2017.

**The data for Austria, Denmark, France and Greece refer to 2017.

Source: Eurostat, 2021.



8. Authorship of scientific publications, by sex

In %, by thematic areas, 2014-2018

■ % men
■ % women

| | Denmark | Germany | Spain | EU-28 | Italy | France | Portugal |
|-------------------|---------|---------|-------|-------|-------|--------|----------|
| ARTS & HUMANITIES | 63.06 | 61.31 | 58.16 | 56.90 | 56.23 | 56.10 | 48.14 |
| | 36.94 | 38.69 | 41.84 | 43.10 | 43.77 | 43.90 | 51.86 |
| COMPUTER SCIENCES | 82.76 | 84.20 | 75.54 | 79.67 | 74.29 | 79.70 | 73.74 |
| | 17.24 | 15.80 | 24.46 | 20.33 | 25.71 | 20.30 | 26.26 |
| SOCIAL SCIENCES | 60.99 | 60.93 | 56.74 | 56.00 | 55.20 | 56.41 | 48.08 |
| | 39.01 | 39.07 | 43.26 | 44.00 | 44.80 | 43.59 | 51.92 |
| ENGINEERING | 83.18 | 84.30 | 74.14 | 79.26 | 74.53 | 79.17 | 69.83 |
| | 16.82 | 15.70 | 25.86 | 20.74 | 25.47 | 20.83 | 30.17 |
| MATHEMATICS | 87.54 | 84.64 | 76.97 | 80.54 | 73.70 | 80.26 | 73.08 |
| | 12.46 | 15.36 | 23.03 | 19.46 | 26.30 | 19.74 | 26.92 |
| MEDICINE | 55.07 | 56.80 | 48.36 | 52.07 | 48.06 | 49.81 | 42.49 |
| | 44.93 | 43.20 | 51.64 | 47.93 | 51.94 | 50.19 | 57.51 |
| ALL AREAS | 64.76 | 67.98 | 56.19 | 61.49 | 56.24 | 61.09 | 51.68 |
| | 35.24 | 32.02 | 43.81 | 38.51 | 43.76 | 38.91 | 48.32 |

The percentage of women who publish in the STEM areas in Portugal and Spain is higher than the European average, which reflects how the proportion of women researchers in the academic sector exceeds, in turn, the European average

Source: *The Researcher Journey Through a Gender Lens*, Elsevier, 2020.

9. Scientific publications within the 10% of the most cited publications worldwide

As a % of the country's total scientific publications, 2020



Although Portugal and Spain have significantly increased their scientific production, their impact, measured as frequently cited publications, continues to be slightly lower than the European average

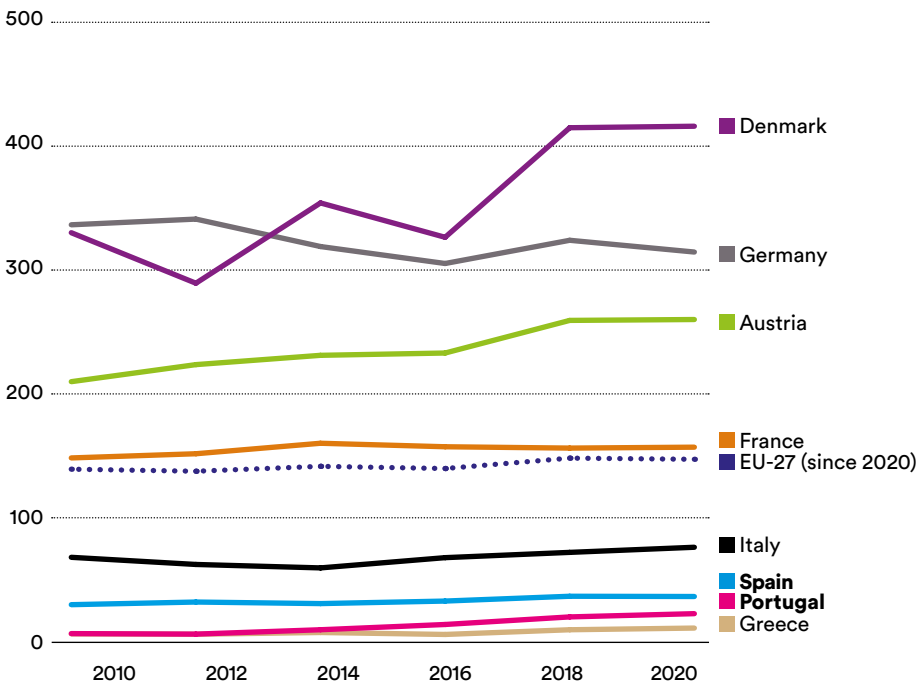
Note: the percentage of the country's scientific publications within the most frequently cited 10% worldwide provides a measure of scientific excellence.

