Monitoring industrial ecosystems

EU MEMBER STATES FACT SHEETS

Portugal

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Key Highlights

This country report has been developed as part of the '**European Monitor of Industrial Ecosystems**' project of the European Commission, Directorate General for Internal Market, Industry, Entrepreneurship and SMEs and the European Innovation Council and SMEs Executive Agency. It provides data insights into the twin transition and the technological performance of industrial ecosystems. The key findings of the report are summarised below:

Portugal

Technological performance in industrial ecosystems:

- In a global comparison, Portugal ranked the highest in **Renewable Energy Technologies, Agri-Food, Health and Textiles** in terms of its share of world patent applications among the EU27 countries.

Digital and green transition technologies:

- Within the EU27, Portugal ranked the highest in generating green and digital technologies in **Advanced Materials, Renewable Energy, Biotechnology,** and respectively **in Micro- and Nanoelectronics and Big Data.**
- It has dynamically increased most remarkably its relative strengths in **Wind Power**, but also in Renewable Energy Technologies and in other renewables such as geothermal or biomass.
- In the field of the digital transition, Portugal has dynamically **increased its global share of patent applications in Big Data and Artificial Intelligence.**

World share of patent applications in industrial ecosystems of Portugal

Legend: Renewable Energies, Agri-Food, Health, Textiles, Construction, Mobility & Automotive, Digital, Electronics, Aerospace and Defence

Source: Fraunhofer ISI based on PATSTAT
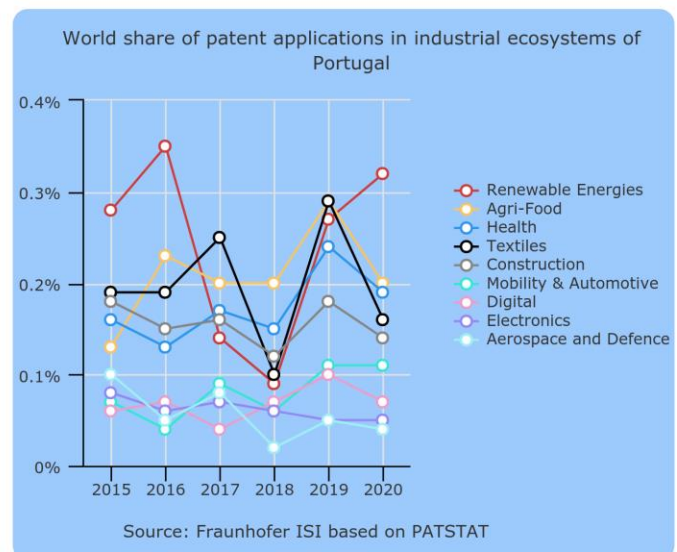
Capacity to produce goods based on digital and green technologies:

- Portugal's share of production in digital technologies over global production indicates that it created the highest value by the deployment of **Big Data and Digital Security.** Trends over time show a dynamic increase in its global share only in Big Data and a decrease or stagnation in all other digital technology related goods.
- In the field of green transition technologies, Portugal created the highest value by the deployment of **Energy Saving and Renewable Energy Technologies.** However, their trends remained stagnant over time.

1. Introduction

This country report has been prepared within the '**European Monitor of Industrial Ecosystems' (EMI)** project, initiated by the European Commission, Directorate General for Internal Market, Industry, Entrepreneurship and SMEs and the European Innovation Council and SMEs Executive Agency (EISMEA). The overall goal of the project is to **analyse the green and digital transformation of industrial ecosystems**.

The EU's updated industrial strategy from May 2021[1] has outlined 14 industrial ecosystems that are in the focus of the project. The 14 industrial ecosystems include *aerospace and defence, agri-food, construction, cultural and creative industries, digital, electronics, energy intensive industries, energy-renewables, health, mobility – transport – automotive, proximity, social economy and civil security, retail, textile and tourism.* The industrial strategy defined industrial ecosystems as encompassing all players operating in a value chain: from the smallest startups to the largest companies, from academia to research, service providers to suppliers[2].

