UNIVERSITY OF CAMBRIDGE

Cambridge Industrial Innovation Policy

UK INNOVATION REPORT 2025

Benchmarking the UK's industrial and innovation performance in a global context

Institute for Manufacturing, University of Cambridge
March 2025

Table of contents

List of charts

Theme 1: Structure and performance of the UK economy

Theme 2: Investment in innovation

Theme 3: Industrial performance – international comparison

Theme 4: Science and engineering workforce

Theme 5: Net-zero innovation

What makes the report different?

The aim of the *UK Innovation Report* is to facilitate policy discussions on innovation and industrial performance – and the interplay between them. While numerous sources of data on the topic of innovation exist, the *UK Innovation Report* makes a contribution by bringing together, in a single place, **innovation and value-added indicators** in a concise and accessible format.

Instead of structuring the report according to traditional input and output indicators, the intention with the report is to include data that provides rich quantitative representations of the vitality of both the **UK's innovation activity** and its **industrial performance** in an **international context**.

An important theme throughout the report is the analysis of **sectoral** data to better understand the drivers of national performance and provide more granular policy insights. While the report does not make specific policy recommendations, it does highlight areas where additional evidence and policy action may be required.

Motivation

- To review the UK's innovation and industrial performance and compare it with that of other selected countries;
- To facilitate discussions on the relation between innovation and sectoral competitiveness; and
- To contribute to the evidence base that is available to inform industrial and innovation policy.

Please reference this report as: Cambridge Industrial Innovation Policy (2025). *UK Innovation Report 2025.* IfM Engage. Institute for Manufacturing, University of Cambridge.

Introduction

The *UK Innovation Report* remains a vital resource for understanding the evolving landscape of innovation and industrial policy in the UK. This year's edition comes at a particularly significant moment, as the UK government has placed industrial strategy at the core of its growth agenda, with a strong emphasis on investment, technology adoption, and high-growth sectors.

In October 2024, the government published the Industrial Strategy Green Paper, marking the first step towards developing a "modern" industrial strategy. The final strategy, set to be launched in spring 2025 alongside the spending review, will outline a long-term vision for strengthening the UK's industrial competitiveness. A key element of this strategy is the development of sector plans for eight priority growth sectors, which include: advanced manufacturing, clean energy industries, creative industries, defence, digital and technology, financial services, life sciences, and professional and business services.

The past year has highlighted the growing need for evidence-based industrial and innovation policymaking. The Green Paper was accompanied by a public consultation that received over 3,000 responses, reflecting widespread engagement from industry and stakeholders. Each sector plan will require in-depth analysis to assess drivers of innovation, competitiveness, and future trends, as well as to identify strategies for enhancing the UK's global position. However, the data necessary to support these plans is neither readily available from official statistics nor straightforward to collect. In response to these challenges, the **Department for Business and Trade (DBT)** launched a call for evidence at the end of 2024, focusing on **access to finance for advanced manufacturing scale-ups**. This initiative aims to identify the key financial barriers that companies face when transitioning from technological development to commercial success. Meanwhile, the **Department for Science, Innovation and Technology (DSIT)** introduced the **Technology Adoption Review**, led by the **Government Chief Scientific Adviser** and the **National Technology Adviser**, to evaluate the UK's effectiveness in adopting cutting-edge technologies.

As the demand for stronger evidence in industrial and innovation policymaking grows, the *UK Innovation Report 2025* makes a timely contribution by providing new data, analyses and perspectives to support evidence-based policy development.

What is new in the 2025 edition of the UK Innovation Report?

This year's *UK Innovation Report* builds on last year's policy discussions and introduces **new indicators and data sources** to assess the UK's **innovation performance over time**. It provides a deeper focus on **sectoral competitiveness**, aligning with the **Industrial Strategy Green Paper**. The report is organised as follows:

- **Section 1** examines changes in the **UK's economic structure**, with a focus on the contribution of the **manufacturing sector**.
- **Section 2** provides an overview of the **UK's research and development (R&D) funding and expenditure landscape**.
- **Section 3** analyses shifts in the **competitive position of the UK's manufacturing sectors** over the past two decades.
- **Section 4** explores **qualification and skills mismatches in the UK**, along with the uptake of **vocational education**.
- **Section 5** reviews **public R&D expenditure on low-carbon and renewable energy technologies**, as well as **patent activity and specialisation in environment-related technologies**.

Contributors and acknowledgements

Cambridge Industrial Innovation Policy

Cambridge Industrial Innovation Policy (CIIP) is a global, not-for-profit policy group based at the Institute for Manufacturing, University of Cambridge. CIIP works with governments and global organisations to promote industrial competitiveness and technological innovation. We offer new evidence, insights and tools based on the latest academic thinking and international best practice. This report was delivered through IfM Engage, the knowledge-transfer arm of the Institute for Manufacturing, University of Cambridge.

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Disclaimer

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Please reference this report as: Cambridge Industrial Innovation Policy (2025). *UK Innovation Report 2025.* IfM Engage. Institute for Manufacturing, University of Cambridge.

Executive summary

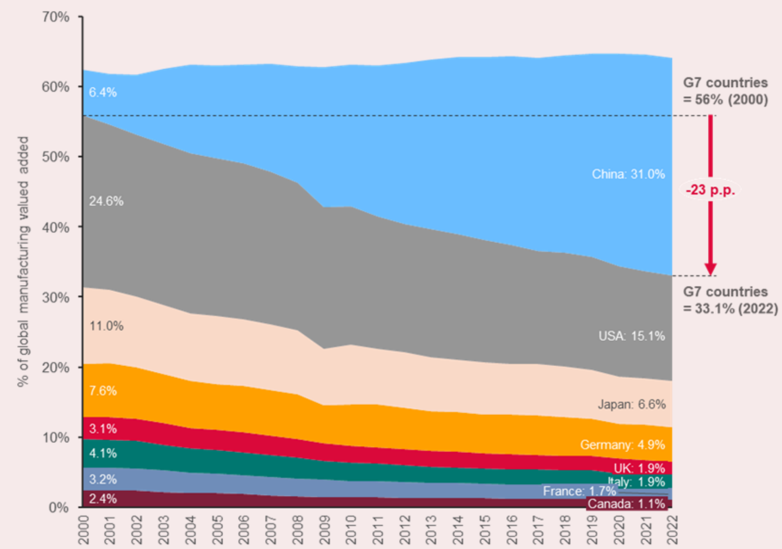
UK INNOVATION REPORT 2025

A defining moment for the UK's industrial competitiveness

- The report highlights the significant shift in the world's industrial centre of gravity since 2000. The G7 countries, including the UK, have seen their combined share of global manufacturing value added decline from 56% in 2000 to 33% in 2022. In contrast, China has emerged as the world's leading industrial player, with its share rising dramatically from 6.4% in 2000 to 31% in 2022.
- Worryingly, the UK's share of global manufacturing value added fell from 3.1% in 2000 to 1.9% in 2022, while its share of global manufacturing exports more than halved, dropping from 3.7% to 1.5%.
- More concerning is the UK's loss of competitiveness in high-value-added industries. Over the past decade, the most significant declines in global export shares have occurred in historically strong sectors, including pharmaceuticals and other transport equipment, which covers aerospace, shipbuilding, and railway equipment. Additionally, the UK's global market share in advanced industries fell from 4.4% in 2000 to 2.6% in 2020.

World manufacturing value-added shares*

G7 countries and China, US$ at constant prices, 2000–2022



*See Chart 3.1, page 44

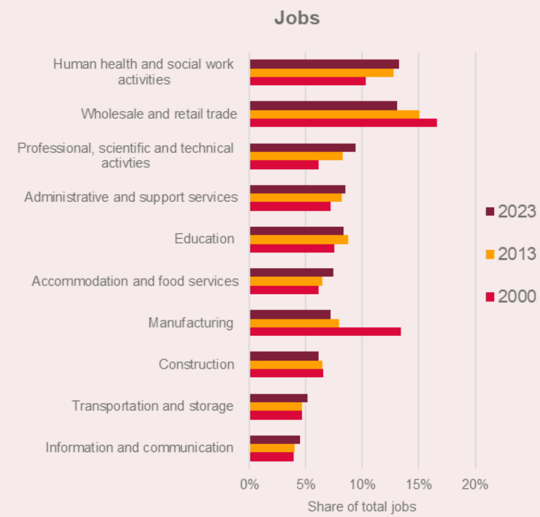
Note: Shares calculated using constant prices. See UNIDO (2017) Indicator 7 for detailed methodology.
Source: UNIDO (2024). Competitive Industrial Performance Index database.

Manufacturing: receding but still vital

- The report confirms that the share of manufacturing jobs in the UK has almost halved, going from 13.4% to 7.2% in the last 20 years. Meanwhile, less well-paid sectors are employing a greater share of workers. In 2023, human health, wholesale and retail trade, and administrative and support services collectively employed more than a third of UK workers, yet their salaries were below the national median.
- Despite this, the report evidences the critical role of manufacturing in raising the UK's economic productivity. Manufacturing stands out as one of the sectors with the fastest productivity growth, with notable productivity gains in transport equipment, machinery, metal products, and automotive between 2010 and 2022.
- The report also estimates the wider impact of manufacturing on the UK economy. Official statistics show that manufacturing accounted for 9.1% of the value added and 7.2% of the employment in 2023. However, the report estimates that manufacturing generates significant indirect economic and employment effects, accounting for around 15% of UK value added and employment.

Top 10 UK industries by employment and salary*

Jobs include employee and self-employed jobs – gross annual pay for employee jobs [1]



Industry	Change 2000–23[2]	Median annual salary (£), 2023
Human health and social work activities	▲3.0	26,215
Wholesale and retail trade	▼-3.5	23,675
Professional, scientific and technical activties	▲3.2	37,694
Administrative and support services	▲1.3	24,722
Education	▲0.8	29,456
Accommodation and food services	▲1.2	15,031
Manufacturing	▼-6.3	33,631
Construction	▼-0.3	34,905
Transportation and storage	▲0.5	32,547
Information and communication	▲0.6	43,497

Whole-economy median annual salary in 2023: £29,511

*See Chart 1.4, page 20

Note: [1] Mining and quarrying, arts, entertainment and recreation, activities of households, and activities of extraterritorial organisations are excluded because estimates are considered unreliable. [2] Percentage points.

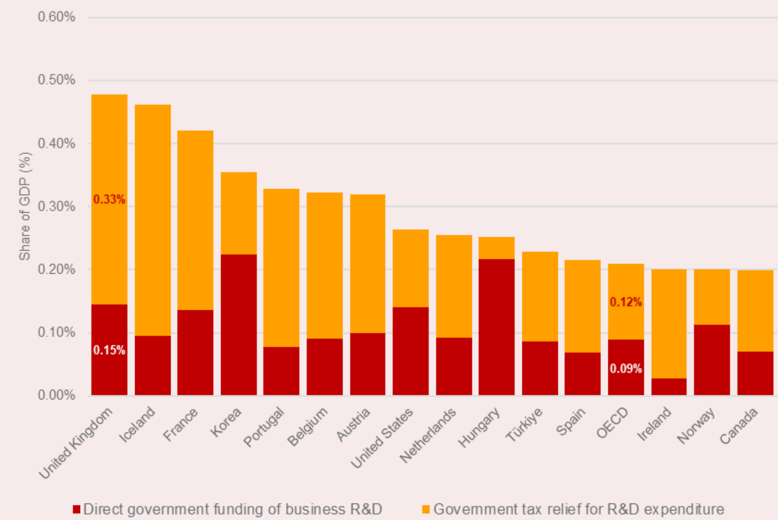
Source: Office for National Statistics (ONS). *Earnings and hours worked, industry by two-digit SIC: ASHE Table 4; JOBS03 Employee jobs by industry (UK totals), Dec 2024; JOBS04 Self Employed jobs by industry (UK totals).*

The UK: a leader in government support for business R&D

- In 2021, the UK provided the highest level of government financial support for business R&D as a share of GDP among OECD countries, reaching 0.48% of GDP, more than double the OECD average. The majority of this support came in the form of R&D tax relief, which accounted for 0.33% of GDP, while only 0.15% of GDP was allocated through direct funding.
- This trend reflects a broader shift seen across OECD countries, where there has been a significant change in the business R&D support policy mix over the past two decades. Most countries have moved away from direct funding instruments and have moved towards a greater reliance on R&D tax incentives. In 2021, R&D tax incentives accounted for approximately 58% of total government support for business R&D across OECD countries, compared to just 35% in 2006.

Government financial support for business R&D in the OECD*

Direct government funding and government tax relief for business R&D expenditure, share of GDP, top 15 OECD countries, 2021 or latest available



*See Chart 2.4, page 35

Note: US data refers to 2020.

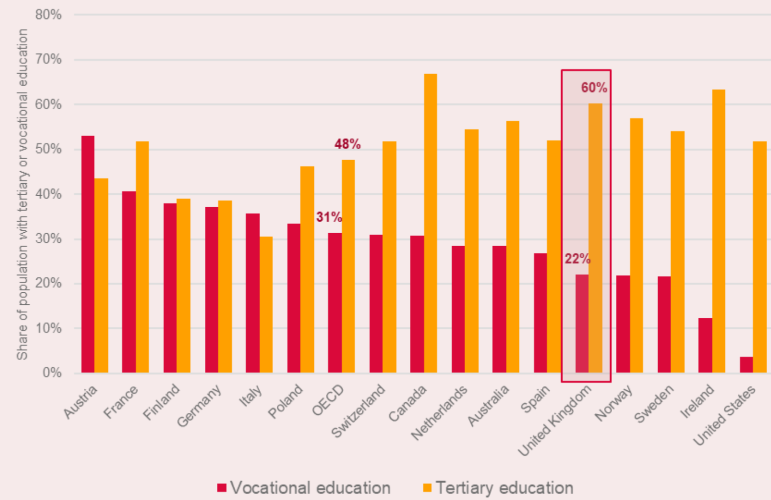
Source: OECD (2024). R&D tax expenditure and direct government funding of BERD database.

Industrial workforce: high tertiary educational attainment but persistent skills mismatches

- In 2023, the UK workforce reported some of the highest levels of qualification and skills mismatches among OECD countries. A total of 37% of UK workers believed their qualifications exceeded the level required for their job, compared to the OECD average of 23%. Similarly, 34% of UK workers felt over-skilled for their current role, higher than the OECD average of 26%.
- Despite having one of the highest tertiary education attainment rates, the UK has a lower share of workers with a vocational education and the technical skills needed in modern industries. In 2023, 60% of 25–34-year-olds in the UK held a university degree, compared to the OECD average of 48%. However, only 22% pursued vocational education, well below the OECD average of 31% and significantly lower than European peers such as France (41%), Germany (37%), and Italy (36%).
- The share of UK graduates in engineering, manufacturing, and construction stood at just 9.3% in 2022, lagging behind the G7 average of 13.9%, with only the USA ranking lower at 6.9%.
- The UK STEM workforce accounted for 28.7% of total employment in 2023. Over the past decade, the STEM workforce grew by 22%, outpacing the 11% growth across all occupations. Looking ahead, projections suggest that employment in STEM occupations could expand as much as 6% to 10% between 2023 and 2030, compared to 3% across all occupations.

Tertiary and vocational education attainment*

Share of population, 25-34 years old, selected countries, 2023



*See Chart 4.2, page 60

Note: Vocational education includes upper-secondary vocational education, post-secondary non-tertiary vocational education and short-cycle tertiary vocational education.

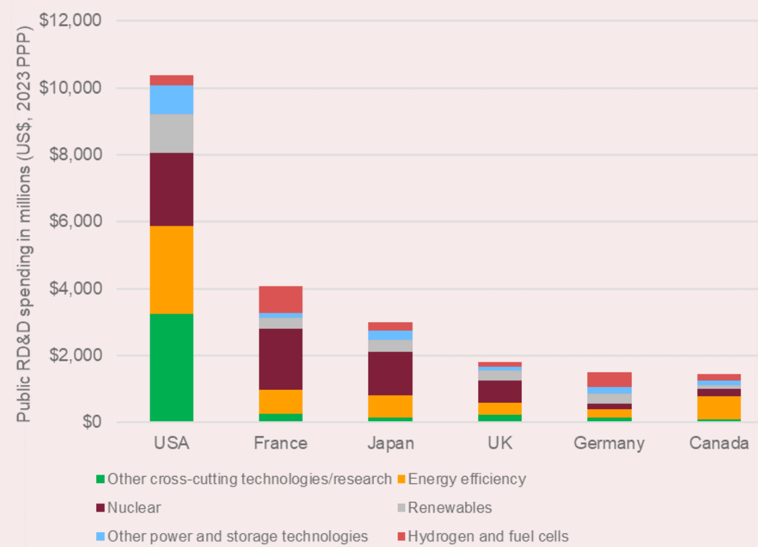
Source: OECD (2024). Education at a Glance 2024.

The UK: a leading innovator in renewable energy technologies

- Based on data from the International Energy Agency, the UK had the fourth-highest public research, development and demonstration (RD&D) expenditure on low-carbon renewable energy technologies between 2013 and 2023, below the USA, France and Japan.
- At US$1.8 billion, the UK's public RD&D budget in low-carbon and renewable energy technologies in 2023 was lower than Japan (US$2.9 billion), France (US$4 billion) and the USA (US$10.3 billion), but higher than Germany (US$1.5 billion) and Canada (US$1.4 billion).
- Among low-carbon technologies, the highest public RD&D expenditure in the UK in 2023 was on nuclear power technologies, followed by energy efficiency, and renewables.

Public RD&D spending on low-carbon and renewable energy technologies – by technology*

Technology breakdown in the IEA's Energy Technology RD&D Budgets database, top six country spenders, US$ million PPP, 2023



*See Chart 5.3, page 68

Source: IEA (2024). IEA Energy Technology RD&D Budgets - October 2024.

UK Innovation Report 2025: data highlights

The **global share of manufacturing value added** for G7 countries declined from 56% in 2000 to 33% in 2022. In contrast, China's share surged from 6.4% to 31% over the same period.

In the last two decades, **UK global manufacturing export shares** decreased from 3.7% to 1.5%. In a selection of **10 advanced industries**, the UK's global market share decreased from 4.4% in 2000 to 2.6% in 2020 in value-added terms.

Manufacturing is the **UK's second-largest market sector by value added** and the **largest contributor to capital investment**. Including its value chain, it represents **around 15% of the UK economy.**

At 2.77%, the **UK's research and development expenditure remains just above the OECD average** but is still behind leading countries such as Korea, the USA and Germany.

Among OECD countries, **the UK leads in total government financial support for business R&D as a share of GDP**, relying heavily on R&D tax relief over direct funding.

In 2023 the **UK remained a global leader per number of top R&D-investing companies**, **but its presence has nearly halved over the past decade.**

The UK shows persistent skills and qualification mismatches: 37% of workers feel over-qualified while 34% believe they are over-skilled.

Only 22% of young people in the UK have pursued **vocational education**, well below the OECD average (31%) and European peers like France (41%) and Germany (37%).

The UK has decoupled GDP growth from greenhouse-gas emissions, meeting its climate targets so far. However, future carbon budgets rely on deeper cuts in hard-to-decarbonise sectors like transport, buildings, and agriculture.

The UK is a leading innovator in renewable energy technologies, ranking fourth in public RD&D spending (2013–2023) and seventh in environment-related patent applications (2010–2021).

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Cambridge Industrial Innovation Policy

THEME ONE

Structure and performance of the UK economy

How has the structure of the UK economy changed in the last two decades?

What is the value of UK manufacturing?

What are the top UK manufacturing industries?

Theme 1: Structure and performance of the UK economy

KEY FINDINGS

Despite the decline in manufacturing as a share of GDP over the past two decades, the sector remains a key contributor to the economy:

- Over the past two decades, one of the most significant changes in the structure of the UK economy has been the decline in the share of manufacturing value added, from 14.8% in 2000 to 9.1% in 2023. In contrast, activities that increased their participation in the UK economy included: human health and social work; professional, scientific and technical activities; and financial and insurance activities.
- Despite the decline in manufacturing value added as a percentage of GDP, it remains the second-largest market sector by value added, the largest contributor to capital investment, the second in labour productivity growth, and the seventh-largest sector by employment.

