Monitoring industrial ecosystems

EU MEMBER STATES FACT SHEETS

Finland

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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:

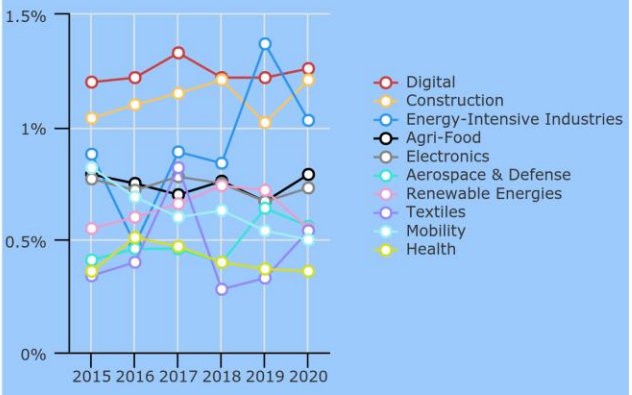
Technological performance in industrial ecosystems:

- Finland had the highest country share of patent applications in the **Digital, Construction and Energy Intensive industrial ecosystems** in 2020 as captured by patent data. In a global comparison, it ranked fifth within the EU27 countries in the Digital industrial ecosystem.

Digital and green transition technologies:

- Among the digital technologies monitored in this project, Finland had the highest country share of patent applications in **Advanced Manufacturing and Robotics.** In the field of green transition technologies, Finland created the most value in related to **Advanced Materials and Nanotechnology.**
- Trends in the world's patent applications show that Finland overall decreased its global share in all green technologies fields, with a recent surge in **Advanced Materials and Nanotechnologies.**
- In the field of digital technologies, the world share of Finland decreased for all technologies from 2010 to 2020.

World share of patent applications in industrial ecosystems of Finland



Source: Fraunhofer ISI based on PATSTAT

Capacity to produce goods based on digital and green technologies:

- Finland's share of production in digital technologies over global production indicates that it created the highest value by deploying **Advanced Manufacturing and Robotics** technologies across all manufactured goods in the economy in 2021. Trends over time show that overall Finland has decreased its share across all digital technologies except for AI and Big Data, where it remained constant over time.
- In the field of green transition technologies, there is a decreasing trend for Energy Saving and Renewable Energy Technology.

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
Advanced Materials and Nanotechnology
Biotechnology (for sustainability)
Energy Saving Technologies
Renewable Energy Technologies
Solar Power
Wind Power
other (geothermal, hydropower, biomass)

Digital technologies
Advanced Manufacturing & Robotics
Advanced Manufacturing
Robotics
Artificial Intelligence
Big Data
Digital Security & Networks/ Cybersecurity
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 Izabella Martins Grapengiesser, Technopolis Group for the European Commission. However, it does not necessarily reflect the views of the European Commission.

[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.

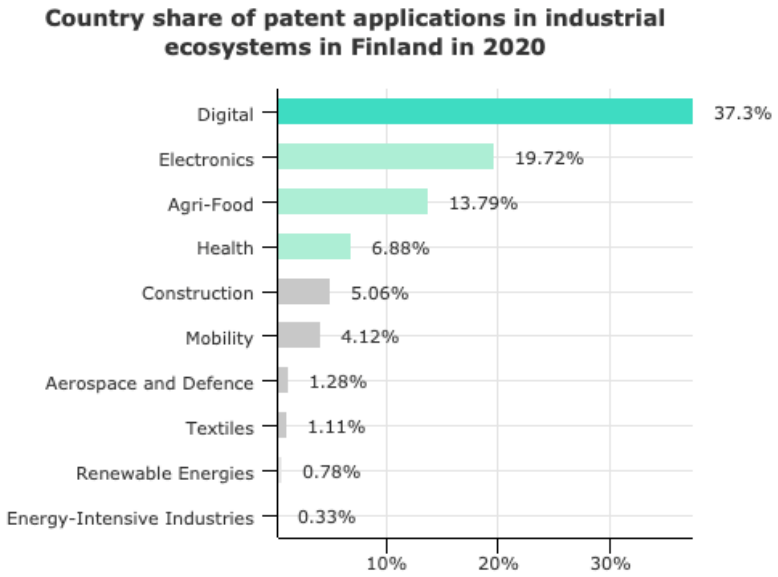
Crunchbase data[7] were used to analyse entrepreneurial dynamics and private equity and venture capital investment. Crunchbase is a widely trusted source of information on venture capital backed innovative companies. Technology startups represent key building blocks in the transition towards a more digital, 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.