The objective of this report is to **present key findings from data** collected within the framework of this project at country level notably on **patent applications, production data, trade** (available only for ten industrial ecosystems)**, private equity and venture capital** investments. Nonetheless, this report does not aim to be comprehensive; the data presented here only complement other important statistics on technology development in each country.

The monitoring framework has a technological focus. Industrial transition is driven by technological, economic, and social changes, and in particular by digital technologies and the shift to a green and circular economy. The green and digital technologies that have been taken into account are presented in the table below.

Table 1: Technologies monitored in the project by patent, trade and prodcom data

Green technologies	Digital technologies
Advanced Materials and Nanotechnology	Advanced Manufacturing & Robotics
Biotechnology (for sustainability)	Advanced Manufacturing
Energy Saving Technologies	Robotics
Renewable Energy Technologies	Artificial Intelligence
Solar Power	Big Data
Wind Power	Digital Security & Networks/ Cybersecurity
other (geothermal, hydropower, biomass)	Digital Technology for Mobility
	Internet of Things
	Micro- and Nanoelectronics & Photonics
	Micro- and Nanoelectronics
	Photonics

Source: Technopolis Group, IDEA Consult and Fraunhofer ISI

The methodological report that sets the conceptual basis and explains the technical details of each indicator is available on the EMI website. This report was prepared by Tiago Pereira, IDEA Consult for the European Commission. However, it does not necessarily reflect the views of the European Commission.

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[1] European Commission (2021). Communication on Updating the 2020 New Industrial Strategy, COM(2021)350 final https://commission.europa.eu/system/files/2021-05/communication-industrial-strategy-update-2020_en.pdf
[2] European Commission (2020). A New Industrial Strategy for Europe, COM/2020/102 final Commission Communication: A New Industrial Strategy for Europe | European Commission (europa.eu)

2. Advanced technologies fostering the green and digital transition of industrial ecosystems

2.1. Data sources

This chapter outlines a set of indicators that capture the capacities of EU Member States to generate technologies that foster the green and digital transformation of industrial ecosystems. Industries that are underpinned by a strong technology basis and supported by vibrant entrepreneurial communities have better conditions for success. The production of technology-based products indicates that technologies are commercialised, while a positive trade balance in technologies is a sign of international competitiveness.

Patent analysis is a widely used method for tracking technological development activities. With a view to industrial ecosystems under study in this project, technology generation and hence patenting takes place in a relatively limited number of ecosystems, while others mainly profit from technologies generated elsewhere. Technology development drives industrial transformation in a general way. The patent analysis is based on transnational patents, notably those filed through the WIPO PCT procedure[3] or at the European Patent Office[4] directly. They have been localised based on the address of the applicant. The different advanced technologies have been identified based on International Patent Classification (IPC) codes and keyword searches.

Trade data, more specifically export data, is a further relevant indicator to document industrial development at higher technology readiness levels. It informs on countries' competitive advantage in specific technology-based product areas. While somewhat simplistic, export strengths in certain technological areas still mark a specific relevance of technology relevant goods for the economy and remain among the reliable indicators of performance. The analysis focuses on trade balances based on UN Comtrade[5] statistics processed specifically for the purposes of this project. The trade balance can help reveal how nations are intricately involved in supply chains with substantial imports and relevant exports. By putting exports in relation to parallel imports, it is possible to assess whether a country displays strength in production.

Prodcom data[6] allows the monitoring of technology diffusion. Prodcom provides statistics on the production of manufactured goods carried out by enterprises on the national territory of the reporting countries. It helps measuring the uptake of technology through the production of manufactured goods by focusing on the specific components and elements enabled by green and digital technologies. Production data allows to measure to what extent technology-related products are being produced in the country. The production indicators are calculated based on product-level data from the Eurostat's Prodcom database.