We estimate that the manufacturing value chain accounts for around 15% of the UK economy:

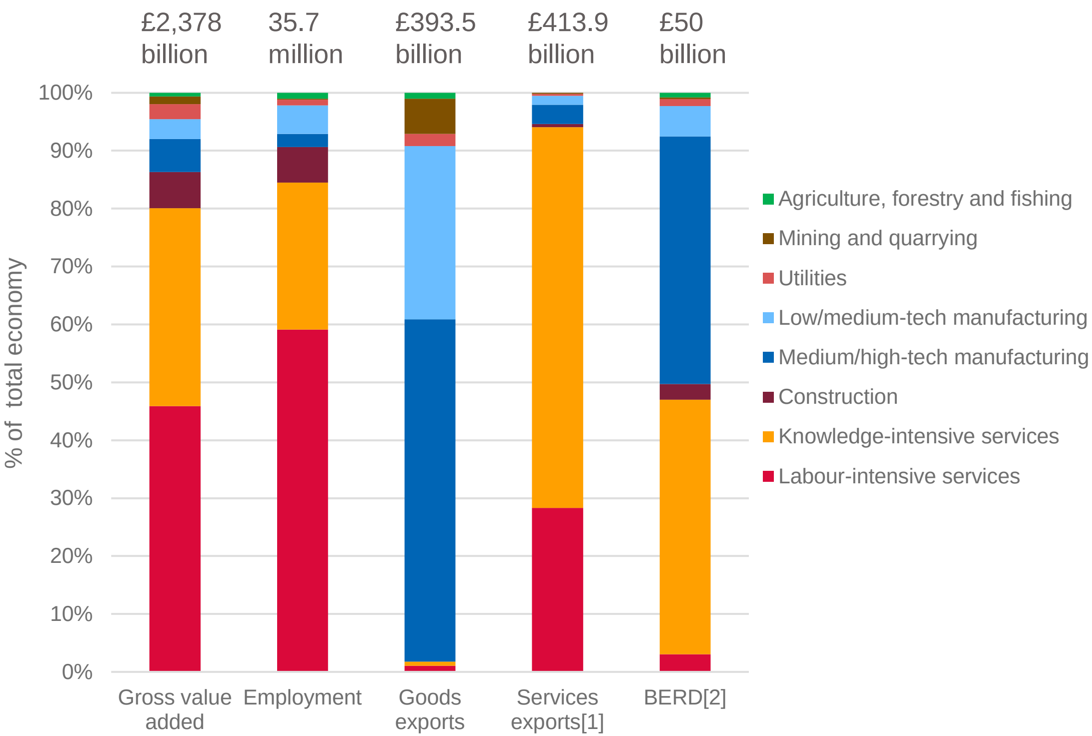
- Manufacturing is a key pillar of the UK economy, accounting for 9.1% of the value added and 7.2% of the employment in 2023. In particular, advanced manufacturing sectors account for around half of the sector's value added and employment, showing above-average productivity levels.
- The wider impact of manufacturing can be measured through its interconnectedness with other industries. Using a value-chain approach, we estimate that manufacturing contributed £331 billion to the economy in 2022 and supported 4.5 million full-time equivalent jobs in 2019. These figures represent approximately 15% of UK value added and employment during the respective reference years.

Key UK manufacturing industries include food products, transport equipment, machinery and equipment, fabricated metals and pharmaceuticals:

- Food products is the largest manufacturing employer, contributes the highest share of value added, and has the second-largest capital investment among manufacturing industries. However, it is more domestically oriented, accounting for just 4.2% of manufacturing goods exports in 2023.
- In comparison, motor vehicles, other transport equipment, machinery and equipment, and fabricated metals are more export-oriented, jointly accounting for nearly half of manufacturing exports, while also making substantial contributions to value added and employment.
- The pharmaceutical industry stands out for its high value added, relatively large services exports, and the highest capital investment among manufacturing industries.

Chart 1.1. Structure of the UK economy, 2023

Gross value added, employment, exports and business enterprise R&D



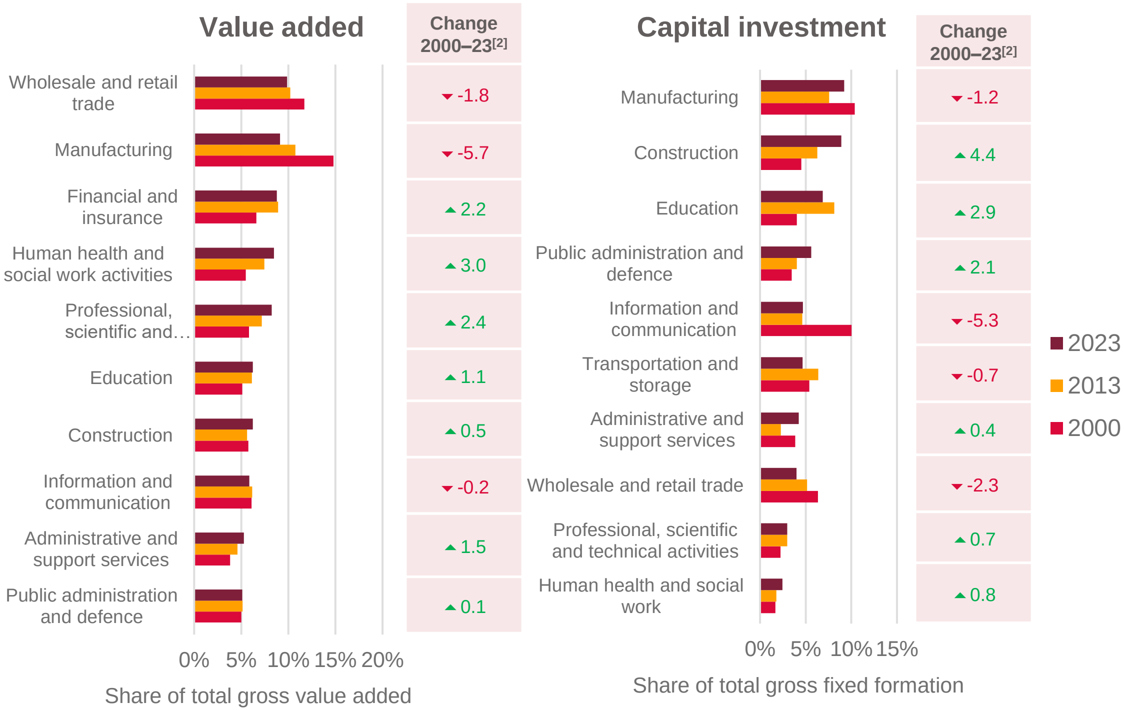
Note: [1] Services exports data corresponds to 2022; goods and exports percentages do not include category “unknown industry”. [2] Business enterprise research and development by detailed product groups.
Source: Office for National Statistics (ONS).

- In 2023 **knowledge-intensive**[1] and **labour-intensive services**[1] contributed to approximately 80% of **the UK** economy’s gross value added and employment.
- **Medium/high-tech manufacturing**[1] represented the largest share of goods exports and the second largest share of R&D performed in UK businesses (BERD). It amounted to 59.1% of goods exports and 43.9% of BERD in 2023.
- **Knowledge-intensive services** accounted for the largest shares of services exports (65.7%) and BERD (43.9%). The main service exports include: business services; financial services; and telecommunications, computer and information services.

[1] **Note:** Appendix 1.1 presents definitions of these sector classifications.

Chart 1.2. Top 10 UK industries by value added and capital investment[1]

Gross value added and gross fixed capital formation, 2000, 2013 and 2023

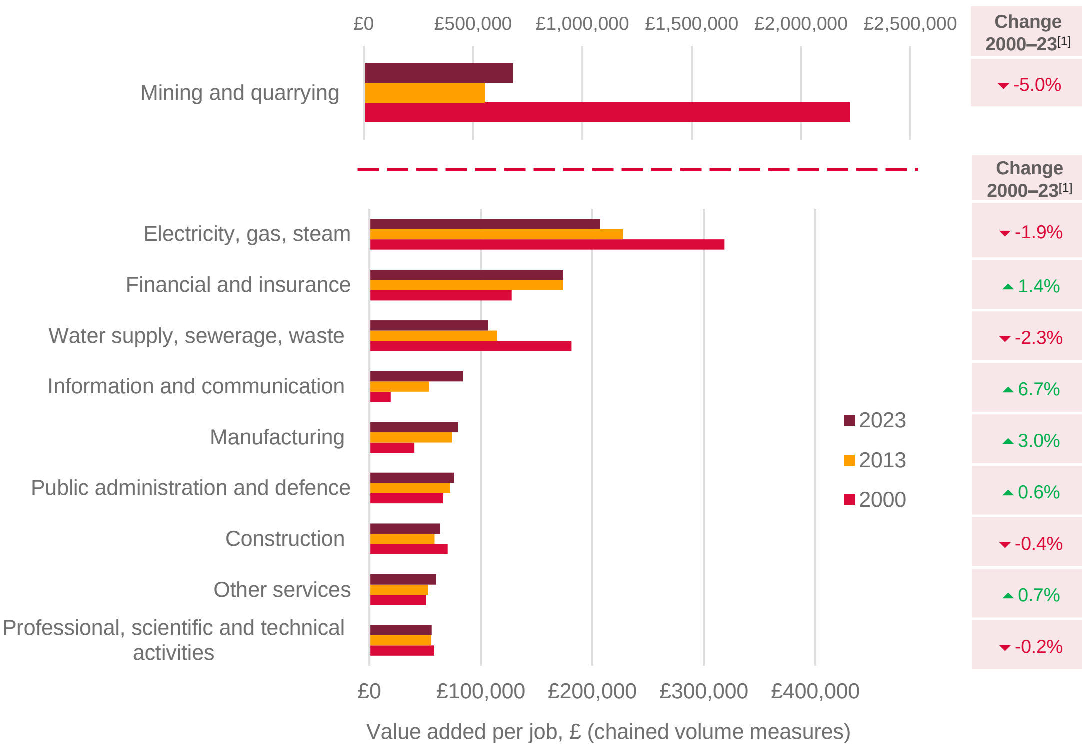


Note: [1] Real estate activities are excluded, as value added includes imputed rents, and asset investment mainly covers dwellings. [2] Percentage points.
Source: Office for National Statistics (ONS). *GDP output approach, low level aggregates, UK, Quarter 3 (Jul to Sept) 2024.*

- At the industry level (sections of the UK Standard Industrial Classification), the top contributing industries to UK value added in 2023 include: **wholesale and retail trade** (9.9%), **manufacturing** (9.1%), **financial and insurance activities** (8.8%), **human health and social work** (8.5%) and **professional, scientific and technical activities** (8.3%).
- Over the past two decades, industries that increased their share of value added include: **human health and social work**, rising from 5.5% in 2000 to 8.5% in 2023; **professional, scientific and technical activities**, going from 5.8% to 8.3%; and **financial and insurance activities**, increasing from 6.6% to 8.8%.
- In contrast, **manufacturing** declined from 14.8% in 2000 to 9.1% in 2023, while **wholesale and retail trade** fell from 11.7% to 9.9%.
- In terms of capital investment, **manufacturing** (9.2%), **construction** (8.9%), **education** (6.9%), **public administration and defence** (5.6%) and **information and communication** (4.7%) accounted for the largest shares in 2023.
- Over the past two decades, however, **information and communication** saw the biggest decline in capital investment, with its share dropping from 10% in 2000 to 4.7% in 2023, while **construction** increased from 4.5% to 8.9%.

Chart 1.3. Top 10 UK industries by labour productivity

Value added (chained volume measures) per job, 2000, 2013 and 2023

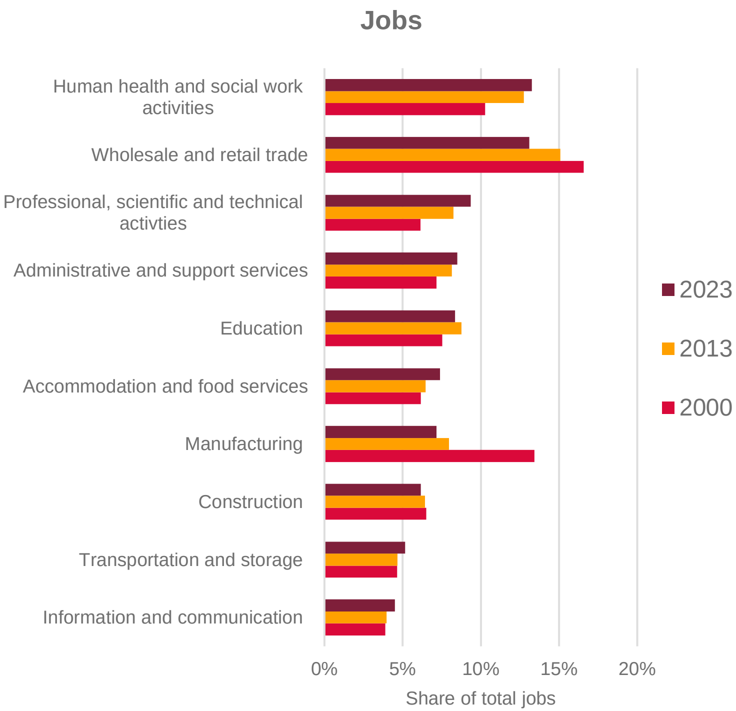


Note: [1] Compound annual growth rate.
Source: Office for National Statistics (ONS). *GDP output approach, low level aggregates, UK, Quarter 3 (Jul to Sept) 2024; JOBS03 Employee jobs by industry (UK totals), Dec 2024*; *JOBS04 Self Employed jobs by industry (UK totals).*

- Industries with the highest labour productivity levels in 2023 include: **mining and quarrying** (£682,519 per job); **electricity, gas, steam and air conditioning supply** (£207,245); **financial and insurance activities** (£173,938); **water supply** (£106,652); and **information and communication** (£84,010).
- Between 2000 and 2023, the industries that saw the fastest productivity growth include: **information and communication** (6.7% annually), **manufacturing** (3.0%) and **financial and insurance activities** (1.4%).

Chart 1.4. Top 10 UK industries by employment and salary[1]

Jobs include employee and self-employed jobs – gross annual pay for employee jobs



Change 2000–23[2]	Median annual salary (£), 2023
▲ 3.0	26,215
▼ -3.5	23,675
▲ 3.2	37,694
▲ 1.3	24,722
▲ 0.8	29,456
▲ 1.2	15,031
▼ -6.3	33,631
▼ -0.3	34,905
▲ 0.5	32,547
▲ 0.6	43,497

Whole-economy median annual salary in 2023: £29,511

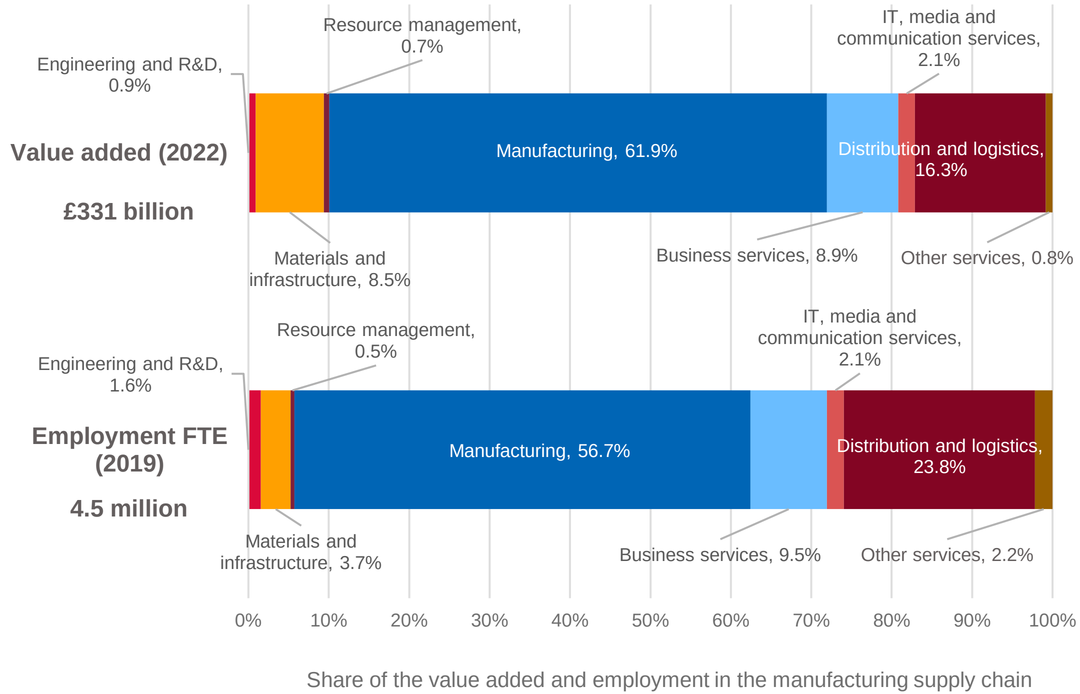
Note: [1] Mining and quarrying, arts, entertainment and recreation, activities of households, and activities of extraterritorial organisations are excluded because estimates are considered unreliable. [2] Percentage points.

Source: Office for National Statistics (ONS). *Earnings and hours worked, industry by two-digit SIC: ASHE Table 4; JOBS03 Employee jobs by industry (UK totals), Dec 2024*; *JOBS04 Self Employed jobs by industry (UK totals).*

- The top contributing industries in terms of employment in 2023 include: **human health and social work** (13.3%); **wholesale and retail trade** (13.1%); **professional, scientific and technical activities** (9.4%); **administrative and support services** (8.5%); and **education** (8.4%).
- In line with the trend in value-added shares, industries that have seen an increase in employment shares over the past decade include: **professional, scientific and technical activities** (rising from 6.1% in 2000 to 9.4% in 2023); **human health and social work activities** (from 10.3% to 13.3%); and **administrative and support service activities** (from 7.2% to 8.5%).
- The largest employing sectors in the UK have some of the lowest salaries. Sectors such as **human health, wholesale and retail trade** and **administrative and support services** collectively employ more than a third of UK workers; yet their salaries fall below the whole-economy median, which was £29,511 in 2023.
- In comparison, top employing sectors that pay above the whole-economy median salary include **professional, scientific and technical activities**, **manufacturing**, **construction**, **transportation and storage** and **information and communication**.

Chart 1.5. The value of the UK manufacturing supply chain

Gross value added and full-time equivalent employment (FTE)[1]



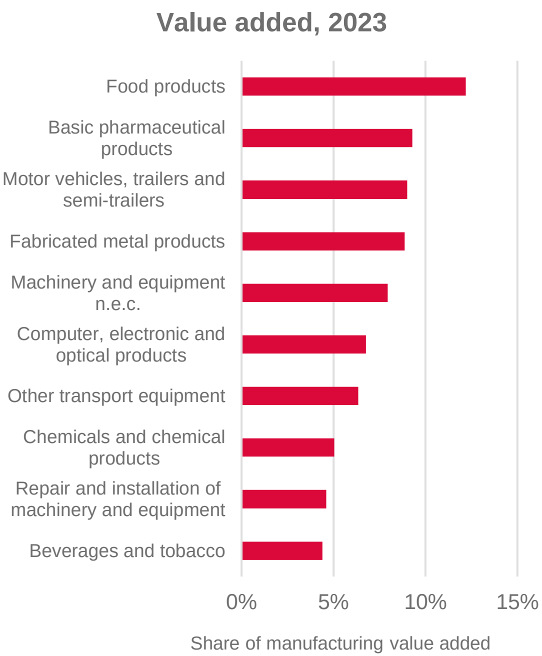
Note: [1] Appendix 1.2 presents the methodology used to compute the value of the manufacturing supply chain.
Source: CIIP calculation based on ONS Input-Output Analytical Tables, Industry by Industry, 2019 and 2022.

- Manufacturing is a key pillar of the UK economy, accounting for 9.1% of the **value added** and 7.2% of the **employment** in 2023.
- Manufacturing is a driving force for innovation and trade. In 2023 it represented 89% of **goods exports** and 48% of **business expenditure on research and development** (BERD).
- The wider impact of manufacturing can be seen in its interconnectedness with other industries. Manufacturers' purchases from various sectors generate significant indirect economic and employment effects.
- Following this **supply chain approach**, we find that manufacturing contributed £331 billion to the economy in 2022 and supported 4.5 million full-time equivalent jobs in 2019.[1] These figures represent approximately 15% of UK value added and employment during the respective reference years.
- The largest indirect impact of manufacturing in value added and employment is seen in **distribution and logistics, business services**, and **materials and infrastructure**.

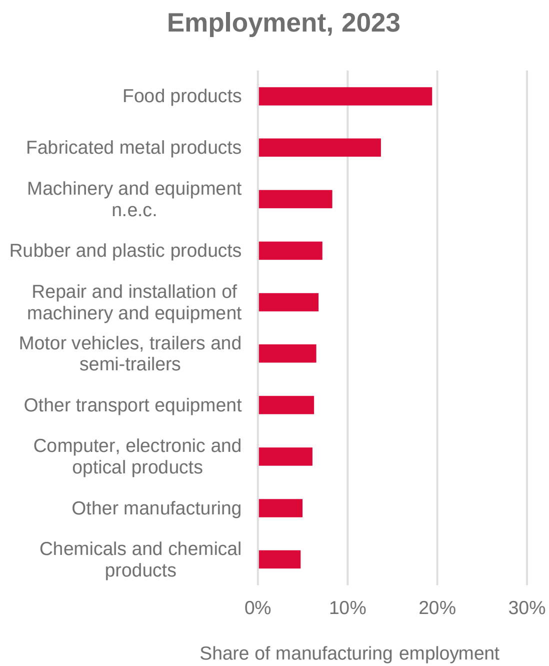
[1] **Note:** The most recent ONS data on employment multipliers is from 2020. However, due to the impact of the COVID-19 pandemic, 2019 data offers a more accurate reflection of the UK economy.