[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

Finland had the highest share of its patent applications within the country in the Digital, Electronics and Agri-Food industrial ecosystems in 2020 as captured by patent data. In a global comparison, it ranked at the fourth place within the EU27 countries in the Digital ecosystem.

Figure 1: Country share and world share (expressed in terms of ranking) in patent applications in industrial ecosystems related technologies



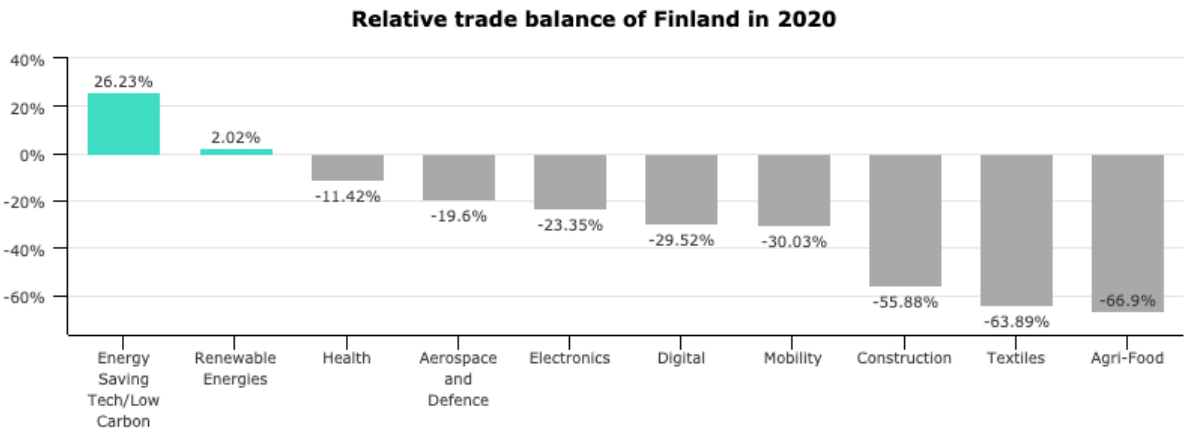
Ranking of Finland within EU27 in terms of its share of global patent applications in 2020
(1 - best performer, 27 worst performer)

Digital	**4**
Energy-Intensive Industries	7
Electronics	7
Aerospace and Defence	8
Textiles	9
Construction	10
Agri-Food	10
Mobility	10
Renewable Energies	10
Health	11

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. Finland registered a trade surplus in technology-based products related to Energy Saving and Renewable Energies.

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



Source: Fraunhofer ISI based on UNCOMTRADE

Most private equity and venture capital investment went into innovative Finnish tech companies operating in the field of Electronics, Creative and Culture, and Health, over the period from 2015 to 2023. As also confirmed by the Finnish Venture Capital Association[8], the

[8] Finnish Venture Capital Association https://paaomasijoittajat.fi/

Finnish startup and venture capital ecosystem has been performing successfully in recent years and startups attracted high amount of venture capital.