Crunchbase data[7] were used to analyse entrepreneurial dynamics and private equity and venture capital investment. Crunchbase is a widely trusted source of information on venture capital backed innovative companies. Technology startups represent key building blocks in the transition towards a more digital, green and resilient economic model. Entrepreneurial activity helps accelerate the diffusion of technologies in industrial ecosystems and startups that provide green and digital solutions are relevant indicators of how the industrial ecosystem is transforming itself to reach environmental sustainability objectives. More information about these data sources can be found in the methodological report of the project.

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[3] World Intellectual Property Organization, WIPO Patent Cooperation Treaty (PCT) https://www.wipo.int/pct/en/
[4] European Patent Office, Supporting Innovation and Patents in Europe https://www.epo.org/en
[5] United Nations Comtrade, UN Comtrade Plus-International Trade Data Platform https://comtradeplus.un.org/
[6] Eurostat, Eurostat PRODCOM-European Union Production and Trade Statistics https://ec.europa.eu/eurostat/web/prodcom
[7] Crunchbase, Business Information and Networking Platform https://www.crunchbase.com/

2.2. Technology development in industrial ecosystems

Regarding technology development, Portugal has been the most specialised in the Health, Agri-Food and Digital industrial ecosystems in 2020 as captured by patent data. In a global comparison, it had relative strengths in Renewable Energies, Health, and Textiles within the EU27 countries.
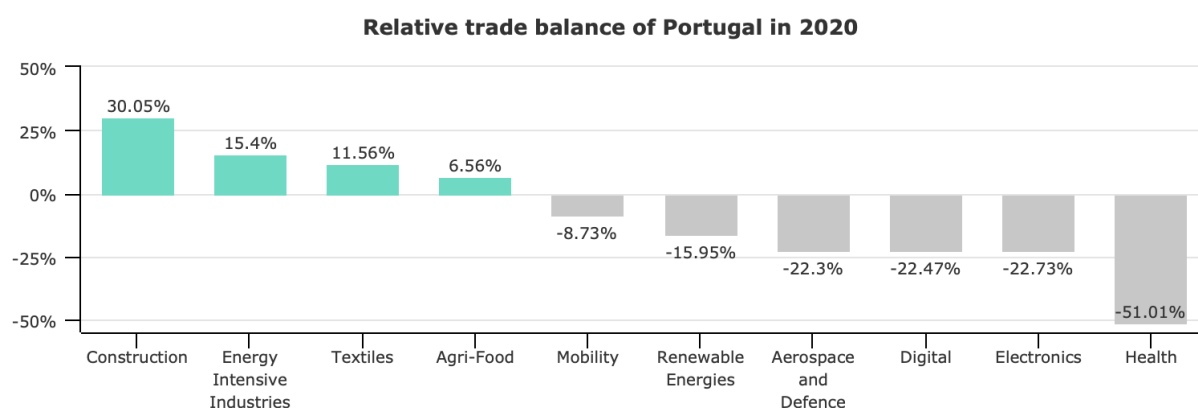
Figure 1: Country share and world share (expressed in terms of ranking) in patent applications in industrial ecosystems related technologies

Portugal's share of patent applications within country in industrial ecosystems in 2020

Industrial ecosystem	Share
Health	24.86%
Agri-Food	23.2%
Digital	14.36%
Electronics	8.56%
Mobility	6.35%
Construction	3.87%
Renewable Energies	3.04%
Textiles	2.21%
Aerospace and Defence	0.55%
Energy-Intensive Industries	0%

Ranking of Portugal within EU27 in terms of its share of global patent applications in 2020 (1 - best performer, 27 worst performer)

Renewable Energies	**12**
Health	13
Textiles	13
Agri-Food	14
Construction	14
Digital	15
Electronics	16
Mobility	16
Energy Intensive Industries	19
Aerospace and Defence	22

Source: Fraunhofer ISI based on Patstat

Trade is a common indicator of international competitiveness because it shows how attractive a country's products are outside of its domestic market. Total exports provide evidence about a country's role as a producer, and trade balance captures its sovereignty in certain areas of production. Figure 2 displays the trade balance in relation to overall trade volume by technology development in industrial ecosystems. Portugal registered a trade surplus in technology-based products related to the Construction, Energy-Intensive Industries, Textiles and Agri-Food industrial ecosystems.