Chart 1.6. Top UK manufacturing industries by value added and employment, 2023

Value added of manufacturing in 2023: **£216.8 billion**



Employment of manufacturing in 2023: **2.6 million**[1]



Note: [1] Includes employee and self-employed jobs.
Source: ONS (2024). *GDP output approach, low level aggregates, UK, Quarter 3 (Jul to Sept) 2024*; ONS (2024). *JOBS03 Employee jobs by industry (UK totals), Dec 2024*; ONS (2024). *JOBS04 Self Employed jobs by industry (UK totals).*

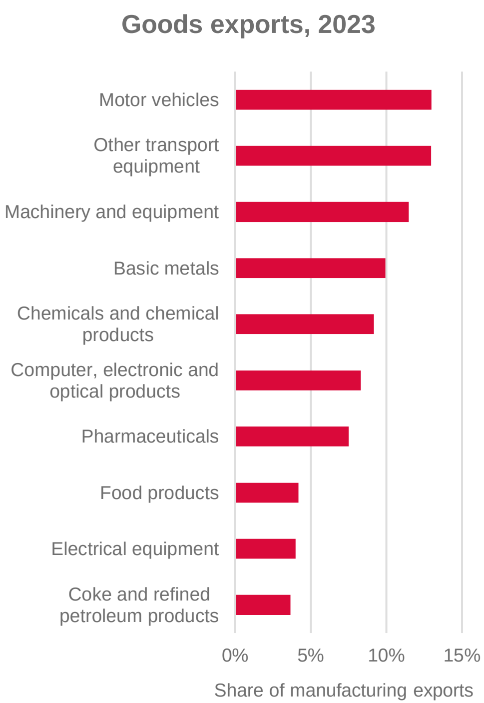
Leading manufacturing industries, based on their contributions to value added and employment, include:

- Top five manufacturing industries by value added in 2023 (share of manufacturing value added in brackets): **food products** (12.2%), **basic pharmaceutical products** (9.3%), **motor vehicles, trailers and semi-trailers** (9.0%), **fabricated metal products** (8.9%) and **machinery and equipment** (7.9%).
- Top five manufacturing industries by employment in 2023 (share of manufacturing employment in brackets): **food products** (19.4%), **fabricated metal products** (13.7%), **machinery and equipment** (8.3%), **rubber and plastic products** (7.2%) and **repair and installation of machinery and equipment** (6.8%).
- **Food products, motor vehicles, fabricated metal products** and **machinery and equipment** stand out for their large contributions to both value added and employment. In contrast, the manufacture of **pharmaceutical products** generates high value added but contributes less to manufacturing employment (2.3%).

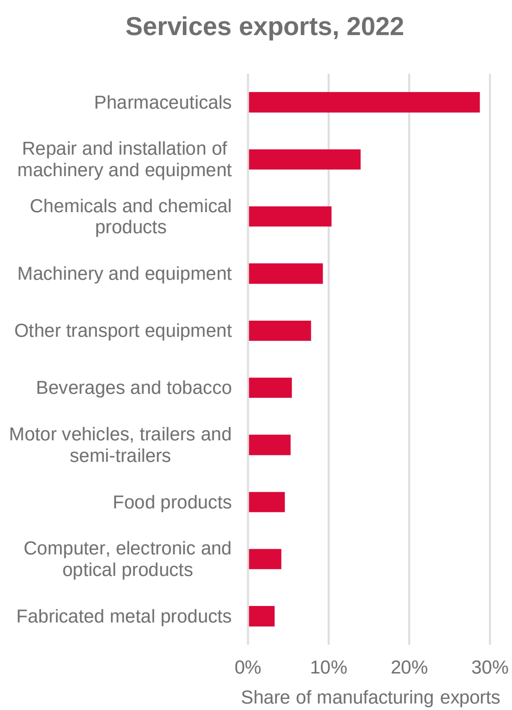
Chart 1.7. Top UK manufacturing industries by goods and services exports, 2023[1]

£, current prices

Goods exports of manufacturing in 2023: **£350.3 billion**



Services exports of manufacturing in 2022: **£19.1 billion**



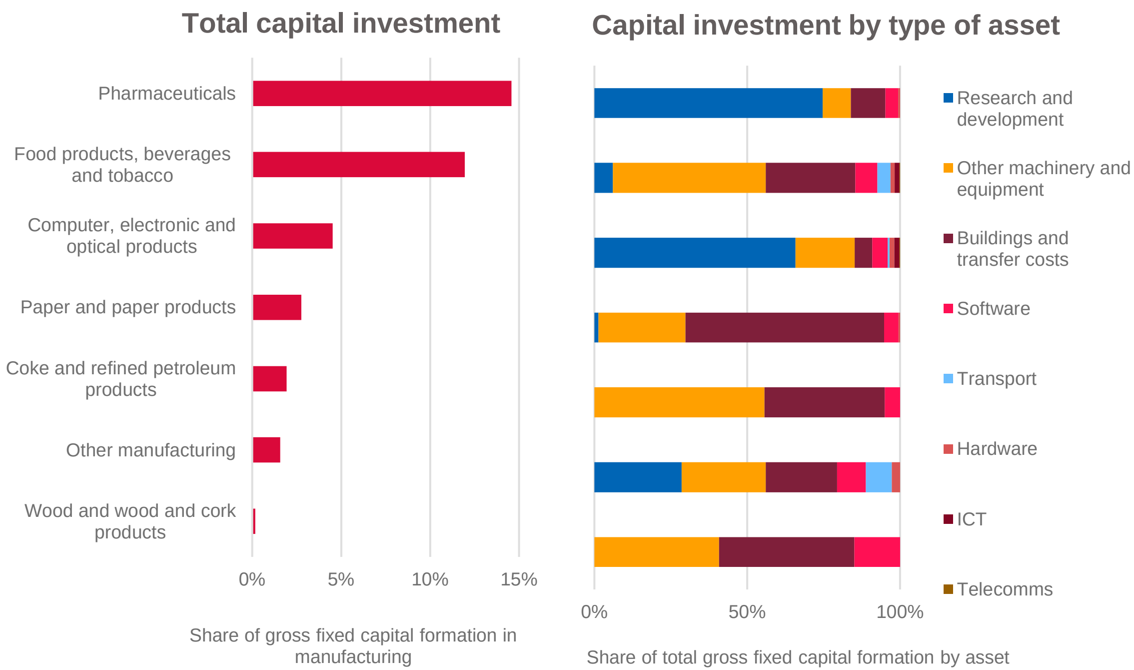
Note: [1] Services export data corresponds to 2022. **Source:** ONS (2024). *Trade in goods: CPA (08) exports and imports*; ONS (2024). *UK trade in services by industry, country and service type, exports.*

- Manufacturing contributes to around 89% of goods exports and 4.9% of service exports. Leading manufacturing industries by their exports of goods in 2023 include (share of manufacturing exports in brackets): **motor vehicles, trailers and semi-trailers** (13%), **other transport equipment** (13%), **machinery and equipment** (11.5%), **basic metals** (9.9%) and **chemicals and chemical products** (9.2%).
- **Manufacture of basic pharmaceutical products** stands out for its relatively large service exports, accounting for 28.7% of total manufacturing service exports in 2022.
- While the **manufacture of food products** is the largest employer in manufacturing and has the highest share of value added, it makes a smaller contribution to manufacturing exports (4.2%).
- In comparison, **motor vehicles, other transport equipment, machinery and equipment** and **fabricated metal products** make substantial contributions to value added, employment and exports.

Chart 1.8. Top UK manufacturing industries by capital investment, 2023

Gross fixed capital formation, £ current prices

Capital investment by manufacturing businesses in 2023: **£44.1 billion**[1]

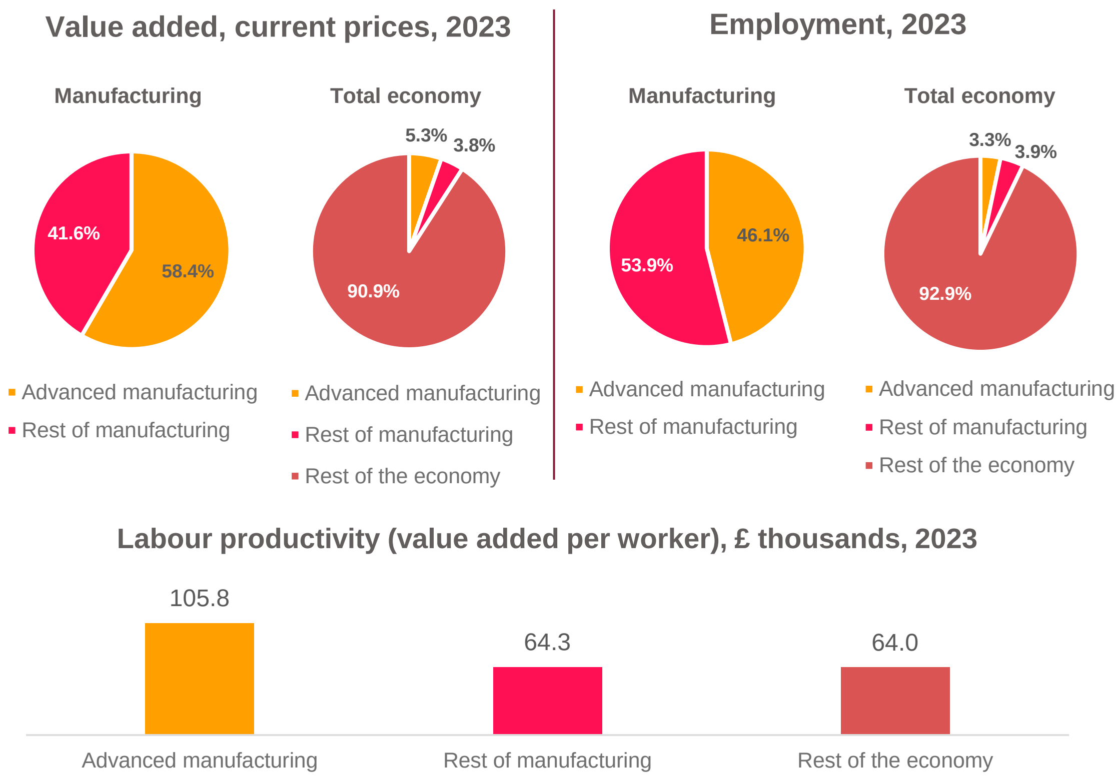


Note: [1] Distribution by asset excludes low and negative values.
Source: ONS (2024). *Annual Gross Fixed Capital Formation by Industry and Asset*.

- Leading manufacturing industries, based on their contributions to capital investment in 2023, include (share of manufacturing capital investment in brackets): **pharmaceutical products** (14.6%); **food products, beverages and tobacco** (12%); and **computer, electric and optical products** (4.5%).
- The nature of investment varies across industries. In 2023 the **pharmaceutical** and **computer and electronics** industries primarily invested in research and development, whereas expenditure on “other machinery and equipment” was the main investment in **food products, beverages and tobacco,** and **coke and refined petroleum products**.

Chart 1.9. Overview of UK advanced manufacturing sectors

Gross value added, employment and labour productivity (value added per worker), 2023

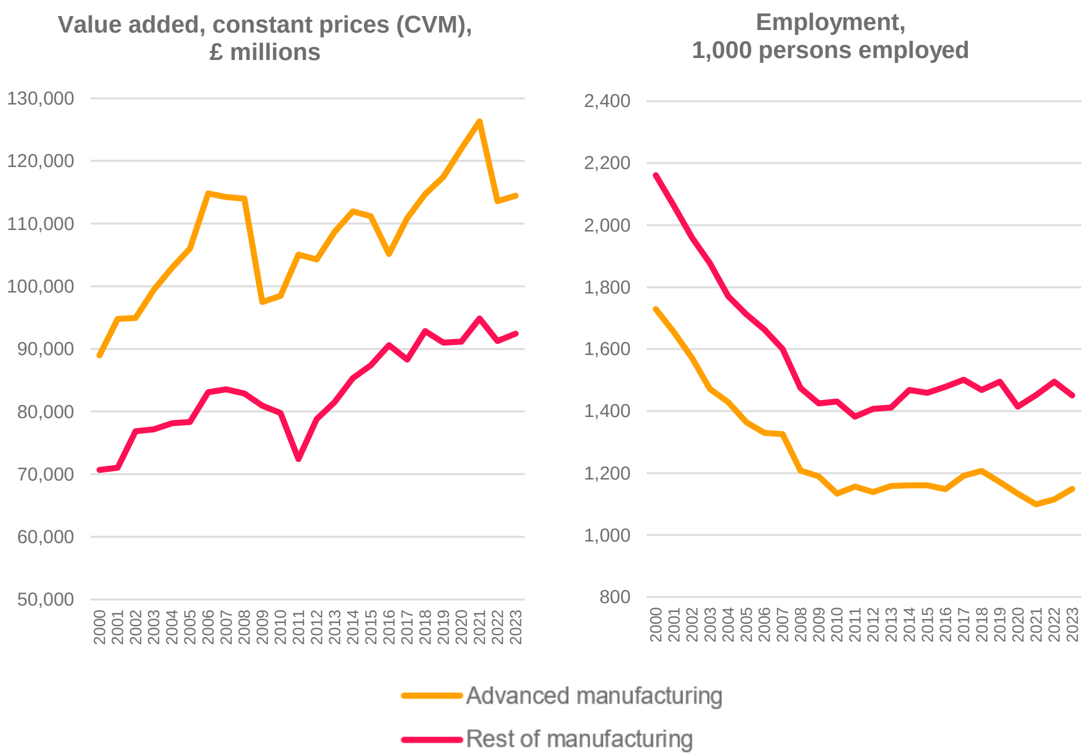


Source: ONS (2024). *GDP output approach, low level aggregates, UK*; ONS (2024). *JOBS03 Employee jobs by industry (UK totals), Dec 2024*; ONS (2024). *JOBS04 Self Employed jobs by industry (UK totals), Dec 2024.*

- We use three indicators – **innovation**, **worker qualification** and **R&D intensity –** to identify advanced manufacturing sectors (see Appendix 1.3–1.4).
- Using this approach, the manufacturing sectors (at two-digit SIC codes) considered to be advanced manufacturing **in the UK** are:
  - 11: Manufacture of beverages
  - 19: Manufacture of coke and refined petroleum products
  - 20: Manufacture of chemicals and chemical products
  - 21: Manufacture of basic pharmaceutical products and pharmaceutical preparations
  - 25: Manufacture of fabricated metal products, except machinery and equipment
  - 26: Manufacture of computer, electronic and optical products
  - 27: Manufacture of electrical equipment
  - 28: Manufacture of machinery and equipment, not elsewhere classified
  - 29: Manufacture of motor vehicles, trailers and semi-trailers
  - 30: Manufacture of other transport equipment
- In 2023 the aggregate of these industries represented 58.4% of **UK** manufacturing value added and 5.3% of total **UK** value added.
- In terms of employment, it represented 46.1% of **UK** manufacturing employment and 3.3% of total **UK** employment.
- Finally, advanced manufacturing sectors have significantly higher labour productivity than the rest of UK manufacturing and the UK economy.

Chart 1.10. Trends in UK advanced manufacturing sectors

Gross value added and employment, 2000-2023 trends



Source: ONS (2024). *GDP output approach, low level aggregates, UK*; ONS (2024). *JOBS03 Employee jobs by industry (UK totals), Dec 2024*; ONS (2024). *JOBS04 Self Employed jobs by industry (UK totals), Dec 2024.*

- From 2000 to 2023, the trajectory of both **advanced** and **non-advanced** manufacturing sectors was one of modest growth, with a 1.1% compound annual growth rate (CAGR) for both groups of sector.
- Advanced manufacturing sectors' value-added performance during the 2008–9 crisis was different from the rest of manufacturing. The **advanced manufacturing sectors** suffered a sharp decline in 2009 and started recovering from 2010 onwards. The **non-advanced manufacturing** sectors, in turn, had a more gradual but longer-lasting reduction in activity, facing reductions in 2009, 2010 and 2011, only starting to recover in 2012.
- The **advanced manufacturing sectors** again suffered a sharper decline during the COVID-19 pandemic than the **non-advanced manufacturing sectors**.
- In terms of employment, the **advanced** and **non-advanced manufacturing** sectors saw similar trends. A sharp decline in employment was observed from 2000 to 2010, and since then employment levels have been relatively stable.
- The similarity of this performance across **advanced** and **non-advanced manufacturing sectors** means it is likely that structural issues, such as infrastructure, skills and costs, are affecting the UK manufacturing sector as a whole.

Appendix 1.1. Sector classification and statistical codes

Classification of sectors based on the UK Standard Industrial Classification (SIC)							
Classification	**Section**	**Division**	**Description**	**Classification**	**Section**	**Division**	**Description**
	C	10–12	Food products, beverages and tobacco		J	58–63	Information and communication
	C	13–15	Textiles, wearing apparel, leather and related products		K	64–66	Financial and insurance activities
	C	16–18	Wood and paper products, and printing	**Knowledge-intensive services**	M	69–75	Professional, scientific and technical activities
Low/medium-tech manufacturing	C	19	Coke and refined petroleum products		P	85	Education
	C	22–23	Rubber and plastics products, and other non-metallic mineral products				
	C	24–25	Basic metals and fabricated metal products, except machinery and equipment		G	45–47	Wholesale and retail trade, repair of motor vehicles and motorcycles
	C	31–33	Furniture; other manufacturing; repair and installation of machinery and equipment		H	49–53	Transportation and storage
	C	20	Chemicals and chemical products		I	55–56	Accommodation and food service activities
	C	21	Basic pharmaceutical products and pharmaceutical preparations		L	68	Real estate activities
Medium/high-tech manufacturing	C	26	Computer, electronic and optical products	**Labour-intensive services**	N	77–82	Administrative and support service activities
	C	27	Electrical equipment		O	84	Public administration and defence; compulsory social security
	C	28	Machinery and equipment n.e.c.		Q	86–88	Human health and social work activities
	C	29	Motor vehicles, trailers and semi-trailers		R	90–93	Arts, entertainment and recreation
	C	30	Other transport equipment		S	94–96	Other service activities
	A	01–03	Agriculture, hunting, forestry and fishing		T	97–98	Activities of households as employers; undifferentiated activities of households for own use
Other production	B	05–09	Mining and quarrying		D	35	Electricity, gas, steam and air conditioning supply – utilities
	F	41–43	Construction	**Utilities**	E	36–39	Water supply; sewerage, waste management and remediation activities – utilities

Appendix 1.2. Methodology used to compute the indirect and direct value of manufacturing

- ONS Input-Output Analytical Tables (105 industries) are used to calculate value-added and full-time equivalent (FTE) employment multipliers.
- Domestic purchases from, and of, manufacturing industries (SIC codes C101 to C33) are aggregated to derive multipliers.
- FTE coefficients (£ per FTE) are estimated using ONS *FTE employment multipliers and effects*.
- The indirect value of manufacturing is calculated using these multipliers and distributed across sectors based on manufacturing's intermediate consumption for all industries outside SIC codes C10–33. For SIC codes C10–33, only direct impact values are used.
- Indirect FTE is allocated based on both manufacturing's intermediate consumption and variations in labour intensity across industries, measured as FTE/£ of output.
- Sector classification:
    - Engineering and R&D (SIC 71, 72)
    - Materials and infrastructure (SIC 1–9, 35, 41–43)
    - Resource management (SIC 36–39)
    - Manufacturing (SIC 10–33)
    - Business services (SIC 64–70, 73–74, 77–82)
    - IT, media and communication services (SIC 58–63)
    - Distribution and logistics (SIC 45–53)
    - Other services (SIC 55, 56, 75, 84–97)

Appendix 1.3. Methodology used to identify advanced manufacturing sectors

STEPS

1. Calculated the value of the following indicators for each manufacturing sector:
   - **Innovation:** share of sectoral turnover carried out by broader innovator firms[1]
   - **Skills:** ONS Qualification Index Score[2]
   - **R&D intensity:** **s**ector research and development (R&D) expenditure/sector gross value added (GVA).
2. Applied a threshold at the **value for the manufacturing sector as a whole** (see tables below).
3. Classified the sectors that meet the threshold in **at least two indicators** as advanced manufacturing sectors.

= sectors that are above the threshold for each indicator

Innovation

SIC code	Sector name
30	Manufacture of other transport equipment
29	Manufacture of motor vehicles, trailers and semi-trailers
27	Manufacture of electrical equipment
28	Manufacture of machinery and equipment n.e.c.
11	Manufacture of beverages
20	Manufacture of chemicals and chemical products
31	Manufacture of furniture
25	Manufacture of fabricated metal products, except machinery and equipment
17	Manufacture of paper and paper products
10	Manufacture of food products
32	Other manufacturing
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
13	Manufacture of textiles
33	Repair and installation of machinery and equipment
15	Manufacture of leather and related products
26	Manufacture of computer, electronic and optical products
23	Manufacture of other non-metallic mineral products
22	Manufacture of rubber and plastic products
16	Manufacture of wood, and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
18	Printing and reproduction of recorded media
24	Manufacture of basic metals
14	Manufacture of wearing apparel
19	Manufacture of coke and refined petroleum products

Skills

SIC code	Sector name
12	Manufacture of tobacco products
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
30	Manufacture of other transport equipment
19	Manufacture of coke and refined petroleum products
26	Manufacture of computer, electrical and optical products
11	Manufacture of beverages
33	Repair and installation of machinery and equipment
32	Other manufacturing
20	Manufacture of chemicals and chemical products
28	Manufacture of machinery and equipment not otherwise specified
29	Manufacture of motor vehicles, trailers and semi-trailers
27	Manufacture of electrical equipment
18	Printing and reproduction of recorded media
24	Manufacture of basic metals
25	Manufacture of fabricated metal products, except machinery and equipment
16	Manufacture of wood, and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
23	Manufacture of other non-metallic mineral products
15	Manufacture of leather and related products
14	Manufacture of wearing apparel
17	Manufacture of paper and paper products
31	Manufacture of furniture
10	Manufacture of food products
13	Manufacture of textiles
22	Manufacture of rubber and plastic products

R&D intensity

SIC code	Sector name
30	Manufacture of other transport equipment
26	Manufacture of computer, electronic and optical products
19	Manufacture of coke and refined petroleum products
29	Manufacture of motor vehicles, trailers and semi-trailers
27	Manufacture of electrical equipment
32	Other manufacturing
28	Manufacture of machinery and equipment not elsewhere classified
25	Manufacture of fabricated metal products, except machinery and equipment
20	Manufacture of chemicals and chemical products
23	Manufacture of other non-metallic mineral products
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations[3]
24	Manufacture of basic metals
22	Manufacture of rubber and plastic products
10	Manufacture of food products
13	Manufacture of textiles
15	Manufacture of leather and related products
17	Manufacture of paper and paper products
33	Repair and installation of machinery and equipment
11-12	Manufacture of beverages and tobacco products
18	Printing and reproduction of recorded media
16	Manufacture of wood, and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
31	Manufacture of furniture
14	Manufacture of wearing apparel

Note*: [1] Broader innovator firms are defined in the UK Innovation Survey as firms that have done at least one of the following activities in the reference period: 1. introduced a new or improved product (goods or services); 2. business processes used to produce or supply all goods or services that the business has introduced, regardless of origin – these innovations may be new to business or new to market; 3. engaged in innovation projects not yet complete or abandoned; and 4. investment activities in areas such as internal research and development, training, acquisition of external knowledge or machinery and equipment linked to innovation activities.
[2] The ONS Qualification Index Score compares how highly qualified population groups are. The index score assigns every individual aged 16 years and over in the population a rank (1 to 4) based on their highest level of qualification, excluding those whose highest level of qualification is unknown. The index score is then the average rank of all individuals in that population. The theoretical maximum value for the index score is 4.00, indicating that 100% of individuals in a population have obtained Level 4 or above qualifications. The minimum value for the index score is 0.00, indicating that 100% of individuals in a population have obtained no qualifications. Full methodology at ONS (2023). The ONS does not provide the value for the manufacturing sector as a whole, so this was calculated using the weighted average of the individual manufacturing sectors.
[3] The pharmaceuticals manufacturing sector did not officially meet the threshold for R&D intensity. However, based on previous analyses comparing R&D expenditure by SIC codes and by product group, the R&D expenditure is underestimated for this sector, given that it is carried out mainly by R&D firms not classified as pharmaceuticals manufacturing. We therefore decided to classify it as meeting the threshold for this indicator.
Source: Own calculation based on data from DBT (2024) UK Innovation Survey; ONS (2023) Education by Industry data tables, England and Wales, August 2023; and ONS (2024) Business enterprise research and development, UK: 2022.