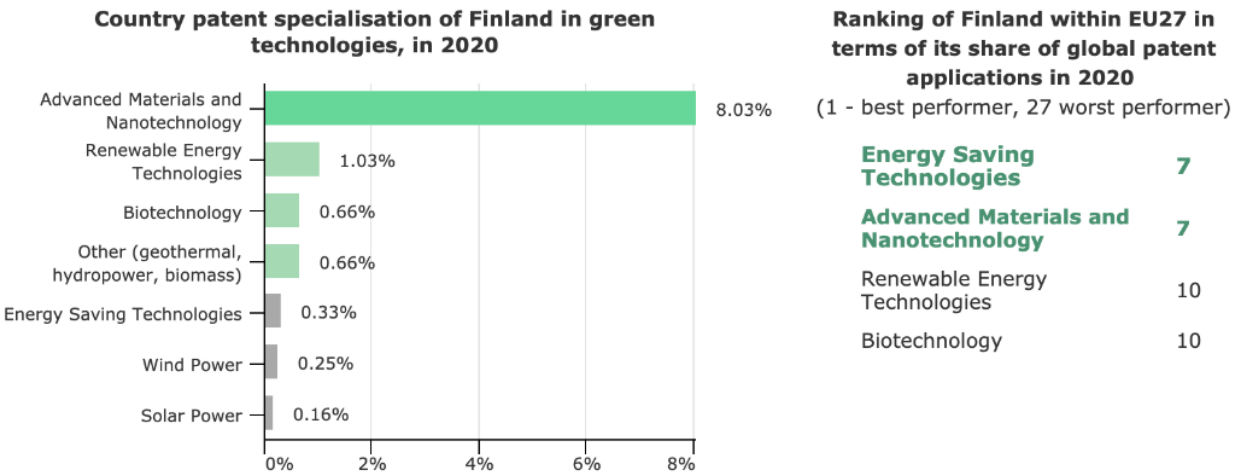
Figure 3: Private equity and venture capital investment into tech companies related to industrial ecosystems in Finland

Source: Technopolis Group based on Crunchbase

2.3 Green transformation

Within the country, Finland has been the most specialised in generating technologies related to Advanced Materials. In a global comparison, Finland ranked at seventh place among the EU27 Member States in generating technologies related to Energy Saving Technologies and Advanced Materials.

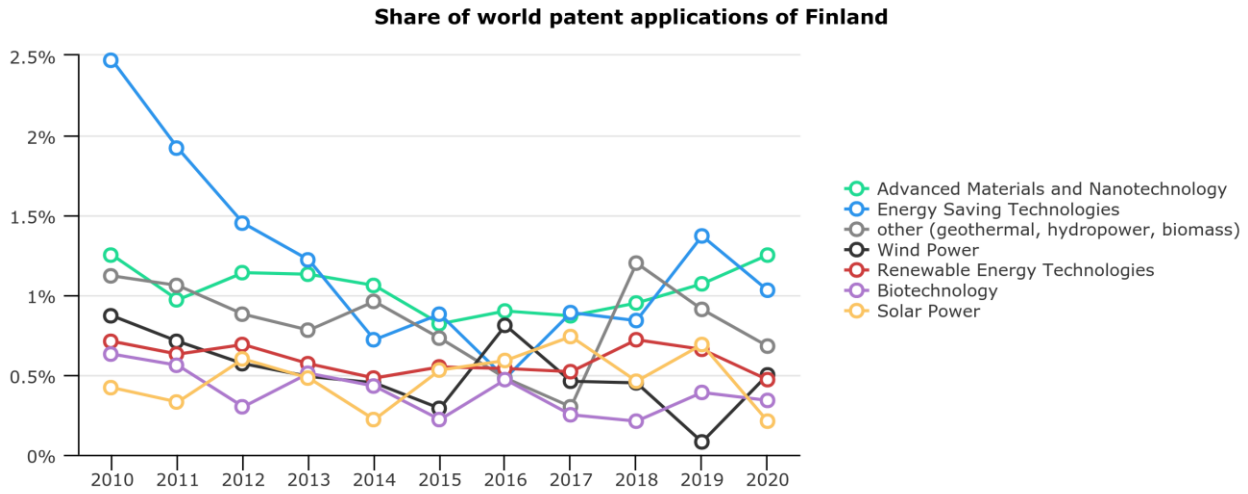
Figure 4: Country specialisation and world share (expressed in terms of ranking) in patent applications of Finland



Source: Fraunhofer ISI based on Patstat

The trends in global patent applications indicate that Finland's share in various green technology fields has either remained stable or decreased over the period from 2010 to 2020, with some fluctuations. Its share shows a sharp decline in Energy Saving Technologies. Finland managed to increase its share of world patent applications in Advanced Materials and Nanotechnology since 2015 (particularly in Nanotechnology).