Figure 2: Trade balance in relation to overall trade volume ((exp - imp)/(exp+imp)) (2020)

Relative trade balance of Portugal in 2020

Industrial ecosystem	Relative trade balance
Construction	30.05%
Energy Intensive Industries	15.4%
Textiles	11.56%
Agri-Food	6.56%
Mobility	-8.73%
Renewable Energies	-15.95%
Aerospace and Defence	-22.3%
Digital	-22.47%
Electronics	-22.73%
Health	-51.01%

Source: Fraunhofer ISI based on UNCOMTRADE

Most private equity and venture capital investment in Portugal went into innovative companies operating in Tourism, followed by Retail and Health over the period from 2015 to 2023.

Figure 3: Private equity and venture capital investment into tech companies related to industrial ecosystems in Portugal

Private equity and VC investment into Portuguese firms (estimate for 2015-2023)

Tourism	€566.64 M	
Retail	€105.61 M	
Health	€86.22 M	
Mobility	€73.96 M	
Creative and Culture	€44.41 M	
Agri-Food	€21.77 M	
Proximity Economy	€8.3 M	
Energy Intensive Industries	€7.88 M	
Aerospace and Defence	€2.05 M	
Construction	€1.89 M	
Textile	€1.75 M	
Renewable Energy	€0.84 M	
Electronics	€0.59 M	
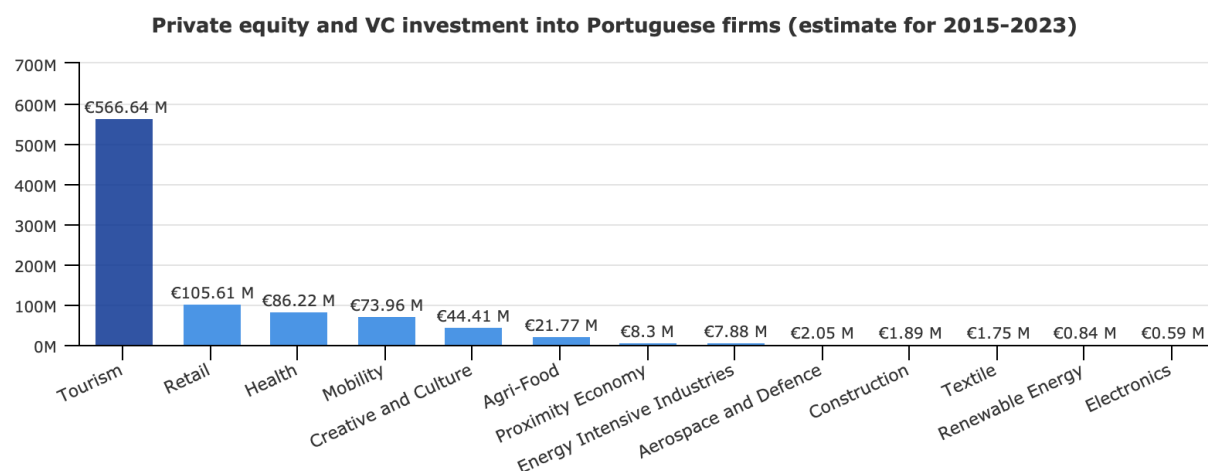
Source: Technopolis Group based on Crunchbase