THEME TWO

Investment in innovation

Is the UK spending enough on research and development?

How do the public and private sectors contribute to national expenditure on innovation?

How does the UK compare with other leading countries?

Theme 2: Investment in innovation

KEY FINDINGS

The UK's investment in innovation remains just above the OECD average, but still behind leading countries such as Korea, the USA, Japan and Germany:

- The UK gross domestic expenditure on R&D amounted to £70.7 billion in 2022, a 6.7% increase from 2021.
- This expenditure represents 2.77% of the UK's GDP, just above the OECD average of 2.73%.
- In terms of GDP, the UK's R&D expenditure is 25% higher than France's and over 60% higher than Canada's, but 16% lower than Switzerland's and almost half that of Korea's.

In 2021, while the UK government's direct funding for R&D as a share of GDP was below the OECD average, the UK led in total government financial support for business R&D, relying heavily on R&D tax relief over direct funding:

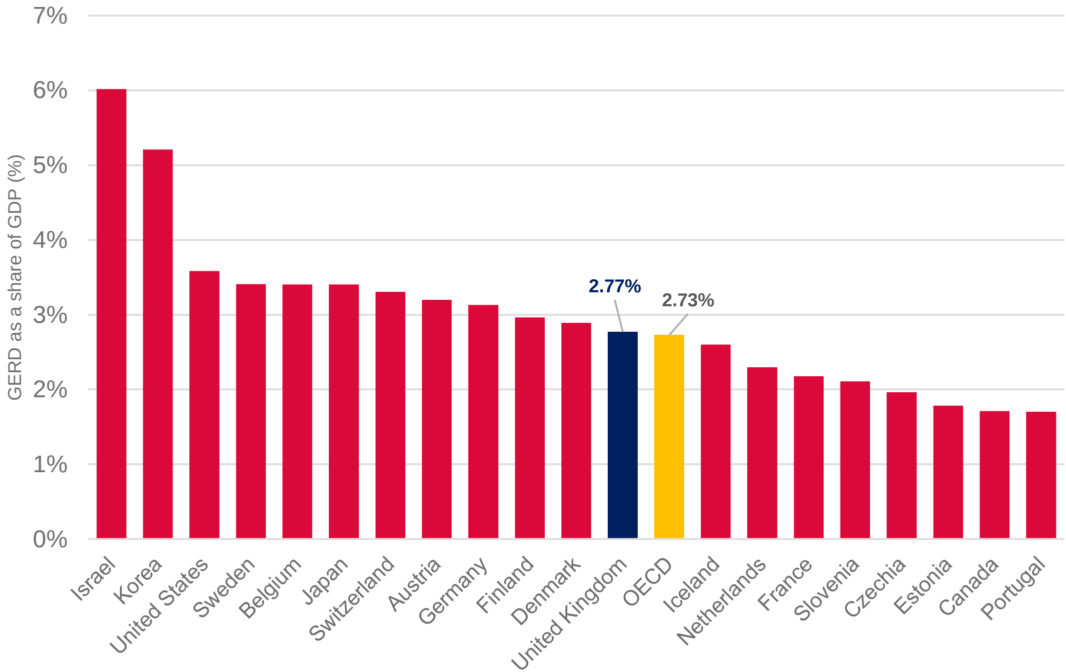
- In 2021 the UK government's direct funding to gross expenditure on R&D performed by all sectors in the economy amounted to 0.56% of GDP, below the OECD average (0.62%), making the UK 18th in the OECD ranking.
- However, a fraction of the UK government's direct funding to R&D goes to the business sector, equivalent to 0.15% of GDP, above the OECD average (0.09%) and countries such as France and the USA.
- Adding R&D tax relief, in 2021 the UK provided the highest government financial support for business R&D in the OECD, measured as a share of GDP, with over two-thirds of this support delivered through tax incentives.

In 2023 the UK remained a global leader per number of top R&D-investing companies, but its presence has nearly halved over the past decade, and its R&D investment in sectors such as ICT and automotive lags behind leading countries:

- In 2023, among the top 2,000 R&D-investing companies in the world, the UK ranked fifth per number of companies and seventh per total R&D investment.
- However, between 2013 and 2023, the number of UK companies among the top 2,000 R&D-investing companies in the world almost halved, going from 118 to 63.
- UK-headquartered R&D-investing companies specialise in health and the financial sector, accounting for almost 70% of the country's R&D investment in 2023, but their R&D investment is comparatively low in sectors such as ICT and automotive.

Chart 2.1. R&D intensity: international comparison

Gross domestic expenditure on research and development (GERD) as a share of GDP, top 20 OECD countries, 2022



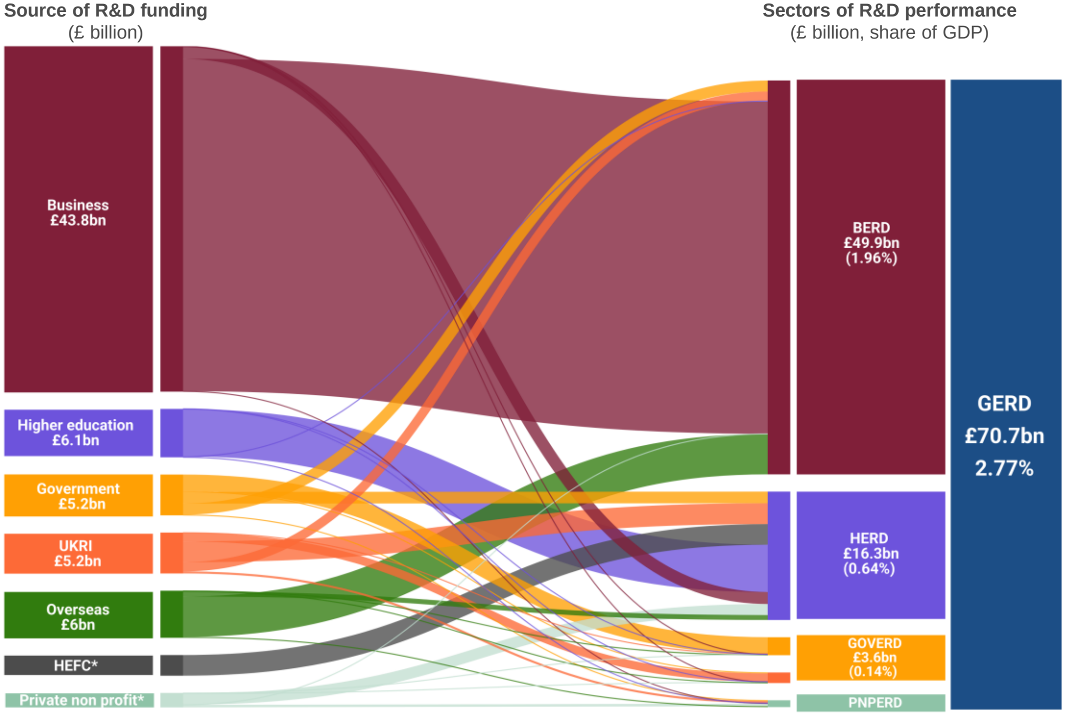
Note: This is the first year that the Office for National Statistics (ONS) published official data on the gross domestic expenditure on R&D as a share of GDP since the introduction in 2022 of revisions to the methodology used to estimate R&D in the UK. These new figures are not comparable with previously published estimates. Switzerland data refers to 2021.
Source: OECD (2024). Main Science and Technology Indicators (MSTI database); UK data: ONS (2024). Gross domestic expenditure on research and development, UK: 2022.

- The **gross domestic expenditure on research and development (GERD)** as a share of the gross domestic product (GDP) is commonly used to compare countries' "R&D intensity" and investment in innovation.
- In 2022 the **UK** R&D intensity was 2.77%, above the **OECD** average (2.73%).
- To put the R&D expenditure into a global perspective, the **UK** performs well compared to some peers but lags behind global leaders, being:
  - **higher than France and Canada –** the **UK**'s R&D expenditure as a share of GDP is 27% higher than **France**'s and over 60% higher than **Canada**'s
  - **lower than Switzerland and Korea –** the **UK** still trails leading economies, with R&D spending of GDP 16% lower than **Switzerland**'s and almost half that of **Korea**'s.
- **In absolute terms**, in 2021 the **UK** ranked fifth in the **OECD** for total expenditure on R&D (US$84 billion), where the **USA** remained the global leader (US$726 billion), followed by **Japan** (US$172 billion), **Germany** (US$129 billion) and **Korea** (US$110 billion).[1]
- **China** ramped up its R&D investment: its R&D intensity went from 1.71% in 2010 to 2.56% in 2022; and its total expenditure on R&D went from US$213 billion to US$687 billion in the same period.[1]

[1] **Note**: US dollars, PPP converted, constant prices. **Source**: OECD (2024). Main Science and Technology Indicators (MSTI database).

Chart 2.2. Overview of UK expenditure on R&D

By source of funds and sector of performance, 2022



*HEFC = £2.6bn; private non-profit = £1.8bn

PNPERD = £0.9bn (0.03%)

Note: UKRI = UK research and innovation;
HEFC = Higher Education Funding Councils.
Source: ONS (2024). Gross domestic expenditure on research and development, UK: 2022.

GERD = Gross domestic expenditure of R&D
BERD = Business enterprise expenditure on R&D
HERD = Higher education expenditure on R&D
GOVERD = Government expenditure on R&D
PNPERD = Private non-profit expenditure on R&D

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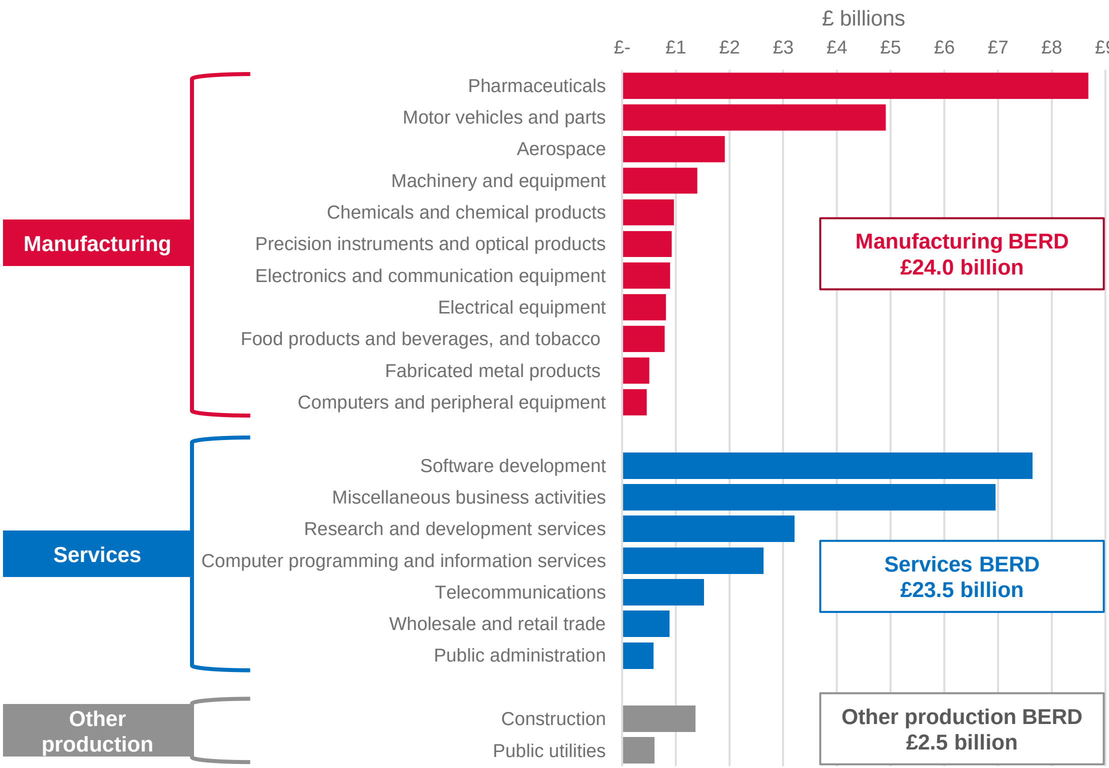
- This chart presents an overview of **UK** expenditure on R&D (GERD) in 2022, breaking down funding sources and performance across different sectors. The key categories include business enterprise R&D (BERD), higher education R&D (HERD), government-funded R&D (GOVERD) and private non-profit R&D (PNPERD).
- In 2022, according to the ONS, the **UK** gross domestic expenditure on R&D was £70.7 billion, increasing by 6.7% from 2021.
- Regarding the sources of R&D funding (i.e. *who funds* the R&D), the **UK** business sector accounted for 62% of the total R&D funding, and the government and UKRI contributed 14.6%.
- In the **UK** and other **G7** countries, the main source of R&D funding is the business sector, although in countries like the **USA** and **Japan,** the funding contribution to domestic expenditure on R&D from businesses can reach 68% and 78%, respectively.[1]
- In terms of sector performance (i.e. *who performs* R&D), the **UK** business sector performs 70.6% of the total R&D, and the business sector remains the main performer of R&D in each **G7** country.
- The **UK** higher education sector performs a relatively high share of R&D (23%) compared to countries such as the **USA** (9.9%) and **Japan** (11.5%).[1]

[1] **Source:** OECD (2024). Main Science and Technology Indicators (MSTI database).

Chart 2.3. UK business research and development

R&D performed in UK businesses (BERD), top 20 product groups, 2023

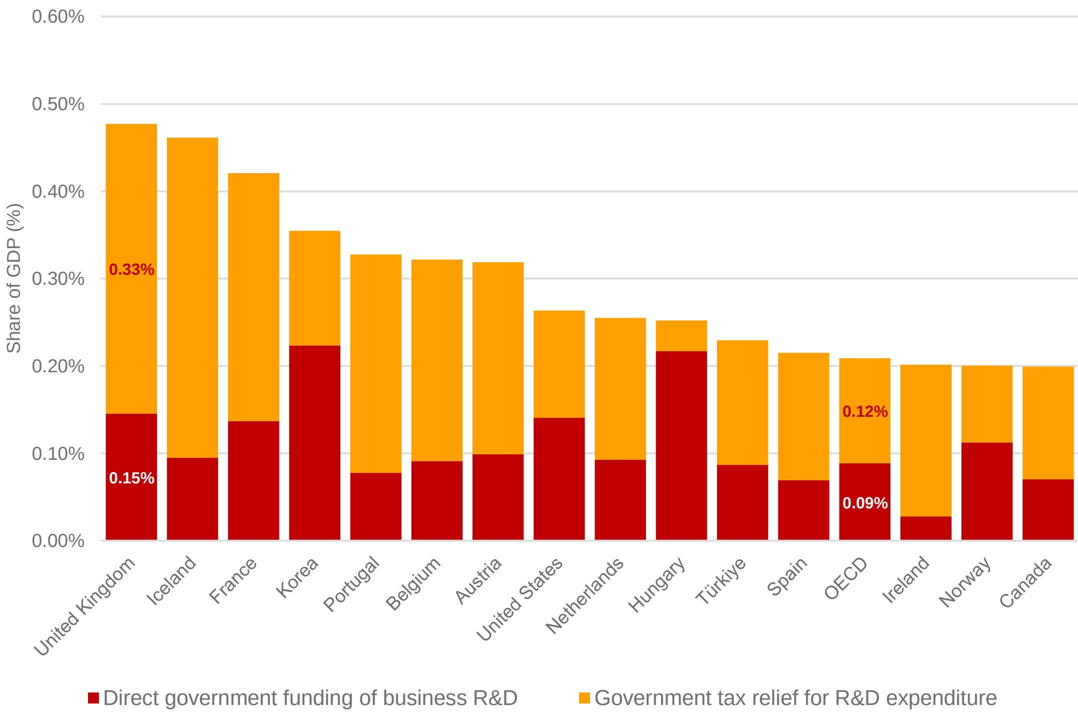


Note: Following the release of ONS (2024), estimates for 2022 have been revised as a result of updated survey data.
Source: ONS (2024). Business enterprise research and development, UK: 2023.

- In 2023 the R&D performed by businesses in the **UK** amounted to £49.9 billion, increasing by 2.9% from 2022.
- Manufacturing products accounted for 48% of total business R&D, followed by services (47%) and other production activities (5%).
- In 2023 the top four products and services, which accounted for 56% of total **UK** business R&D, equivalent to £28.2 billion, were: **pharmaceuticals** (£8.7 billion), **motor vehicles** (£4.9 billion), **software development** (£7.6 billion) and **miscellaneous business activities** (£7 billion).

Chart 2.4. Government financial support for business R&D in the OECD

Direct government funding and government tax relief for business R&D expenditure, share of GDP, top 15 OECD countries, 2021 or latest available



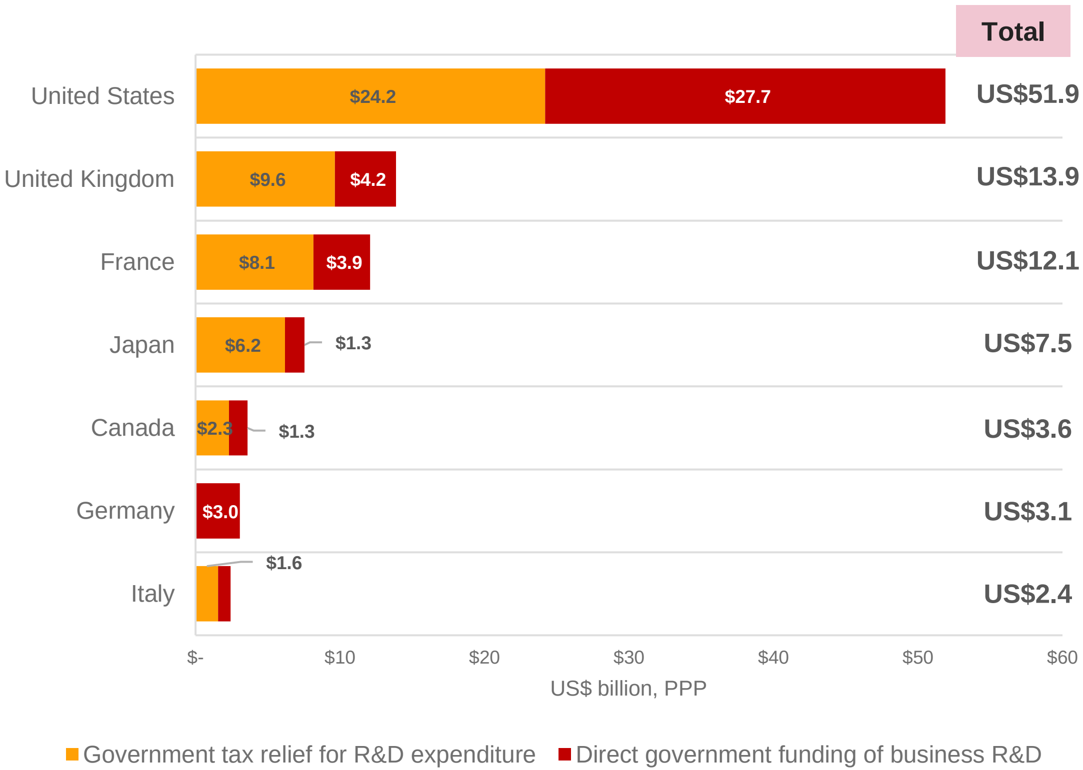
Note: US data refers to 2020.
Source: OECD (2024). R&D tax expenditure and direct government funding of BERD database.