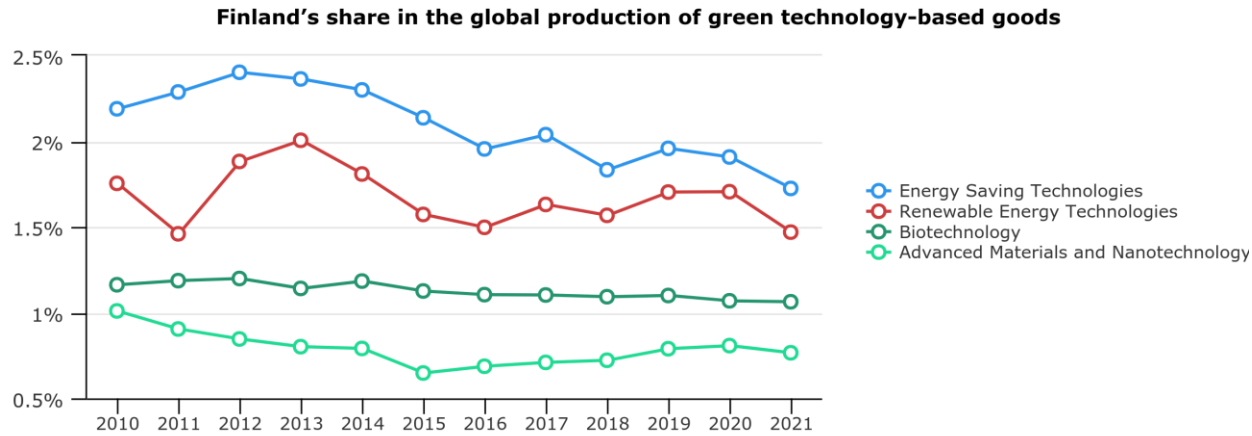
Figure 5: Trends over time in Finland's share in world patent applications



Source: Fraunhofer ISI based on Patstat

The Prodcom-based indicator measures the share of advanced technology-related production in Finland for a given year. The share of production in a certain technology over Finland's total production indicates an overall decrease in the case of Energy Saving Technologies, and Renewable Energy Technologies.

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

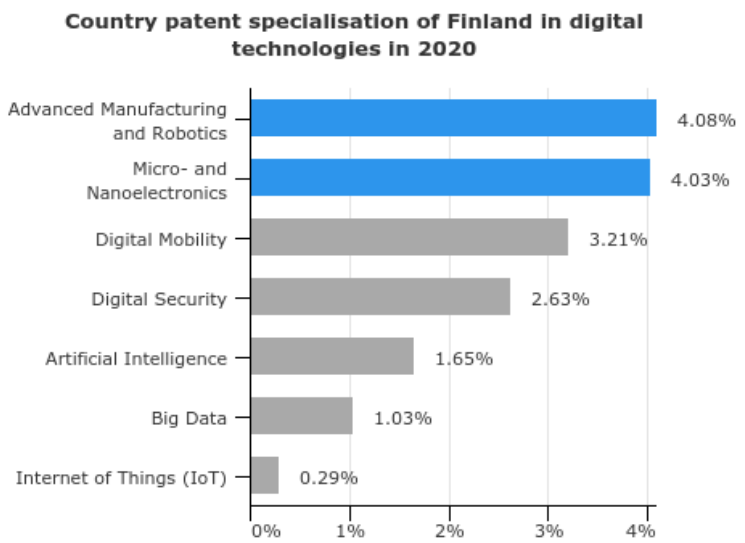


Source: IDEA Consult based on Prodcom data

2.4 Digital transformation

Among the digital technologies monitored in this project, Finland has been the most specialised in Advanced Manufacturing and Robotics and Micro- and Nanoelectronics, while it ranks for Digital Mobility in 5th place among the EU27 Member States.

Figure 7: Country specialisation and world share (expressed in terms of ranking) in digital technology related patent applications of Finland