2.3. Green transformation

Within the country, Portugal has been the most specialised in generating technologies related to Renewable Energy Technologies, which has the potential to drive the green transformation of its ind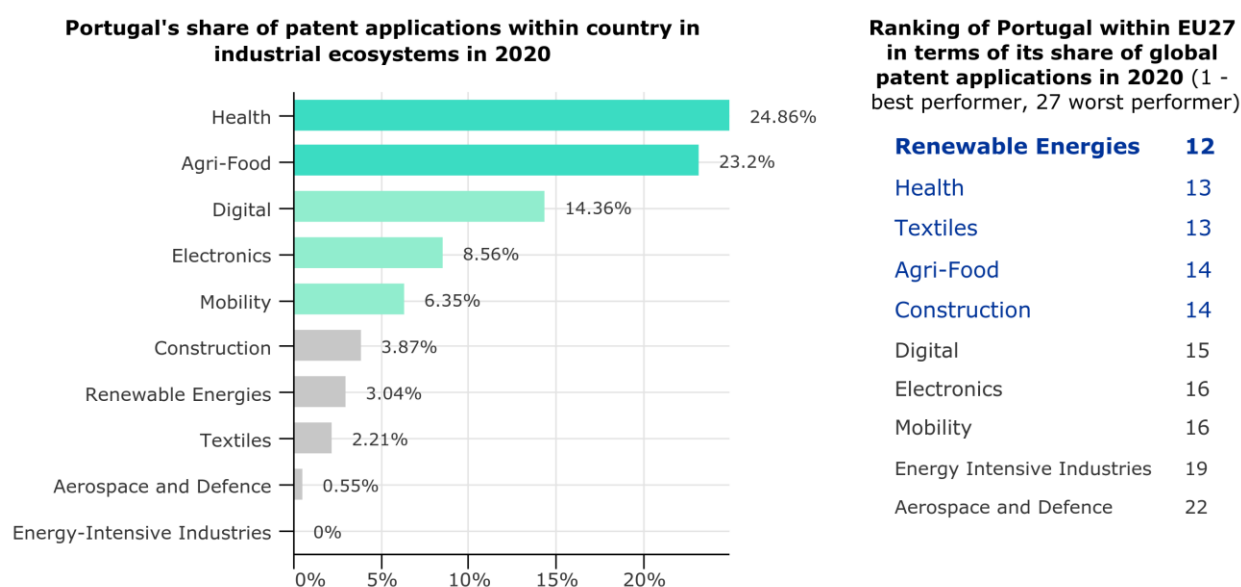ustries. In a global comparison, Portugal has ranked at the 12th place among the EU27 Member States in generating technologies related to Renewable Energy Technologies.

Figure 4: Country specialisation and world share (expressed in terms of ranking) in patent applications of Portugal

Portugal's share of patent applications within country in industrial ecosystems in 2020

Health	24.86%
Agri-Food	23.2%
Digital	14.36%
Electronics	8.56%
Mobility	6.35%
Construction	3.87%
Renewable Energies	3.04%
Textiles	2.21%
Aerospace and Defence	0.55%
Energy-Intensive Industries	0%

Ranking of Portugal within EU27 in terms of its share of global patent applications in 2020 (1 - best performer, 27 worst performer)

Renewable Energies	**12**
Health	13
Textiles	13
Agri-Food	14
Construction	14
Digital	15
Electronics	16
Mobility	16
Energy Intensive Industries	19
Aerospace and Defence	22

Source: Fraunhofer ISI based on Patstat

The trends in global patent applications show that Portugal significantly increased its share in Renewable Energy Technologies, particularly in Wind Power, and Other Renewables including Geothermal, Hydropower and Biomass.