- Government financial support for business R&D can be a mix of policy instruments, namely *direct funding* (including R&D grants and public procurement of R&D services) and *indirect support* through tax relief.
- Among OECD countries, the **UK** provided the largest government financial support to business R&D as a share of GDP in 2021: 0.48% of GDP, against the **OECD** average of 0.21%.
- The share of the **UK** government's direct funding to business sector R&D is equivalent to 0.15% of GDP. This figure is also above the **OECD** average (0.09%) and countries such as **France** and the **USA,** both at 0.14% of GDP in 2021.
- The last two decades have seen a change in the mix of policy instruments used to support business R&D. In 2021, R&D tax incentives accounted for approximately 58% of total government support for business R&D across OECD countries, compared to just 35% in 2006.[1]
- In 2021 over two-thirds of **UK** government support to business R&D was in the form of R&D tax relief (0.33% of GDP). Only around one-third was in the form of direct funding (0.15% of GDP).

[1] **Source**: OECD (2024). OECD R&D tax incentives database.

Chart 2.5. Government financial support for business R&D in G7 countries

US billion dollars, purchasing power parity, 2021 or latest available

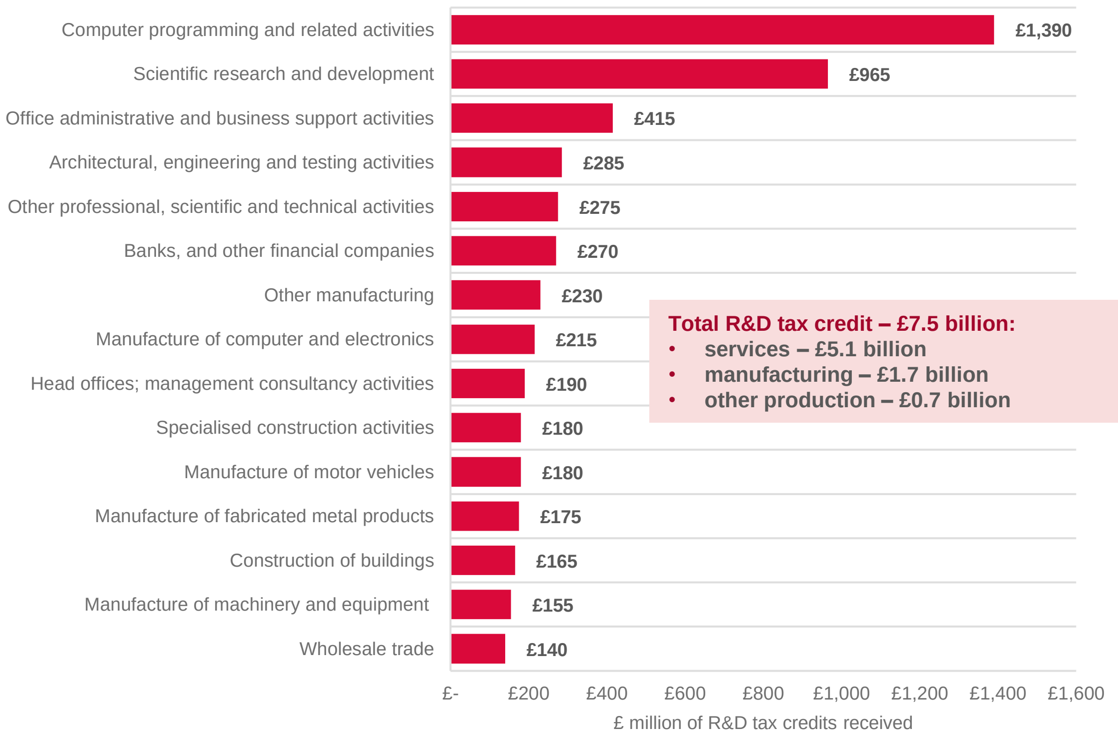


Note: US data refers to 2020. Values of less than £1 are not displayed.
Source: OECD (2024). R&D tax expenditure and direct government funding of BERD.

- In 2021 the **UK** government's total financial support to business R&D was equivalent to US$13.9 billion, second only to the **USA** (US$51 billion) across the G7 countries.
- In the **UK** almost 70% of government financial support to business R&D in 2021 took the form of tax relief (£9.6 billion), while 30% was direct government funding, through R&D grants and public procurement of R&D services (US$4.2 billion).

Chart 2.6. UK Government R&D tax credits

Top 15 industry sectors, two-digit level, by R&D tax credit received, tax year 2022-2023



Note: Data includes both *SME scheme* and *Research and Development Expenditure Credit (RDEC)* scheme claims. Other production includes: agriculture, forestry, fishing; mining and quarrying; electricity, gas, steam and air conditioning; water, sewerage and waste; and construction.
Source: HMRC (2024). Research and Development Tax Credits: Supplementary tables 2024.

- For the 2022–23 tax year, **UK** businesses claimed a total of £7.5 billion in R&D tax relief support. This figure is more than twice the £2.6 billion of direct support to business R&D provided by the government and UKRI in 2022.[1]
- In terms of R&D tax credit claims by firm size in the UK, in the 2022–23 tax year:[2]
  - 67% (US$5 billion) were claimed by small and medium enterprises
  - 33% (£2.5 billion) were claimed by large firms.

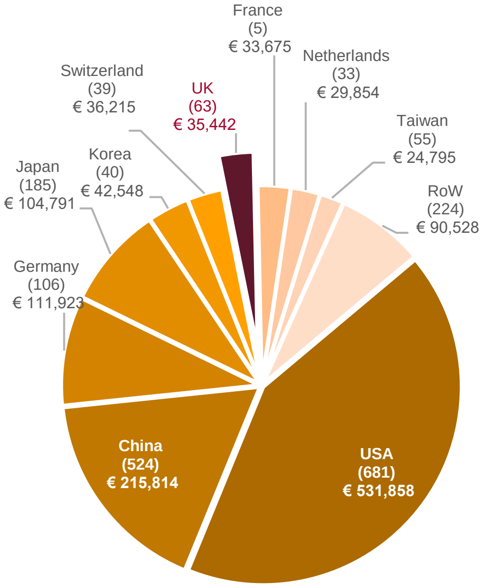
[1] **Source:** ONS (2024). Gross domestic expenditure on R&D, UK: 2022.
[2] **Source**: HMRC (2024). Research and Development Tax Credits: main tables 2024.

Chart 2.7. Top R&D-investing companies in the world

Top 10 economies by R&D expenditure, and expenditure by sector, 2023

R&D investment by country

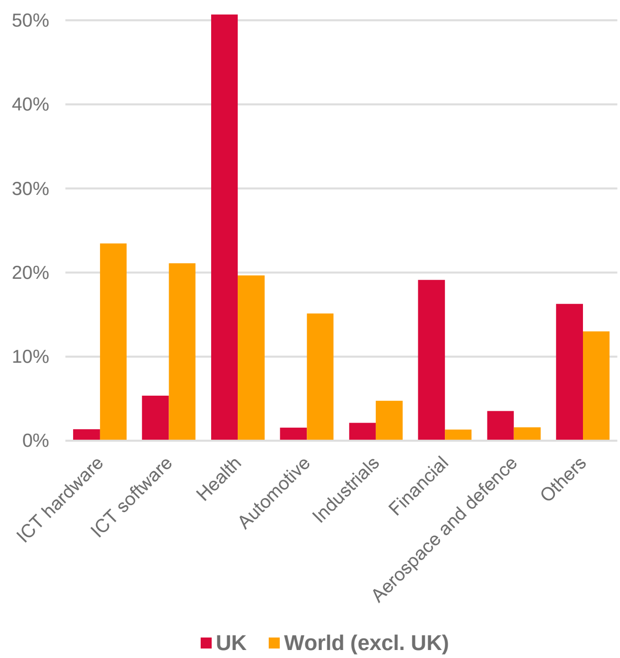
(€ million, brackets show number of companies)



Total R&D expenditure: €1,257bn
Total number of companies: 2,000

R&D expenditure by sector

(% of total expenditure)



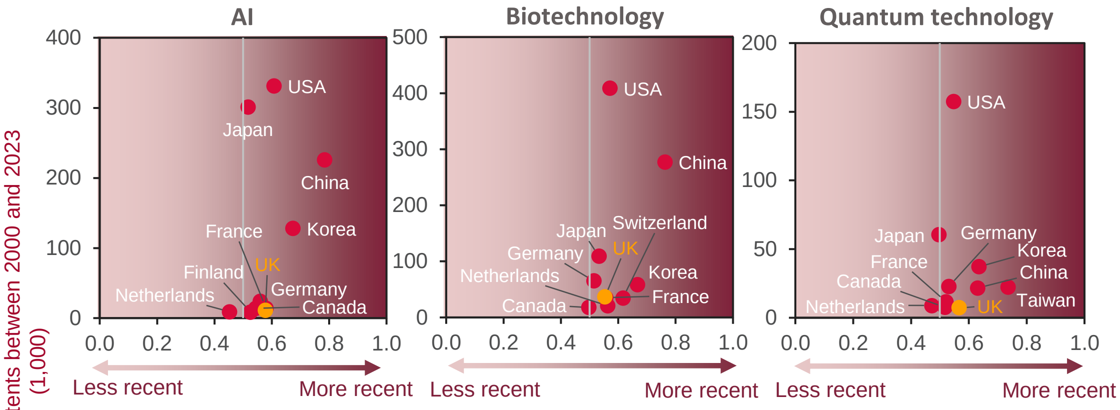
Note: RoW = rest of the world; see Appendix 2.1 for sector definition.
Source: European Commission (2024). The 2024 EU Industrial R&D Investment Scoreboard.

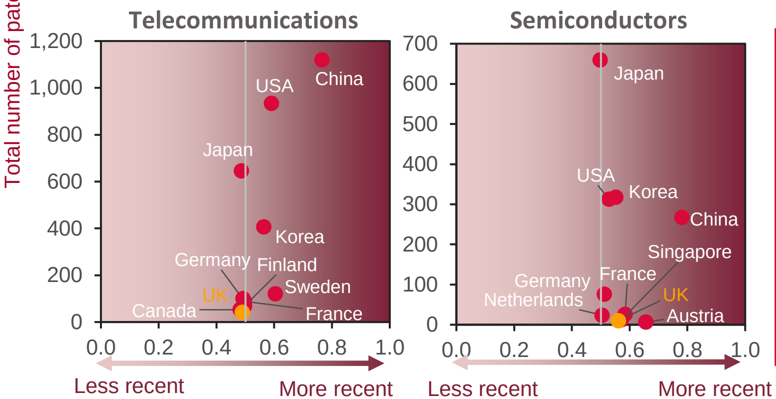
- In 2023, 63 companies with headquarters in the **UK** were among the top 2,000 R&D-investing companies in the world. This placed the **UK**:
  - fifth in the world per number of top R&D-investing companies headquartered in the country (3.2% of total companies in the world)
  - seventh in the world per total investment by top R&D-investing companies headquartered in the country (2.8% of total R&D investment).[1]
- Between 2013 and 2023, however, the number of **UK** companies among the top 2,000 R&D-investing companies in the world almost halved, going from 118 to 63.
- In 2023 only two **UK**-headquartered companies were among the top 100 R&D-investing companies in the world, namely AstraZeneca (14th) and GSK (33rd), both **pharmaceuticals.**
- Compared to the rest of the world, in 2023 UK R&D-investing companies:
  - were specialised in **health** (i.e. pharma, medical devices) and **finance** (i.e. banks and other financial services), accounting for almost 70% of the country's R&D investment in 2023;
  - were under-represented in sectors such as **ICT** and **automotive**.

[1] **Note**: The 2024 EU Industrial R&D Investment Scoreboard covers the world's top 2,000 R&D-investing companies with headquarters across 40 countries and over 900,000 subsidiaries across the world. In 2023 those companies accounted for over 85% of global business-funded R&D. The unit of analysis of the Scoreboard is investment in R&D by company headquarters, regardless of where the R&D activity is conducted. **Source**: European Commission (2024). The 2024 EU Industrial R&D Investment Scoreboard.

Chart 2.8. Patent applications in key technology fields

Top 10 patent origin economies by number of patents, worldwide, 2000-2023





How to read

Y axis – innovation intensity is measured by the total number of published patents between 2000 and 2023.

X axis – recency measures how recently patent applications were first filed for specific technologies. It is calculated as a weighted average of patent applications, where a higher weighting is given to inventions filed in more recent years.

Note: The "innovation maturity matrix" depicts innovation intensity against the recency of innovation for selected key technology, based on relevant patent applications filed worldwide between 2000 and 2023. Recency and innovation intensity are calculated based on the annual number of patent applications counted by countries of origin. See Appendix 2.1 for key technology fields and WIPO (2024) for methodological details. **Source**: WIPO (2024). WIPO IP Statistics Data Center and EPO (2024). PATSTAT 2024 Autumn.

- In 2023 *the UK Science and Technology Framework* identified "five critical technologies":
  - artificial intelligence (AI)
  - engineering biology
  - future telecommunications
  - semiconductors
  - quantum technologies.[1]
- The UK was among the top ten countries in the world in all five critical technologies, as measured by the total number of patent applications filed between 2000 and 2023.
- When considering the scale of patent application, however, leaders such as the USA, Japan, China and Korea are far ahead of the UK. For example, between 2000 and 2023:
  - in AI, the USA filed 331,382 patents, Japan 301,373, and the UK 11,279
  - in quantum technologies, the USA filed 157,311 patents, Japan 60,426, and the UK 7,225
  - in semiconductors, Japan filed 659,131 patents, Korea 317,664, and the UK 10,098.

[1] **Source:** DSIT (2023) The UK Science and Technology Framework.

Appendix 2.1. Sector classification

Sector classification as per Industry Classification Benchmark (ICB)

ICB 3-digit	ICB 4-digit	ICB 3-digit	ICB 4-digit
Aerospace and defence	Aerospace; defence	**Industrials**	General industrials
Automotive	Automobiles and parts		Industrial engineering
Chemicals	Chemicals		Industrial metals and mining
Construction and materials	Construction and materials		Industrial transportation
Energy	Alternative energy		Mining
	Electricity	**Others**	Beverages
	Gas, water and multi-utilities		Food and drug retailers
	Oil and gas producers		Food producers
	Oil equipment, services and distribution		Forestry and paper
Financial	Banks		General retailers
	Financial services		Household goods and home construction
	Non-life insurance		Leisure goods
	Real estate investment and services		Media
Health	Healthcare equipment and services		Personal goods
	Pharmaceuticals and biotechnology		Support services
ICT hardware	Electronic and electrical equipment		Tobacco
	Technology hardware and equipment		Travel and leisure
ICT software	Fixed line telecommunications		
	Mobile telecommunications		
	Software and computer services		

Appendix 2.2. Key technology fields

Key technology fields	Description	Sources
Semiconductors	**IPC code**: H01L; H10	WIPO IP Statistics *Semiconductors is one of the fields of technology identified by WIPO. For further information, please refer to Concept of a Technology Classification for Country Comparisons and https://www.wipo.int/ipstats/en/.
Biotechnology	**IPC code**: (C07G; C07K; C12M; C12N; C12P; C12Q; C12R; C12S) not A61K	WIPO IP Statistics *Biotechnology is one of the fields of technology identified by WIPO. For further information, please refer to Concept of a Technology Classification for Country Comparisons and https://www.wipo.int/ipstats/en/.
Telecommunication	**IPC code**: G08C; H01P; H01Q; H04B; H04H; H04J; H04K; H04M; H04N001; H04N-007; H04N-011; H04Q; H04L; H04N21; H04W	WIPO IP Statistics *Telecommunication in this slide is to merge two technology fields identified by WIPO: telecommunications and digital communication. For further information, please refer to Concept of a Technology Classification for Country Comparisons and https://www.wipo.int/ipstats/en/.
Quantum technology	H04L 9/08; H04L 9/12; H04L 9/00; H04K 1/00; H04B 10/00; H04B 10/04; H04L 9/32; H04B 10/70; H04B 10/06; H04B 10/30 **(IPC code for quantum telecommunications)** G06N 99/00; G06N 1/00; H01L 29/06; H01L 39/22; H01L 29/66; G02F 3/00; H03K 19/195; H01L 29/02; G06E 3/00; G06F 15/00 **(IPC code for quantum computation)** G01R 33/035; G01R 33/02; A61B 5/05; H01L 39/22; G01N 27/72; A61B 5/055; G01R 33/12; G01N 27/82; G01V 3/00; H01L 39/04 **(IPC code for quantum sensor)** G04F 5/14; H03L 7/26; H01S 1/06; H03B 17/00; G04F 5/00; H01S 1/00; H03H 3/02; H03H 9/02; H03H 9/19 **(IPC code for quantum timing and atomic clock)**	PATSTAT online (PATSTAT 2024 Autumn version) *The IPC codes used here to identify quantum-technology-related patents were applied by the UK Intellectual Property Office in the Eight Great Technologies Quantum Technologies A patent overview report.
Artificial intelligence	AI techniques, AI functional applications, AI application fields, and AI in general	WIPO AI Index AI is one of the technological fields identified by WIPO. For further information, please refer to WIPO IP Statistics, Indicator 4c: patent publications by AI-related technology.

UNIVERSITY OF CAMBRIDGE

Cambridge Industrial Innovation Policy

THEME THREE

Industrial performance – international comparison

Are the UK's manufacturing industries becoming more or less competitive internationally?

How are UK manufacturing industries performing in terms of productivity, value added, employment and exports?

How is the UK's performance in key manufacturing industries?

Theme 3: Industrial performance – international comparison

KEY FINDINGS

Since 2000, G7 countries, including the UK, have reduced their share of global manufacturing, while China has become a dominant player:

- Since 2000, the manufacturing sector has experienced a decline across G7 countries, with their combined share of global manufacturing value added dropping from 56% in 2000 to 33.1% in 2022. Over the same period, their share of global manufacturing exports fell from 51.9% to 30%.
- The UK's manufacturing sector followed a similar trend, with its share of global manufacturing value added shrinking from 3.1% to 1.9% between 2000 and 2022, its share of global manufacturing employment declining from 1.3% to 0.6% between 2000 and 2022, and its share of global manufacturing exports narrowing from 3.7% to 1.5% between 2000 and 2020.
- Meanwhile, China has emerged as a prominent manufacturing player, gaining global market presence in manufacturing industries. China's share of global manufacturing value added rose from 6.4% in 2000 to 31% in 2022.

The UK's top manufacturing industries by value added have shown varying trends in value added, employment, productivity and exports since 2010. Among them, automotive manufacturing stands out as one of the fastest-growing industries:

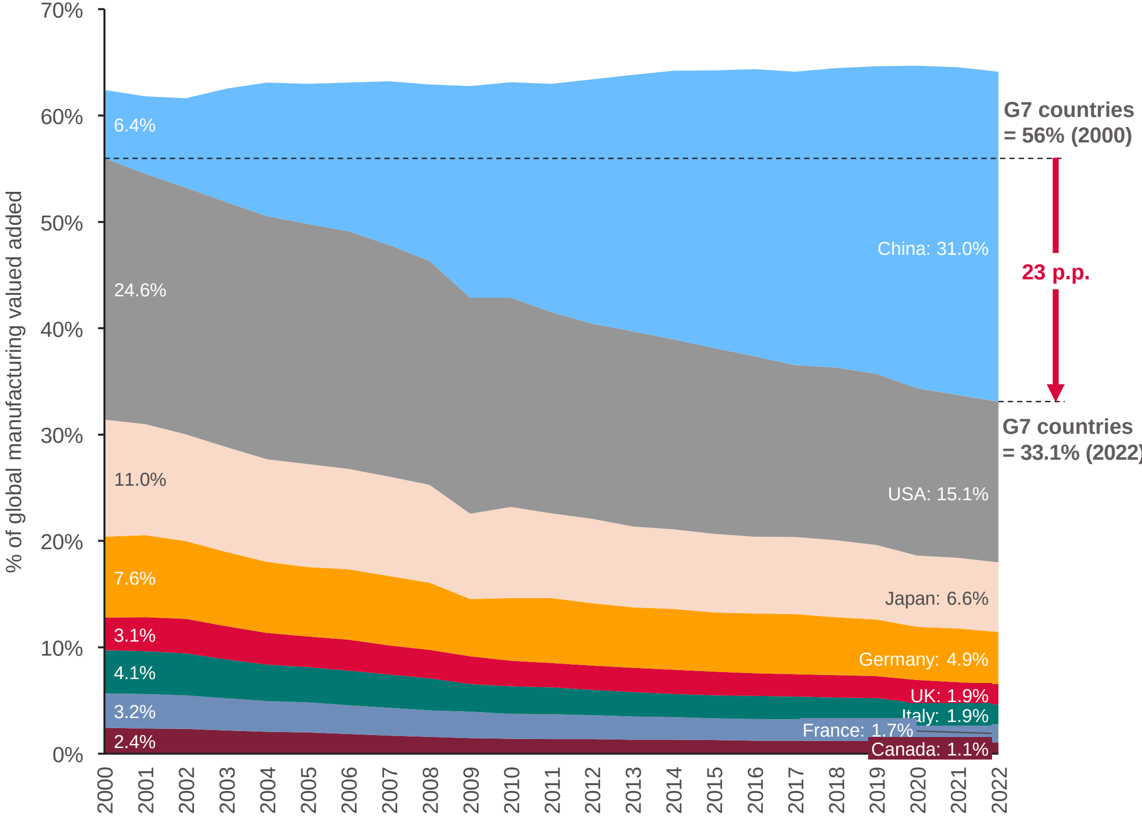
- The top seven UK manufacturing industries by value added include food, beverage and tobacco, pharmaceuticals, metal products, computer and electronics, machinery and equipment, automotive and other transport equipment.
- Among the seven manufacturing industries, automotive saw the highest growth between 2010 and 2022, with value added rising 72% and employment up 18.7%. It was also one of the fastest-growing export manufacturing sectors, with a 51.9% increase between 2000 and 2020.
- Since the 2008 financial crisis, the UK's overall productivity growth has been sluggish, but sectoral performance varies. Manufacturing stands out as one of the fastest-growing sectors, with notable productivity gains seen in other transport equipment (CAGR 4.1%), machinery and equipment (4.05%), metal products (3.3%) and automotive (3.2%) between 2010 and 2022.