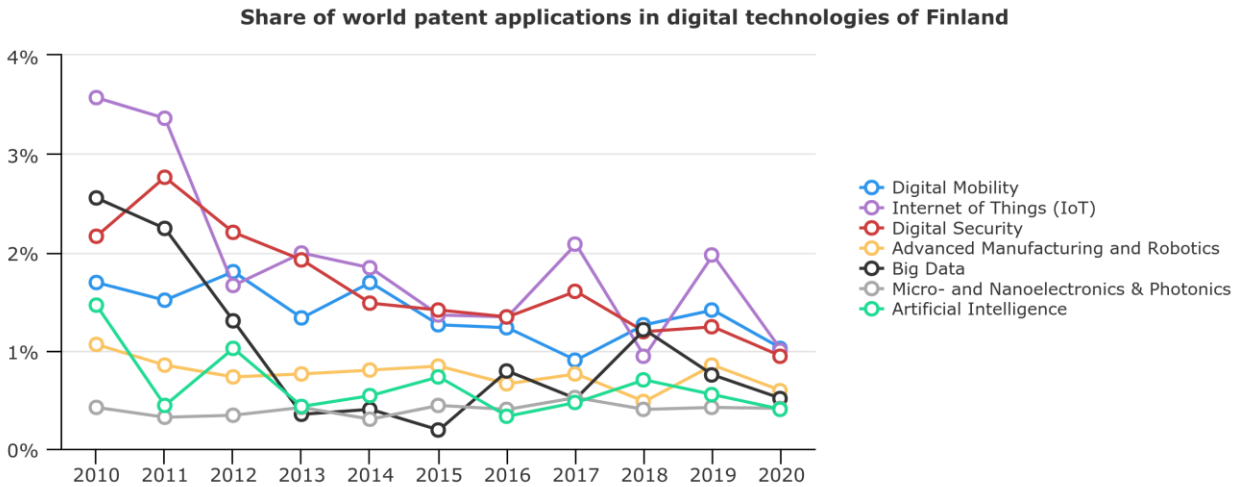
Ranking of Finland within EU27 in terms of its share of global patent applications in 2020 (1 - best performer, 27 worst performer)

Digital Mobility	**5**
Internet of Things (IoT)	7
Big Data	7
Digital Security	7
Micro- and Nanoelectronics & Photonics	8
Artificial Intelligence	8
Advanced Manufacturing and Robotics	10

Source: Fraunhofer ISI based on Patstat

Trends over time indicate an overall decrease of Finland's global position in the fields of all digital technologies over the period from 2010 to 2020.

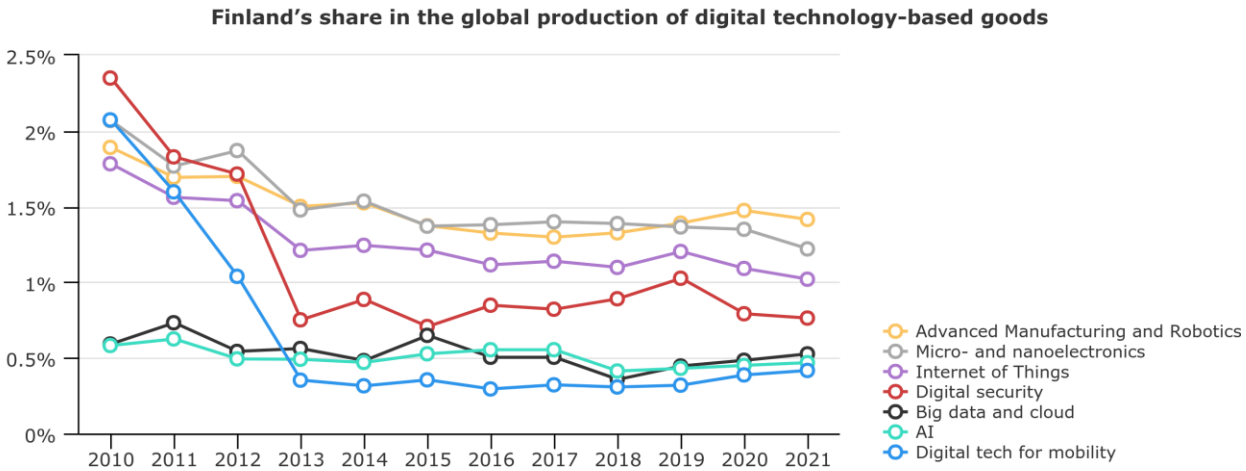
Figure 8: Trends over time in Finland's share of world patent applications



Source: Fraunhofer ISI based on Patstat

The Prodcom-based indicator measures the share of Finland in advanced technology-related production for a given year. The share of production in a particular technology over Finland's total production indicates that it has the largest share in the field of Advanced Manufacturing and Robotics. Overall, there has been a decrease in production across all fields over the period from 2010 to 2021.

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



Source: IDEA Consult based on Prodcom data

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