Figure 5: Trends over time in Portugal's share in world patent applications

Share of world patent applications of Portugal
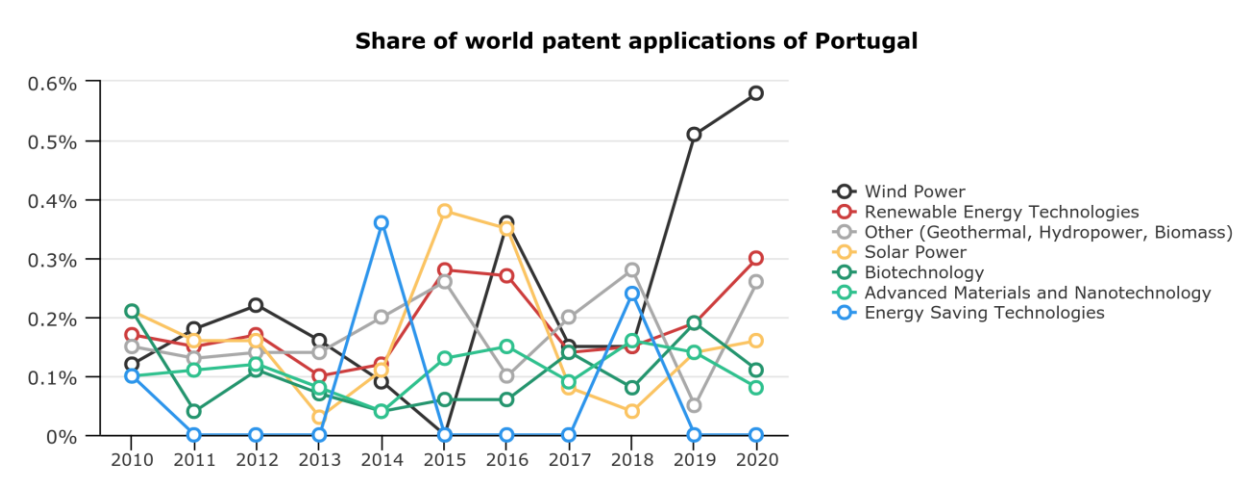
Source: Fraunhofer ISI based on Patstat

The Prodcom-based indicator measures the share of advanced technology-related production in Portugal for a given year. The share of production in a certain technology over Portugal's total production indicates that Portugal has the largest shares in Energy Saving Technologies and Renewable Energy Technologies.