The UK has lost competitiveness in key manufacturing industries, including those in which the country has traditionally been strong, such as pharmaceuticals and other transport equipment:

- In the last decade the UK has seen a decrease in its global manufacturing export shares. This reduction has been largest in industries in which it has traditionally been strong, such as pharmaceuticals (-5.3 percentage points) and other transport equipment (-4.2 percentage points). In a selection of 10 advanced industries, the UK's market share (in value-added terms) decreased from 4.4% in 2000 to 2.6% in 2020.
- In the 2000–2020 period, the UK increased its specialisation (measured by a revealed comparative advantage index of value added) in two advanced industries: automotive, and information and communication services. In all other advanced industries, the UK has seen a decrease in specialisation, with the largest reductions being in basic metals, chemicals and electrical equipment.

Chart 3.1. World manufacturing value-added shares

G7 countries and China, US$ at constant prices, 2000–2022



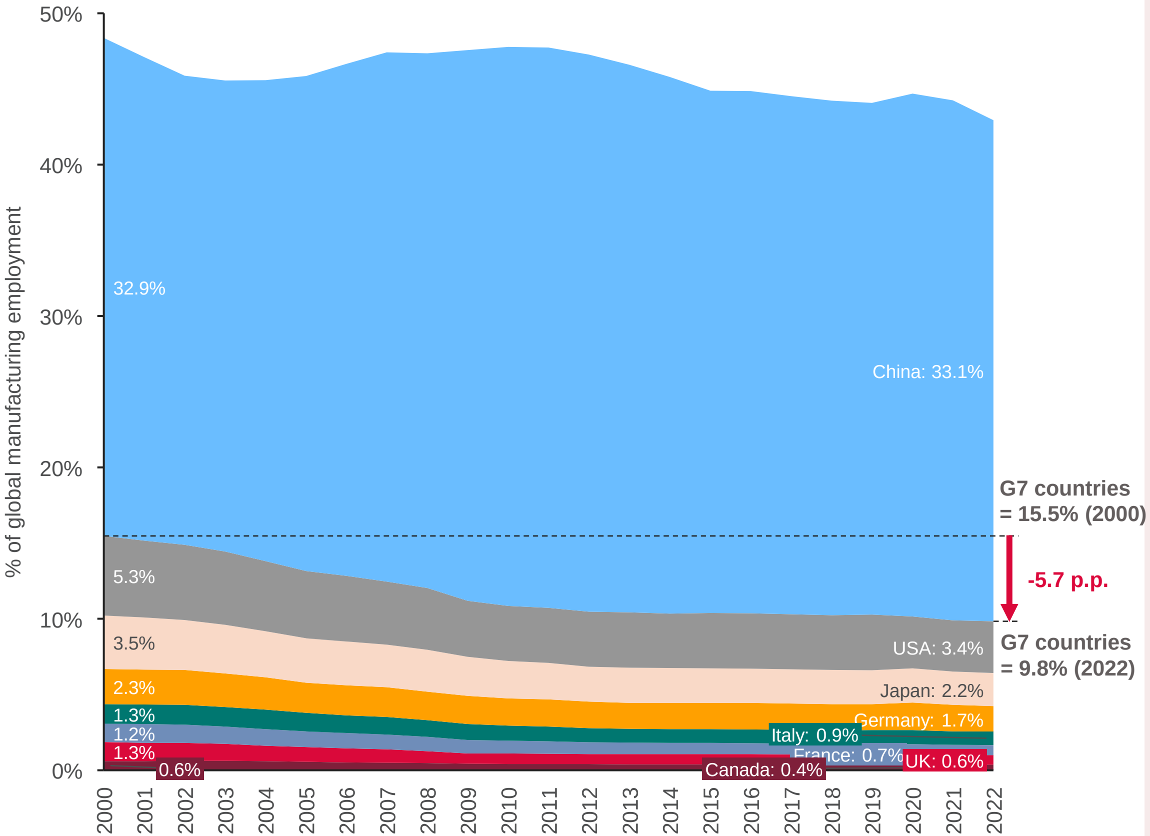
Note: Shares calculated using constant prices. See UNIDO (2017) Indicator 7 for detailed methodology.
Source: UNIDO (2024). Competitive Industrial Performance Index database.

- Between 2000 and 2022, manufacturing as a share of global GDP declined from 18.3% to 15.8%.[1]
- The **UK**'s share of global manufacturing value added changed from 3.1% in 2000 to 1.9% in 2022.
- Overall**, G7 countries** (including the UK) reduced their total manufacturing value-added shares from 56% in 2000 to 33.1% in 2022.
- The manufacturing value-added shares of **Canada**, **Italy** and **France** roughly halved during this period (56.3%, 53.7% and 47.4% reductions, respectively).
- **China** captured manufacturing value-added shares from other countries, going from a 6.4% share in 2000 to 31% in 2022.

[1] **Source:** World Bank. World Development Indicators.

Chart 3.2. World manufacturing employment shares

G7 countries and China, 2000–2022



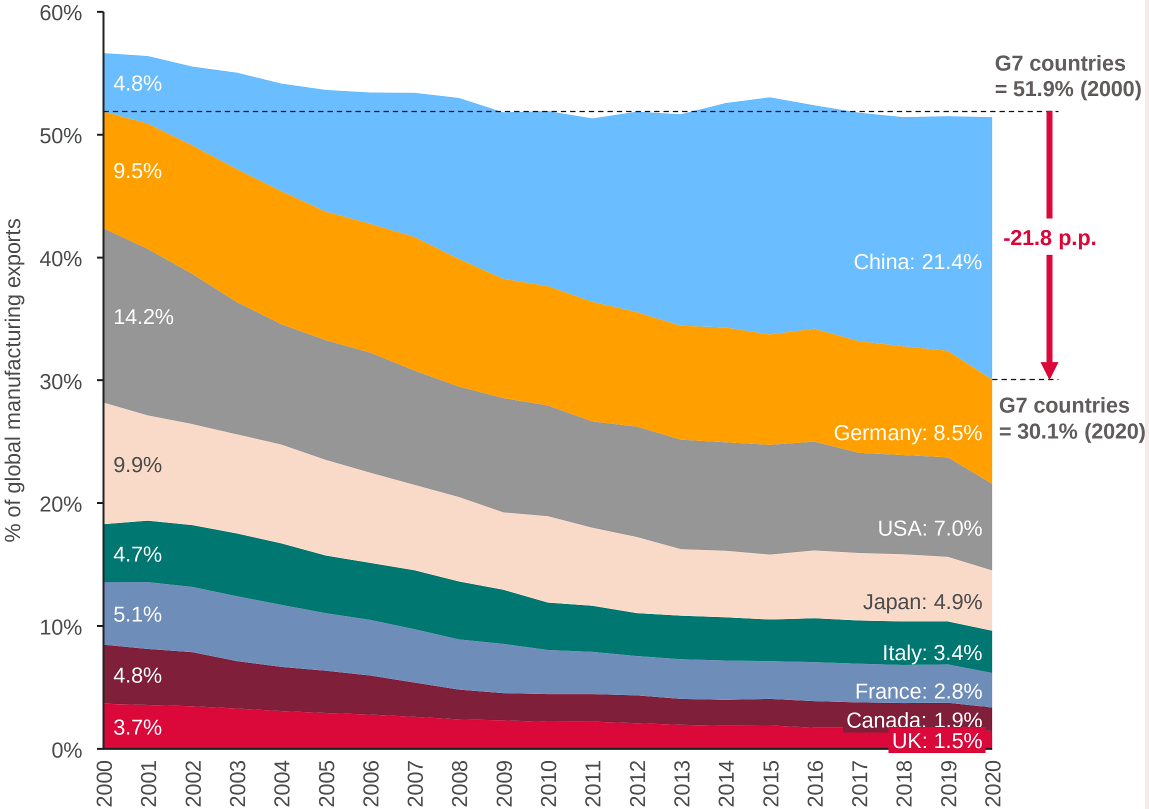
Source: ILOSTAT (2024). Employment by sex and economic activity -- ILO modelled estimates, Nov. 2024 (thousands).

- Between 2000 and 2022, total global employment increased by 30.8%, while the growth of global manufacturing employment was 28.6% over the same period.[1]
- **G7 countries**' shares of global manufacturing employment dropped from 15.5% to 9.8% between 2000 and 2022.
- The **UK** was the G7 country with the largest reduction (50.7%) in global manufacturing employment share, going from 1.3% to 0.6%, followed by **France,** with a reduction of 45.3%. In 2022 the **UK's** manufacturing sector provided 2.4 million jobs, accounting for 7.4% of total **UK** employment.[2]
- **China**'s share of global manufacturing employment remained stable, with a slight increase from 32.9% in 2000 to 33.1% in 2022.

[1] **Source:** ILOSTAT (2024). Employment by sex and economic activity -- ILO modelled estimates, Nov. 2024 (thousands).
[2] OECD (2024). Annual employment by detailed economic activity, domestic concept.

Chart 3.3. World manufacturing export shares

G7 countries and China, US$ at current prices, 2000–2020



Note: Export data here is adjusted for re-exports. Please see OECD (2023) Gross exports (EXGR) for detailed methodology
Source: OECD (2024). Trade in Value Added (TiVA) data.

- From 2000, the **UK's** share in global manufacturing exports more than halved, going from 3.7% in 2000 to 1.5% in 2020, representing a 60% reduction.
- The **G7 countries** reduced their global shares in manufacturing goods exports, from 51.9% in 2000 to 30.1% in 2020.
- In some countries the reduction was less pronounced, such as **Germany,** whose export share went from 9.5% in 2000 to 8.5% in 2020, a reduction of 10.7%.
- **China** saw substantial growth, gaining manufacturing export shares over other countries: from 4.8% in 2000 to 21.4% in 2020.

Chart 3.4. International industrial competitiveness rankings

Top 30 ranking countries, 2000 and 2020

UNIDO's CIP index – Top 30 ranking, out of 153 countries		
Rank	2000	2020
1	United States of America	Germany
2	Germany	China
3	Japan	Ireland
4	Canada	Republic of Korea
5	Italy	Japan
6	Ireland	United States of America
7	France	China, Taiwan Province
8	Switzerland	Switzerland
9	Belgium	Singapore
10	Republic of Korea	Netherlands
11	United Kingdom	Italy
12	Singapore	France
13	Netherlands	Belgium
14	Sweden	Austria
15	China, Taiwan Province	United Kingdom
16	Mexico	Czechia
17	Spain	Sweden
18	Austria	Mexico
19	Finland	Denmark
20	Denmark	Canada
21	Malaysia	Malaysia
22	Israel	Poland
23	China	Spain
24	Thailand	Finland
25	Australia	Thailand
26	Czechia	Hungary
27	Hungary	Slovakia
28	Norway	Turkey
29	Portugal	Israel
30	Brazil	United Arab Emirates

ITIF's Hamilton Index		
Rank	2000	2020
1	Taiwan	Taiwan
2	Singapore	Korea
3	Korea	Singapore
4	China	Switzerland
5	Sweden	China
6	Malaysia	Germany
7	Germany	Japan
8	Japan	Israel
9	Israel	Sweden
10	Switzerland	Malaysia
11	Belgium	Austria
12	Thailand	Thailand
13	India	India
14	Philippines	Philippines
15	Austria	Denmark
16	Canada	Belgium
17	Mexico	Italy
18	United States	Mexico
19	Italy	United States
20	France	Poland
21	South Africa	Netherlands
22	Spain	Turkey
23	United Kingdom	Vietnam
24	Netherlands	Russia
25	Denmark	France
26	Vietnam	United Kingdom
27	Brazil	Brazil
28	Indonesia	Spain
29	Russia	Argentina
30	Argentina	Canada

Source: UNIDO (2024). Competitive Industrial Performance Index database; ITIF (2023). The Hamilton Index, 2023: China Is Running Away With Strategic Industries.

UNIDO's Competitive Industrial Performance (CIP) index

- UNIDO's CIP Index is a composite index that combines measures of a country's capacity to produce and export manufactured products, its technological sophistication, and its impact on world manufacturing production and trade.
- In the global ranking of this index, the **UK** fell from position 11 in 2000 to position 15 in 2020.
- Most **G7** countries lost positions during this time period. The only exception was **Germany**, which went from position 2 in 2000 to position 1 in the global ranking in 2020.
- **China**, in turn, went from position 23 to position 2 in the global ranking during this period.

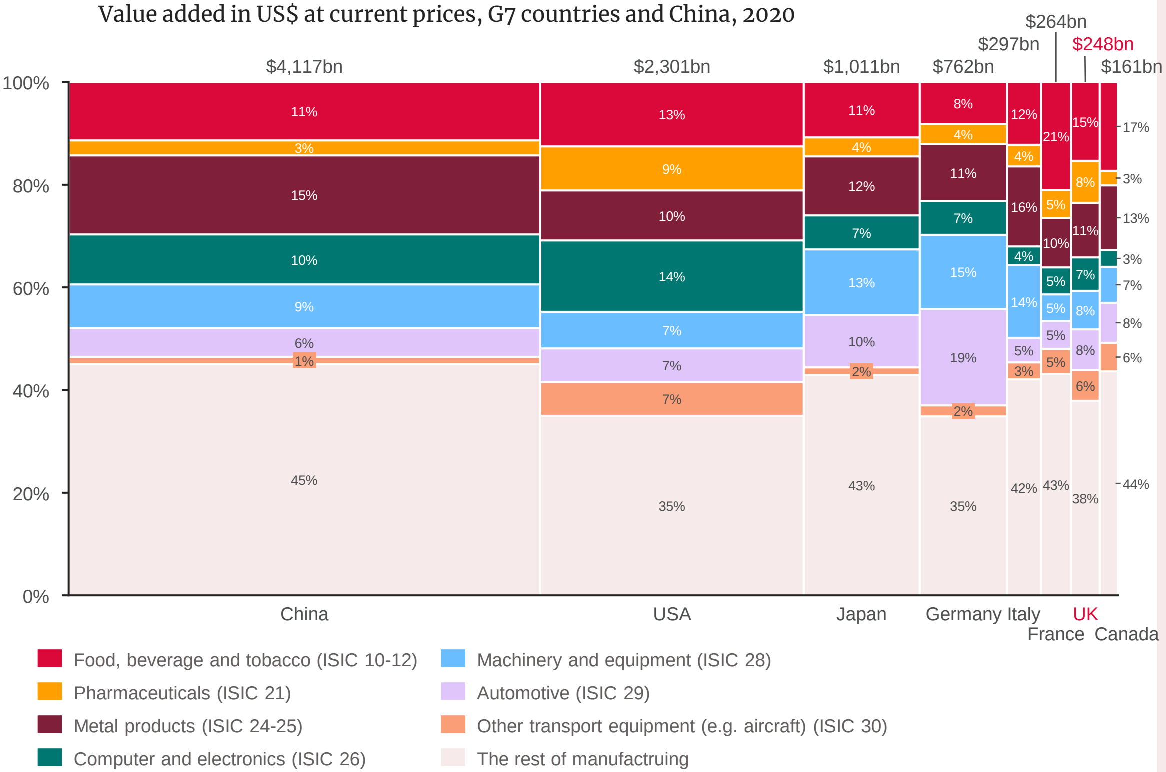
ITIF's Hamilton Index

- The Hamilton Index is a composite index that measures countries' competitive position in 10 advanced industries.[1]
- The **UK** went from position 23 in 2000 to position 26 in 2020 in this index, showing a loss of specialisation in advanced industries.
- Of the other **G7** countries, **Germany**, **Italy** and **Japan** went up in the ranking from 2000 to 2020, while the **USA**, **Canada** and **France** went down.
- **China** lost only one position during this time, moving from position 4 to position 5 between 2000 and 2020.

[1] **Note:** Pharmaceuticals; electrical equipment; machinery and equipment; motor vehicles; other transportation (aerospace, rail and sea transportation); computer, electronics and optical products; IT and information services; chemicals; basic metals; and fabricated metals.

Chart 3.5. Structure of manufacturing value added across G7 and China

Value added in US$ at current prices, G7 countries and China, 2020

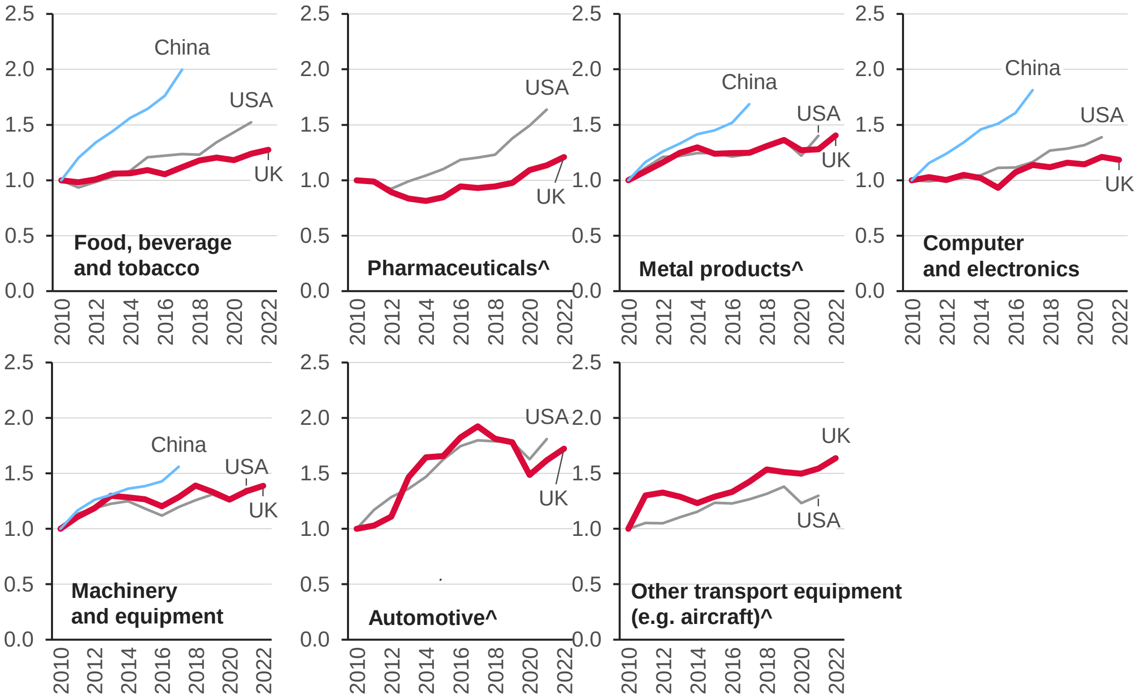


Note: The bar width for each country is proportional to each country's manufacturing value added in US$ billion. The top seven UK manufacturing sectors by valued added are highlighted. The "rest of manufacturing" category includes the manufacturing of wood products and furniture, repair and installation of machinery and equipment, printing, plastic and rubber products, paper products, non-metallic mineral products, coke and refined petroleum products, clothing and footwear, chemical products, and other manufacturing n.e.c.
Source: OECD (2024). Trade in Value Added (TiVA) 2023 edition: Principal Indicators, levels [cloud replica].

- In 2020, seven sectors – **food, beverage and tobacco**, **pharmaceuticals**, **metal products**, **computer and electronics**, **machinery and equipment**, **automotive** and **other transport equipment –** accounted for 62% of the UK's manufacturing value added.
- The **UK**'s manufacturing structure is similar to that of the **USA**. However, the **computer and electronics** sector contributed 14% to the USA's manufacturing value added, which is 7% higher than in the **UK**.
- Among G7 countries, the **USA** had the highest manufacturing value added in 2020, at US$2,301 billion, while the **UK**'s manufacturing sector generated US$248 billion, ranking sixth within the G7.
- **China**'s manufacturing value added reached US$4,117 billion in 2020, 1.8 times that of the USA, with the **metal products** sector being one of the largest, accounting for 15% of its total manufacturing value added.