Source: European Innovation Scoreboard, European Commission, 2021.



10. Patent applications submitted to the European Patents Office

Per million inhabitants, 2010-2020



A country's **patents** are an indicator of the result of the innovation and competitive advantage of its companies.



The relative position of Portugal and Spain, with regard to patent applications, is very distant from countries that are leaders in innovation. However, the growth over the period 2010-2020 was higher than the European average (6%) both in Spain (23%) and, very notably, in Portugal (216%)

Source: Eurostat, 2021.

11. Women inventors

Ratio with respect to men, 2013-2016



Although only one out of every ten inventors in Europe is a woman, the proportion in Portugal is one out of every four and in Spain, one out of every five

Source: *She Figures 2018*, European Commission, 2019.



Although it is difficult to define and measure innovation, its undoubted importance for the economy, society and the environment has required the development of synthetic indicators that enable its most important components to be recorded and measured.

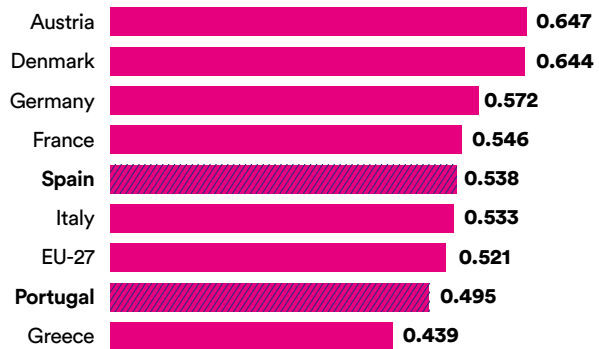
The **Eco-Innovation Index** provides a holistic view of innovation from the economic, environmental and social spheres. For this, it is based on sixteen indicators grouped into five dimensions: inputs, outputs, activities, socioeconomic results and resources efficiency.

The **Digital Economy and Society Index (DESI)**, is a composite index referring to digital performance in Europe that is calculated as a weighted average of five main dimensions: connectivity (25%), human capital (25%), internet use (15%), integration of digital technology (20%) and digital public services (15%).

12. Eco-Innovation Index

2021

Portugal is in an intermediate situation in relation to the leading countries in environmental innovation, whereas Spain is among the leading countries

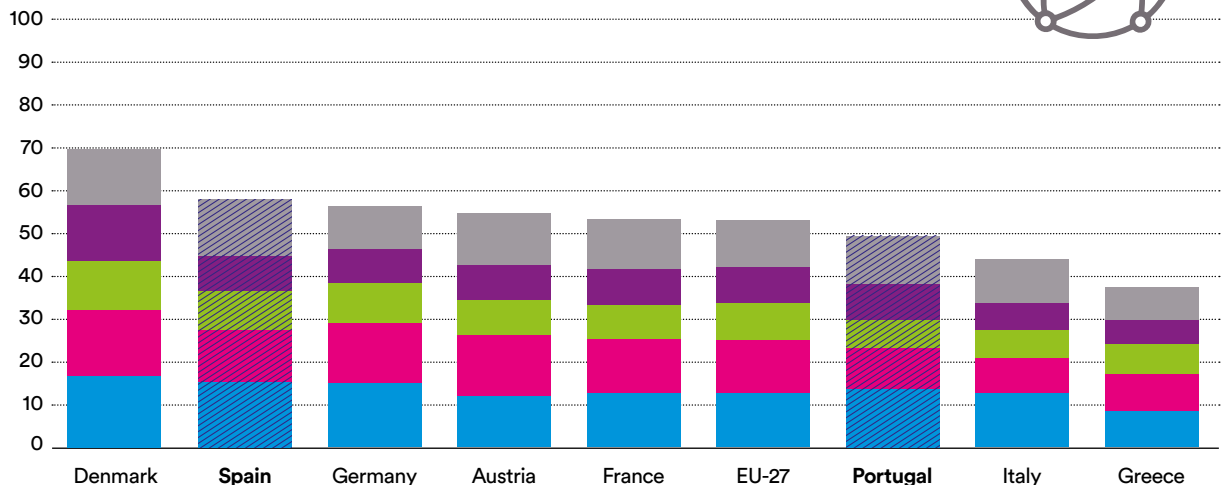


Source: Eco-Innovation Index, European Commission, 2021.

13. Digital Economy and Society Index

2020

Score (0 to 100)



■ Connectivity
■ Human capital
■ Internet use
■ Integration of digital technology
■ Digital public services

Source: DESI, European Commission, 2020.