Figure 6: Production of advanced technology-based products in Portugal

Portugal's share in the global production of green technology-based goods

Source: IDEA Consult based on Prodcom data

2.4. Digital transformation

Portugal has been the most specialised in Micro- and Nanoelectronics among the digital technologies monitored in this project, and it ranked thirteenth among EU countries in this field in 2020. Additionally, Portugal demonstrates significant international strength in Big Data based on its share of world patent applications.
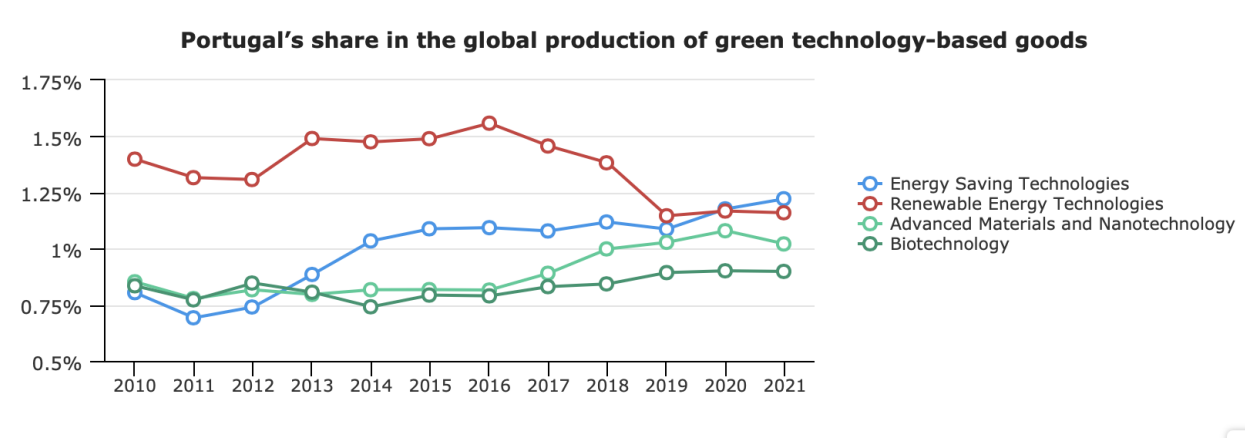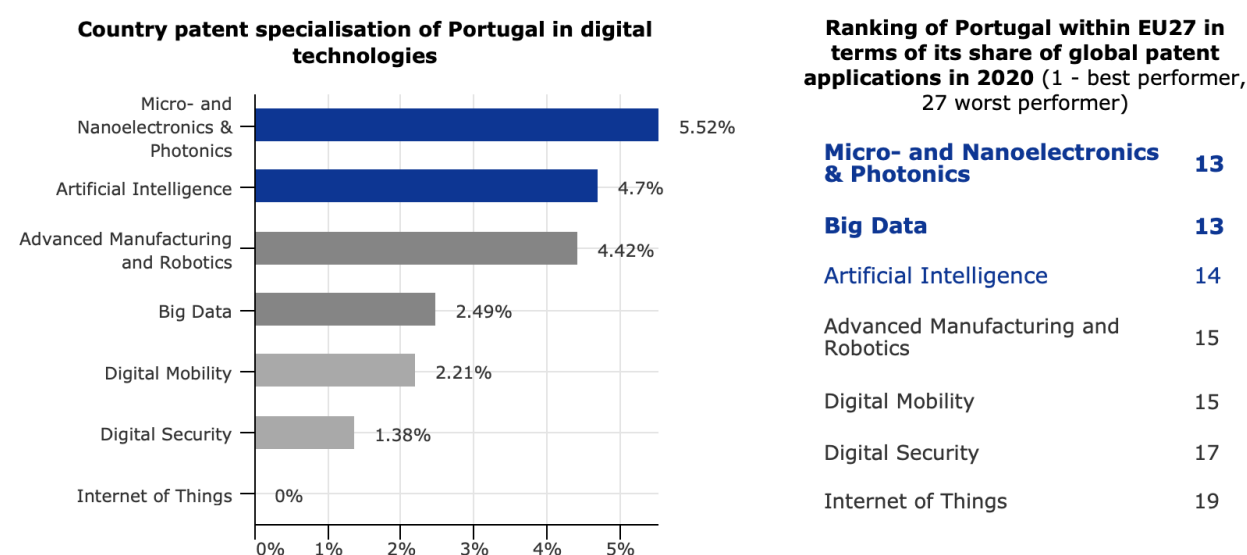
Figure 7: Country specialisation and world share (expressed in terms of ranking) in digital technology related patent applications of Portugal

Country patent specialisation of Portugal in digital technologies

Ranking of Portugal within EU27 in terms of its share of global patent applications in 2020 (1 - best performer, 27 worst performer)

Micro- and Nanoelectronics & Photonics	**13**
Big Data	**13**
Artificial Intelligence	14
Advanced Manufacturing and Robotics	15
Digital Mobility	15
Digital Security	17
Internet of Things	19