Chart 3.6. Value-added trends of key manufacturing sectors

Selected manufacturing sectors, value-added index (2010 = 1.0), current prices in local currency, UK, USA and China, 2010–2022 or latest year

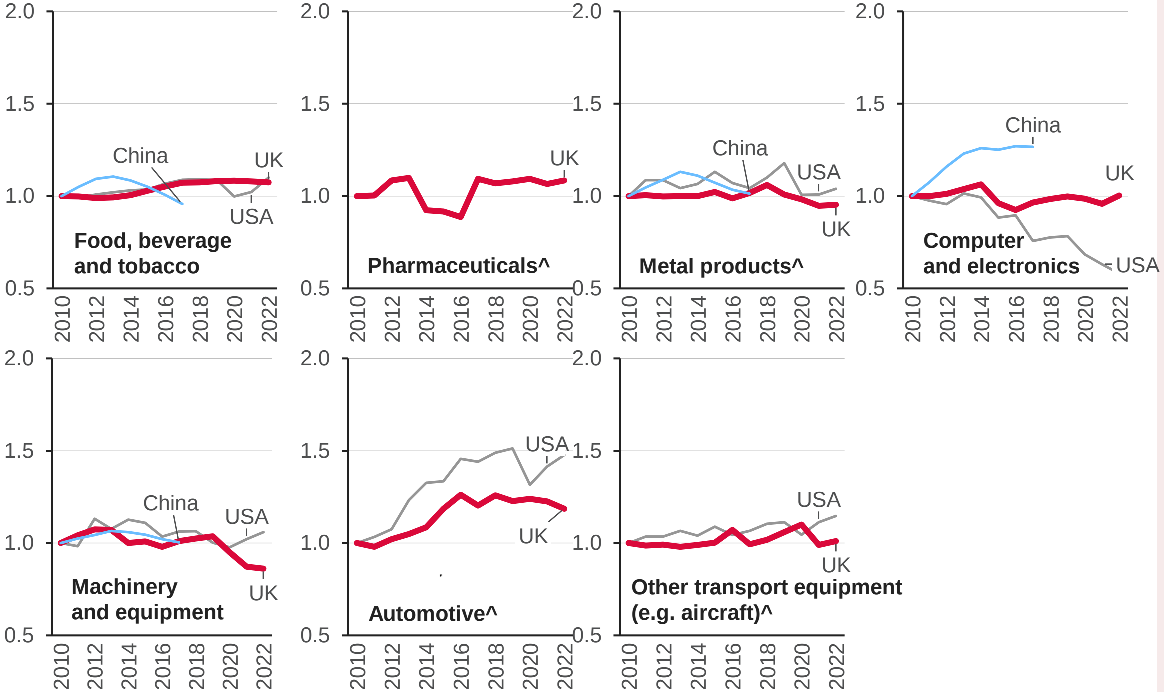


Note: Absolute manufacturing value added in 2010 is set to 1.0, with values in subsequent years expressed as a ratio relative to 2010; the top seven UK manufacturing sectors by valued added are selected. ^China's economic data is sourced from the CIP 4.0 Database, where China's industrial classifications have been reclassified. Data for pharmaceuticals, automotive and other transport equipment in China is not available. The "metal products" sector presented in this slide includes both "primary & fabricated metal industries" and "metal products (excluding rolling products)", as classified in the CIP 4.0 Database. For further details, please refer to the IARIW 2024 paper.
Source: OECD (2024). Annual value added and its components by economic activity; CIP Database (2023). The CIP 4.0 Database.

- The **UK** experienced value-added growth across all selected manufacturing sectors between 2010 and 2022. Among these industries, the **automotive** sector saw the fastest growth, with a 72% increase from 2010.
- The **UK** and the **USA** exhibited similar value-added growth trends in the manufacturing of **metal products** and **machinery and equipment**. The **UK** led the **USA** in the growth of the **other transport equipment** industry.
- **China**'s manufacturing growth stands out compared to the USA and the UK. As shown in the charts, all selected sectors in China reported higher value-added growth by 2017, with increases ranging from 56% in **machinery and equipment** to 99.8% in **food, beverage and tobacco**, compared to 2010.

Chart 3.7. Employment trends of key manufacturing sectors

Selected manufacturing sectors, employment index (2010 = 1.0), UK, USA and China, 2010–2022 or latest year



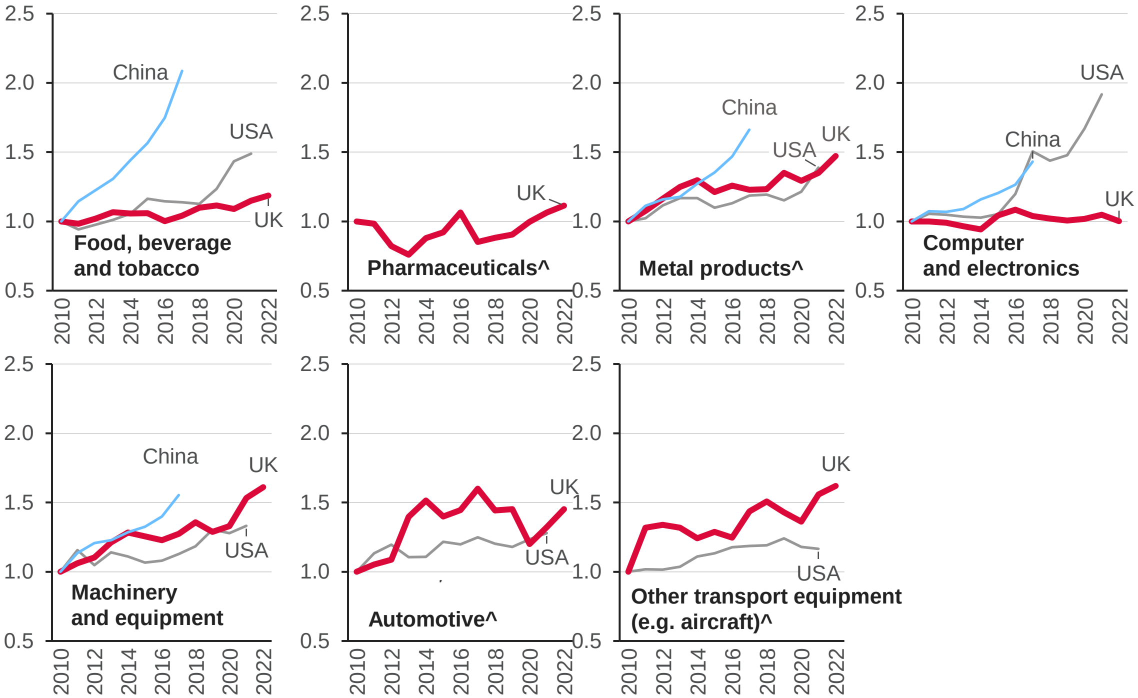
- Between 2010 and 2022, the **UK**'s employment growth was modest or even negative in many selected industries. In contrast, the **automotive** sector saw the largest growth, with a 20% increase.
- The **US** experienced a notable decline in **computer and electronics** manufacturing jobs. **China**, on the other hand, saw significant employment growth in **computer and electronics**, outpacing both the **USA** and the **UK**.

Note: Absolute manufacturing employment in 2010 is set to 1.0, with values in subsequent years expressed as a ratio relative to 2010; the top seven UK manufacturing sectors by valued added are selected; data for pharmaceuticals in the USA is not available; ^China's economic data is sourced from the CIP 4.0 Database, where China's industrial classifications have been reclassified. Data for pharmaceuticals, automotive and other transport equipment in China is not available; the "metal products" sector presented in this slide includes both "primary & fabricated metal industries" and "metal products (excluding rolling products)", as classified in the CIP 4.0 Database. For further details, please refer to the IARIW 2024 paper.

Source: OECD (2024). Annual employment by detailed economic activity, domestic concept; CIP Database (2023). The CIP 4.0 Database.

Chart 3.8. Productivity trends of key manufacturing sectors

Selected manufacturing sectors, labour productivity (value added at current prices in local currency per employment) index (2010 = 1.0), UK, USA and China, 2010–2022 or latest year



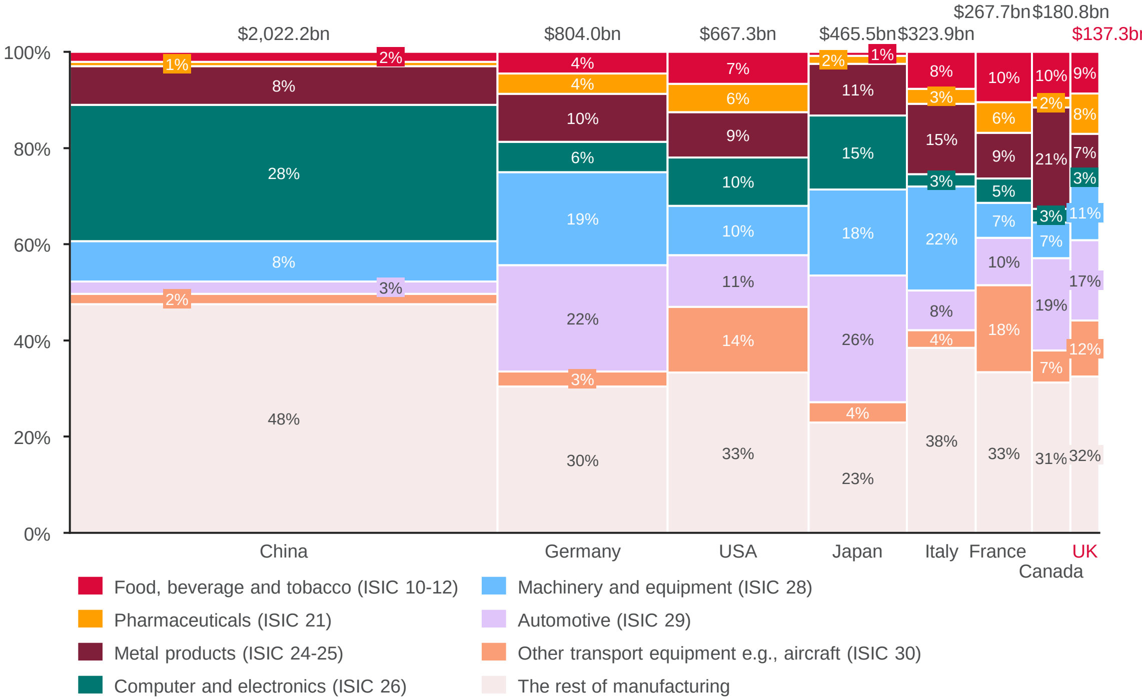
Note: Absolute manufacturing productivity in 2010 is set to 1.0, with values in subsequent years expressed as a ratio relative to 2010; data for pharmaceuticals in the USA is not available; ^China's economic data is sourced from the CIP 4.0 Database, where China's industrial classifications have been reclassified. Data for pharmaceuticals, automotive and other transport equipment in China is not available; the "metal products" sector presented in this slide includes both "primary & fabricated metal industries" and "metal products (excluding rolling products)", as classified in the CIP 4.0 Database. For further details, please refer to the IARIW 2024 paper.
Source: OECD (2024). Annual value added and its components by economic activity; CIP Database (2023). The CIP 4.0 Database; OECD (2024). Annual employment by detailed economic activity, domestic concept.

- Since the 2008 global financial crisis, the **UK**'s overall productivity growth has been sluggish. However, productivity and growth rates vary across sectors, with some consistently outperforming others. Among them, manufacturing industries stand out as one of the fastest-growing sectors.[1]
- Specifically, the **UK** achieved productivity growth in the manufacturing of **other transport equipment,** with a compound annual growth rate (CAGR) of 4.1%, followed by **machinery and equipment** (4.05%), **metal products** (3.3%) and **automotive** (3.2%) between 2010 and 2022.
- Among these four industries, only the productivity growth in **automotive** manufacturing was driven by obvious growth in both value added and employment over the same period.
- **China**'s productivity growth in the manufacturing of **food, beverage and tobacco**, **metal products** and **machinery and equipment** outpaced that of the **USA** and **UK**.
- **China**, the **UK** and the **USA** exhibited different productivity growth trends in **computer and electronics**, with the **USA** recording strong labour productivity growth, primarily driven by a reduction in employment.

[1] **Source:** CIIP (2022). Understanding sectoral sources of aggregate productivity growth: a cross-country analysis.

Chart 3.9. Structure of manufacturing exports across G7 and China

Gross manufacturing exports in US$ at current prices, G7 countries and China, 2020

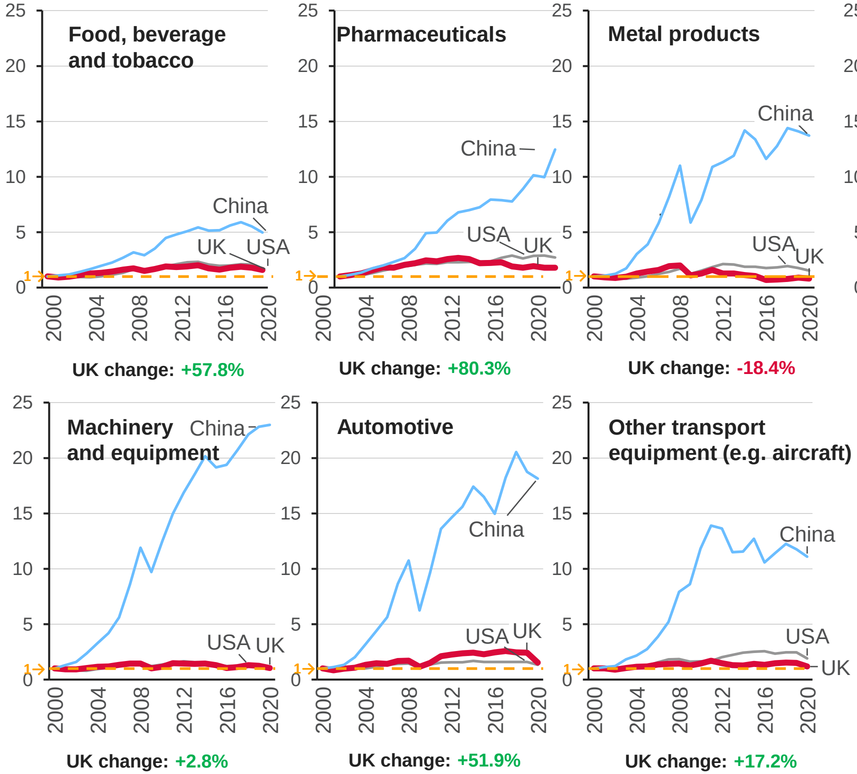


Note: Gross export data here is adjusted for re-exports. Please see OECD (2023) Gross exports (EXGR) for detailed methodology; the bar width for each country is proportional to its absolute manufacturing exports. The top seven UK manufacturing sectors by valued added are highlighted; the "rest of manufacturing" category includes the manufacturing of wood products and furniture, repair and installation of machinery and equipment, printing, plastic and rubber products, paper products, non-metallic mineral products, coke and refined petroleum products, clothing and footwear, chemical products and other manufacturing n.e.c.
Source: OECD (2024). Trade in Value Added (TiVA) 2023 edition: Principal Indicators, levels [cloud replica].

- The **UK** had the lowest manufacturing exports among the G7 countries in 2020, valued at US$137.3 billion.
- In 2020 **automotive** manufacturing was the **UK**'s largest manufacturing export, accounting for 17% of the total, followed by **other transport equipment** (12%) and **machinery and equipment** (11%).
- Among the G7, the **UK**'s manufacturing export structure was most similar to that of **France**. However, top manufacturing exports in **France** included **other transport equipment** (18%), **automotive** (10%) and **food, beverage and tobacco** (10%).
- Compared to G7 countries, **China** exported less in the seven industries highlighted, while **computers and electronics** made up 28% of its total manufacturing exports.

Chart 3.10. Export trends of key manufacturing sectors

Selected manufacturing sectors, export index (2000 = 1.0), US$ at current prices, UK, USA and China, 2000–2020

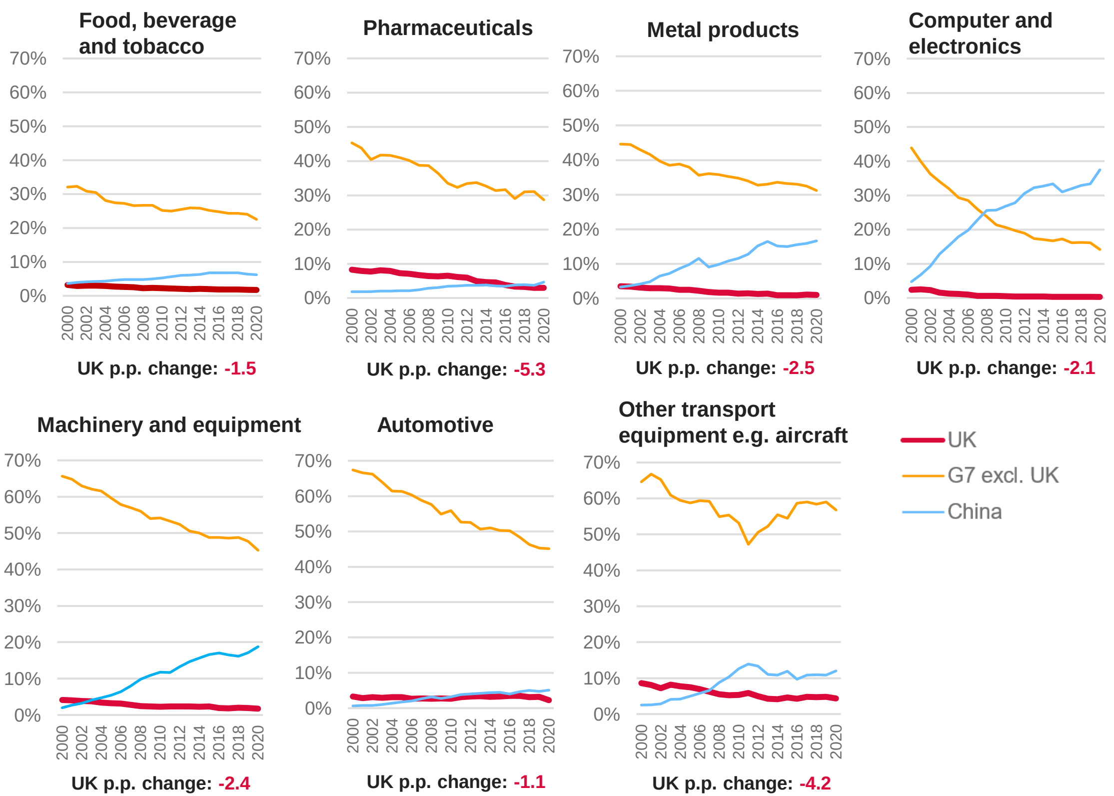


Note: Export data here is adjusted for re-exports. Please see OECD (2023) Gross exports (EXGR) for detailed methodology; the top seven UK manufacturing sectors by valued added are selected; the absolute manufacturing exports in 2000 is set to 1.0, with values in subsequent years expressed as a ratio relative to 2000.
Source: OECD (2024). Trade in Value Added (TiVA) 2023 edition: Principal Indicators, levels [cloud replica.

- Between 2000 and 2020, the **UK** experienced export growth in the following key manufacturing industries: **food, beverage and tobacco** (a 57.8% increase), **pharmaceuticals** (80.3%), **machinery and equipment** (2.8%), **automotive** (51.9%) and **other transport equipment** (17.2%).
- In contrast, the **UK**'s exports in the manufacturing of **metal products** and **computer and electronics** declined over the 2000–20 period.
- **China** saw exceptional export growth across all selected industries compared to the **USA** and **UK,** with a CAGR ranging from 8.3% in **food, beverage and tobacco** to 17% in **machinery and equipment** from 2000 to 2020.
- **China**'s **automotive** exports grew almost 20 times from 2000 to 2020, but starting from a very low basis of US$2.9 billion in **automotive** exports in 2000. As a comparison, in the same year, the value of the **USA**'s **automotive** exports was US$54.0 billion and that of the **G7** countries was US$320.8 billion. This explains why despite this growth **China**'s global export share in this sector has not become very large (see Chart 3.11).

Chart 3.11. Global export shares in key manufacturing sectors

Selected manufacturing sectors, US$ at current prices, G7 countries and China, 2000–2020



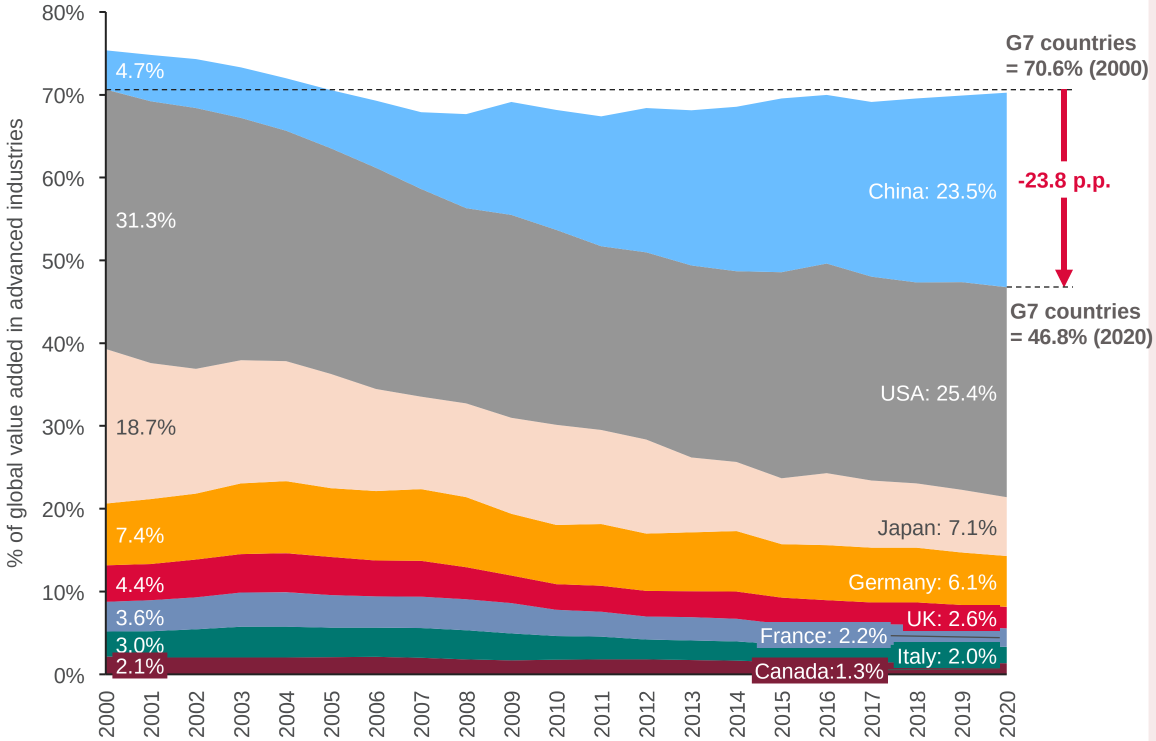
Note: P.p. = percentage point.
Source: OECD (2024). Trade in Value Added (TiVA) 2023 edition: Principal Indicators, levels [cloud replica].