Source: Fraunhofer ISI based on Patstat

Trends over time indicate an increase in the world share of Portugal in Big Data (over the period from 2016-2020) and Artificial Intelligence technologies (since 2018) that underpin its digital industrial ecosystem. Nevertheless, trends over time indicate a decrease in the field of Digital Security and the Internet of Things.
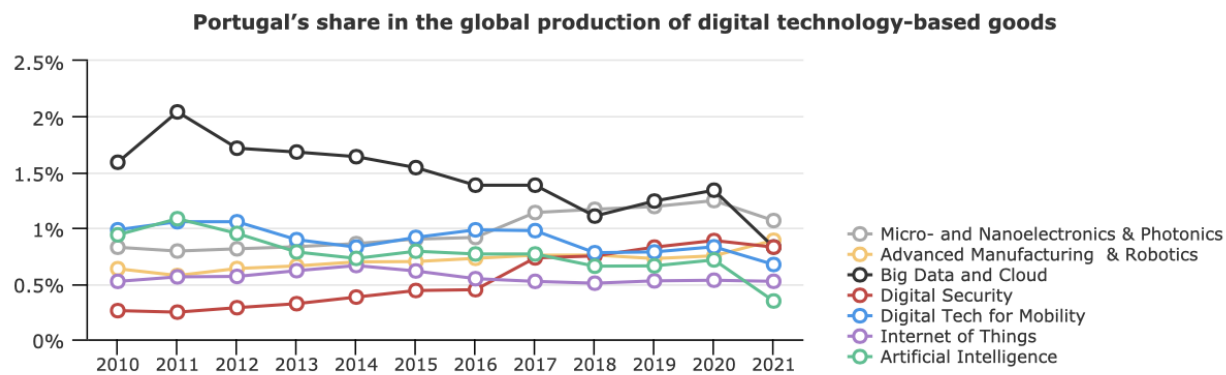
Figure 8: Trends over time in Portugal's share of world patent applications

Share of world patent applications of Portugal
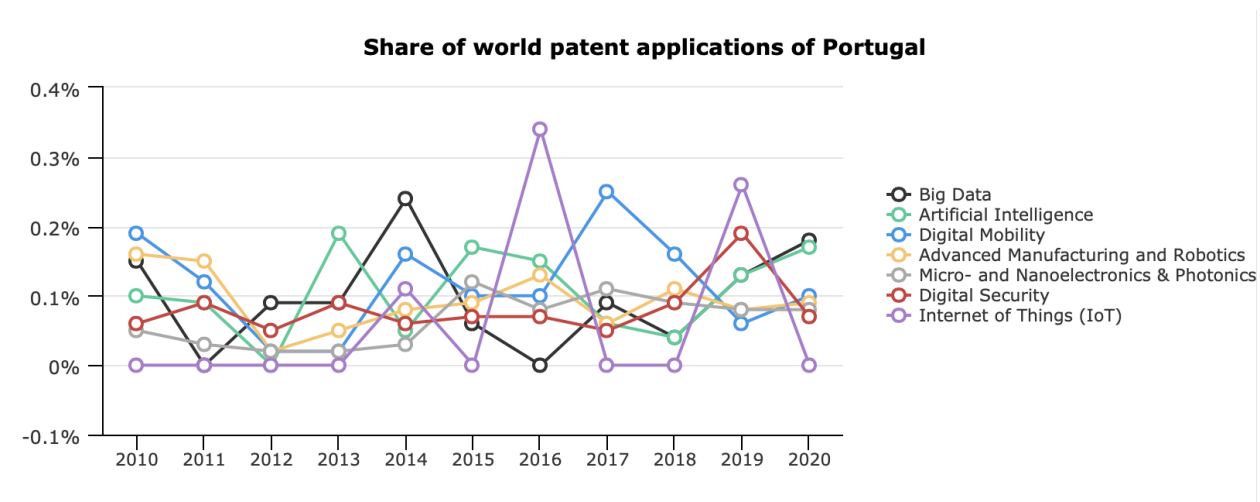
Source: Fraunhofer ISI based on Patstat

The Prodcom-based indicator measures the share of Portugal in advanced technology-related production for a given year. The share of production in a certain technology over Portugal's total production indicates an overall decrease across all technologies. Portugal had the largest shares in Micro-Nanoelectronics and Photonics, where it managed to increase its share in global production over time indicating that its technological strengths are also translated into commercialised products.

Figure 9: Production of advanced technology-based products in Portugal

Portugal's share in the global production of digital technology-based goods

Legend:
- Micro- and Nanoelectronics & Photonics
- Advanced Manufacturing & Robotics
- Big Data and Cloud
- Digital Security
- Digital Tech for Mobility
- Internet of Things
- Artificial Intelligence

Source: IDEA Consult based on Prodcom data