- Overall, there was a cross-industry reduction in export shares for **G7 countries** between 2000 and 2020.
- In the **UK** this decline was largest in industries in which it has traditionally been strong, such as **pharmaceuticals** (-5.3 percentage points) and **other transport equipment,** including aircraft, maritime and railway equipment (-4.2 percentage points).
- **China's** growing presence as a manufacturing exporter powerhouse is particularly visible in sectors such as **metal products**, **computer and electronics** and **machinery and equipment**.
- In the **automotive** sector, **China**'s export share was not particularly large until 2020 (the latest available year in the TiVA database used in our analysis). However, the latest data from other sources shows that **China**'s exports in this sector have grown remarkably since 2020,[1] highlighting growing Chinese competitiveness in this sector.
- This trend in the **automotive** sector is further heightened by **China's** dominance in **electric vehicles (EV)**. According to the International Energy Agency (IEA), Chinese carmakers moved from accounting for 35% of global EV sales in 2015 to 45% in 2022. This was led by companies such as BYD (18%), Geely (6%), and several other firms including SAIC, Chery, Changan, Dongfeng, Hozon, CHJ, Great Wall, NIO, Xiaopeng and Leap.[2] Other estimates put **China**'s global **EV** market share as high as 69% in 2024.[3]

[1] **Source:** UNCOMTRADE.
[2] IEA (2023) Global EV Outlook 2023. p. 97
[3] Dongshu - China Passenger Car Association (2024)

Chart 3.12. Global value-added market shares in advanced industries

Advanced industries,[1] US$ at current prices, G7 countries and China, 2000–2020



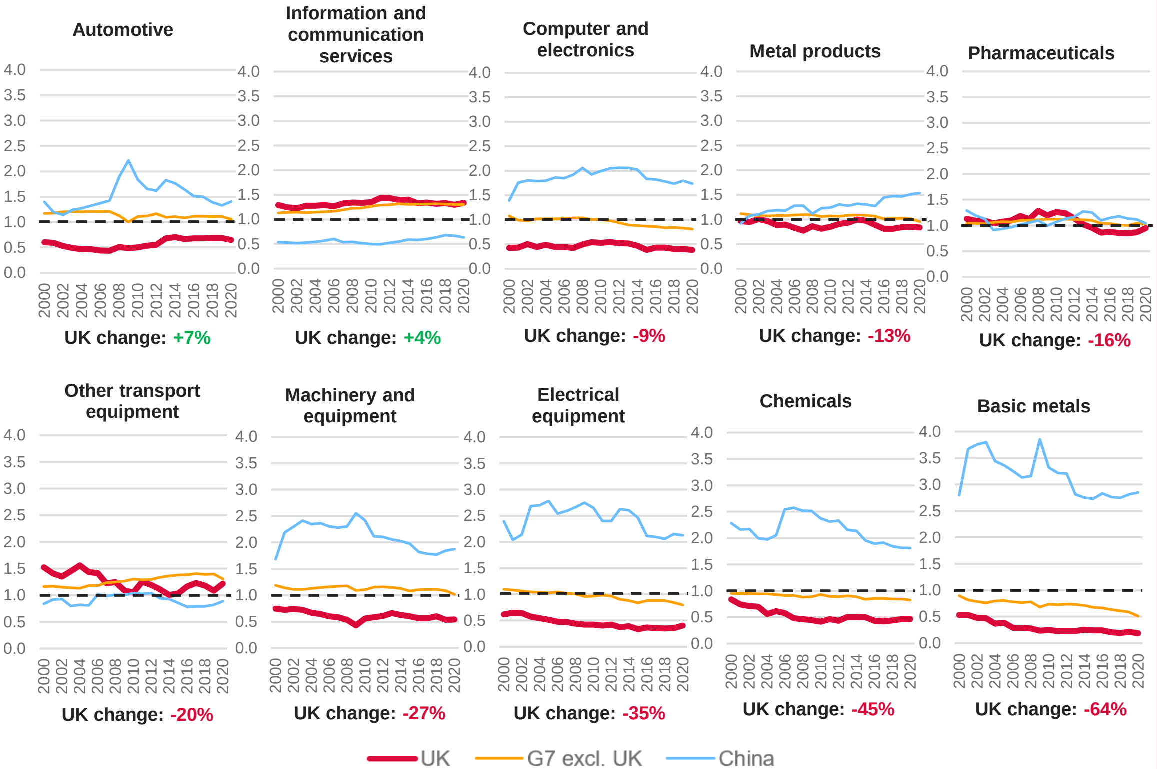
[1]**Note:** Advanced industries selection based on ITIF (2023), including pharmaceuticals; electrical equipment; machinery and equipment; motor vehicles; other transportation (aerospace, rail and sea transportation); computer, electronics and optical products; IT and information services; chemicals; basic metals; and fabricated metals.

Source: OECD (2024). Trade in Value Added (TiVA) 2023 edition: Principal Indicators, levels [cloud replica].

- This chart shows the global market share (in value-added terms) in advanced industries.
- The share of **G7** countries decreased from 70.6% in 2000 to 46.8% in 2020.
- The **UK**'s market share in the aggregate of these industries decreased from 4.4% in 2000 to 2.6% in 2020. **Japan** saw the most drastic change – from 18.7% to 7.1% – while **Germany** had the lowest reduction – from 7.4% to 6.1%.
- **China** saw striking growth, going from a 4.7% market share in 2000 to 23.5% in 2020, reaching almost the same market share as the **USA** (25.4%).

Chart 3.13. Level of specialisation in advanced industries

Revealed comparative advantage index of value added in advanced industries,[1] US$ at current prices, G7 countries and China, 2000–2020



[1]**Note:** Advanced industries selection based on ITIF (2023), including pharmaceuticals; electrical equipment; machinery and equipment; motor vehicles; other transportation (aerospace, rail and sea transportation); computer, electronics and optical products; IT and information services; chemicals; basic metals; and fabricated metals.
Source: OECD (2024). Trade in Value Added (TiVA) 2023 edition: Principal Indicators, levels [cloud replica].

- The Revealed Comparative Advantage (RCA) index measures a country's level of specialisation in different industries. It measures the market share (in value-added terms) of the country in a specific industry, divided by the market share of the country in all industries. This indicates how specialised the country is in that specific industry. An RCA index above 1 means the country has high specialisation in that industry (i.e. its market share is higher than the country's average market share).
- From this analysis, we see that in 2020 the **UK** was specialised (RCA > 1) in two advanced industries: **information and communication services** and **other transport equipment.**
- In the 2000–2020 period, the **UK** increased its specialisation in only two advanced industries: **automotive** and **information and communication services**.
- The largest reductions in **UK** specialisation were in **basic metals** (-64%), **chemicals** (-45%) and **electrical equipment** (-35%).
- Compared to the other G7 countries, the **UK**'s specialisation in 2020 was significantly lower in six advanced industries and similar in four.
- **China**'s specialisation in 2020 was significantly higher than the **UK** and other **G7** countries in most advanced industries. The exceptions are **information and communication services,** in which **China**'s specialisation was lower than the **UK** and other **G7** countries, and **pharmaceuticals** and **other transport equipment**, in which it was similar.

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THEME FOUR

Science and engineering workforce

Is the UK producing enough scientists and engineers?

Are there skills mismatches in science, technology, engineering and mathematics (STEM) disciplines in the UK?

How does this compare with other countries?

Theme 4: Science and engineering workforce

KEY FINDINGS

In 2023 the UK workforce reported one of the highest qualification and skills mismatches across OECD countries:

- 37% of workers in the UK thought their qualification was above the level required for their job, against 23% of the OECD average.
- 34% of UK workers reported they were over-skilled for their current job, against 26% of the OECD average.
- 41% of workers in the UK reported their field of study was not related to the most relevant field for their job, against 38% of the OECD average.

The UK is among the OECD countries with the highest levels of tertiary education attainment, but it lacks workers with vocational education and produces a relatively low share of graduates in engineering, manufacturing and construction:

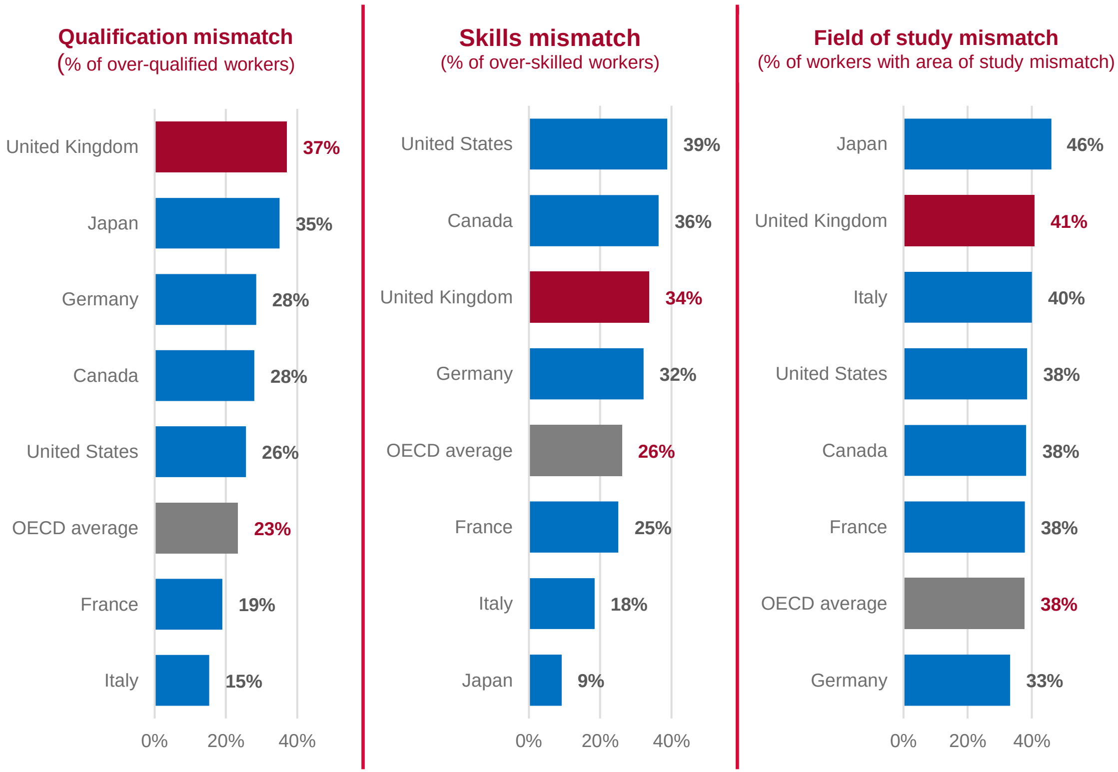
- In 2023, 60% of the 25–34-year-old population in the UK had a university degree, against 48% of the OECD average.
- In the same year 22% of the 25–34-year-old population in the UK pursued vocational education below the OECD average (31%) and European peers such as France (41%), Germany (37%) and Italy (36%).
- In 2022 UK graduates in engineering, manufacturing and construction represented 9.3% of total graduates in the country, less than the G7 average (13.9%), and only above the USA, which had 6.9% of total graduates in this discipline.

In 2023 the UK workforce in science, technology, engineering and mathematics (STEM) occupations accounted for 28.7% of the total workforce and is expected to grow by 2030:

- In 2023 the UK STEM workforce comprised 9.4 million workers, including 2.6 million workers in the occupations most relevant to critical technologies such as artificial intelligence, engineering biology, quantum technologies, future telecommunication and semiconductors.
- Between 2013 and 2023, the UK STEM workforce grew by 22%, more than the 11% growth seen for the average of all occupations.
- Assuming fast technological growth and adoption of automation technologies, it is estimated that the STEM workforce in the UK will continue to grow, between 6% and 10% from 2023 to 2030.

Chart 4.1. Workforce mismatches in G7 countries

Share of employed adults aged 25-65 who are not self-employed, %, 2023



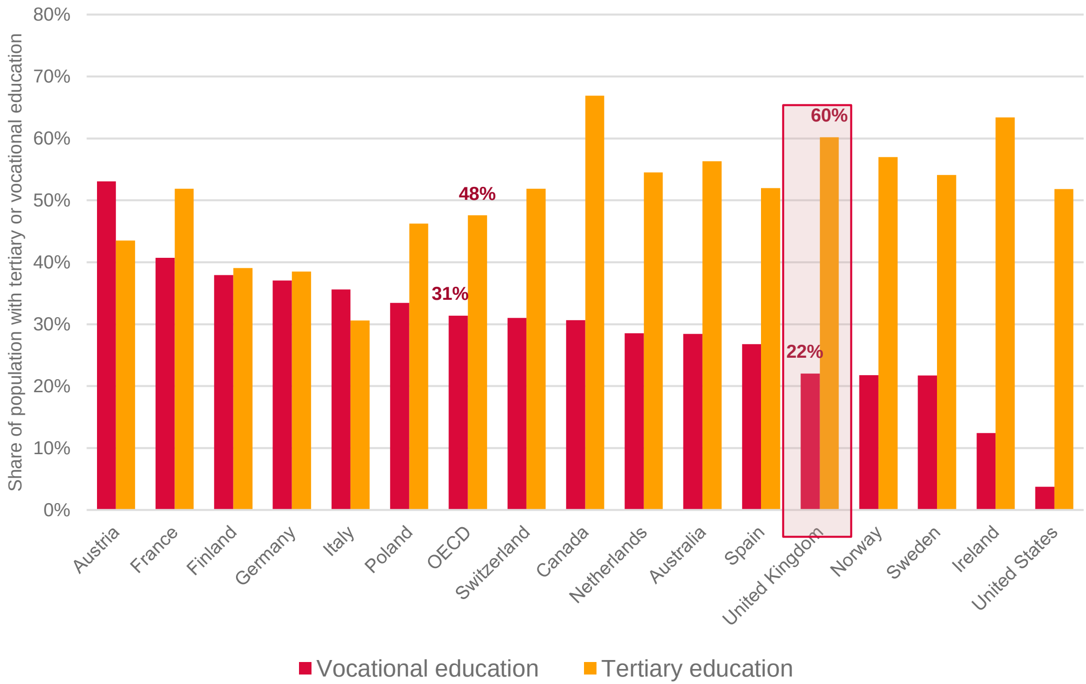
Note: United Kingdom data only covers England. ***Qualification mismatch***: A worker is classified as over-qualified when the level of their highest qualification is above the qualification level required for their job. ***Skills mismatch***: A worker is classified as over-skilled if their skills are higher than required by their job. ***Field of study mismatch***: A worker is classified as mismatched by field of study if the area of study of their highest qualification is not related to the field that is most relevant to their job.
Source: OECD (2024). Do Adults Have the Skills They Need to Thrive in a Changing World? Survey of Adult Skills 2023.

- The **UK** government's *Invest 2035: The UK's Modern Industrial Strategy* document emphasises the role of people and skills as a driving force to support businesses' growth. Barriers such as skills mismatches need to be addressed to further support economic growth.[1]
- According to **OECD** data, the **UK** presents several mismatches in the job market, including:
  - **Qualification mismatch:** 37% of workers in the **UK** think their qualification is above the level required for their job, against 23% of the **OECD** average.
  - **Skills mismatch:** 34% of **UK** workers report they are over-skilled for their current job, against 26% of the **OECD** average.
  - **Field of study mismatch:** 41% of workers in the **UK** report their field of study is not related to the most relevant field for their job, against 38% of the OECD average.

[1] **Source**: UK GOV (2024). Invest 2035: The UK's Modern Industrial Strategy.

Chart 4.2. Tertiary and vocational education attainment

Share of population, 25-34 years old, selected countries, 2023

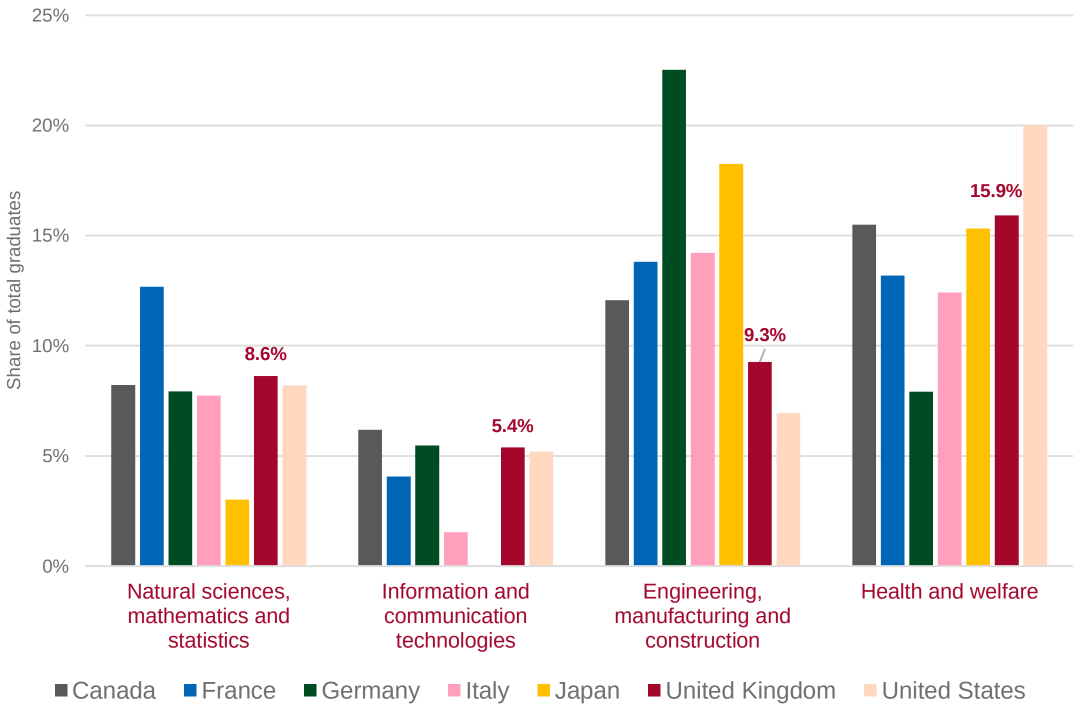


Note: Vocational education includes upper-secondary vocational education, post-secondary non-tertiary vocational education and short-cycle tertiary vocational education.
Source: OECD (2024). Education at a Glance 2024.

- The **UK** has historically been among the **OECD** countries with the highest levels of tertiary education attainment.
- In 2023, 60% of the 25–34-year-old population in the **UK** had a university degree, against the 48% **OECD** average.
- Compared to the **OECD**, the **UK** has a lower share of workers with a vocational education that provides the technical skills needed in modern industrial processes.
- In 2023, 22% of the 25–34-year-old population in the **UK** had pursued vocational education (including upper-secondary, post-secondary and short-cycle tertiary education).This number is below the **OECD** average (31%) and European peers such as **France** (41%), **Germany** (37%) and **Italy** (36%).

Chart 4.3. Graduates in STEM and health disciplines

Share of total graduates, tertiary education, %, G7 countries, 2022



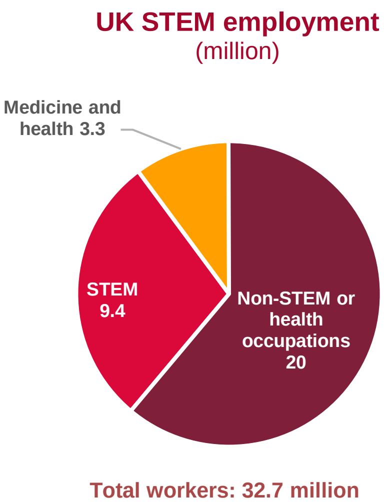
Note: *Tertiary education includes* short-cycle tertiary education, Bachelor's or equivalent level, Master's or equivalent level, and doctoral or equivalent level. *Information and communication technologies* field data for Japan is unavailable.
Source: OECD (2024). Education at a Glance 2024.

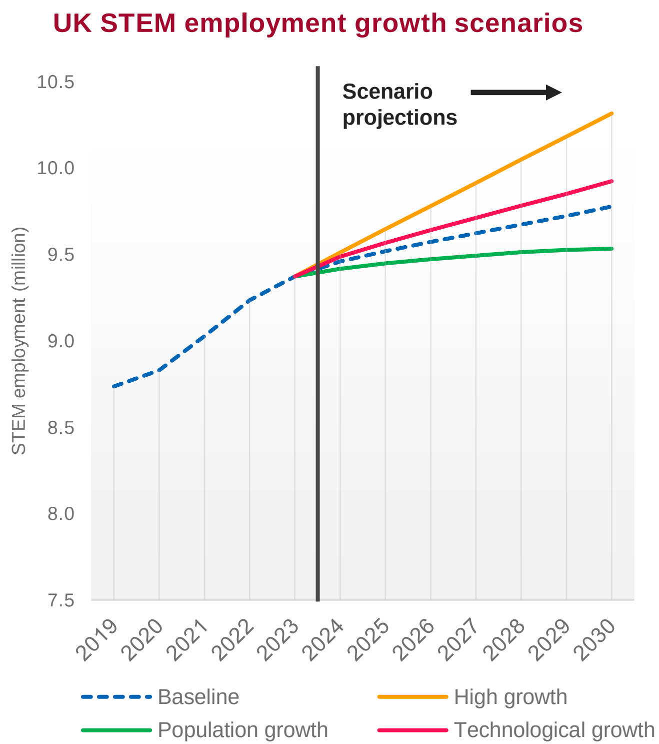
- In 2022 the **UK** produced 227,860 graduates with a tertiary education degree in science, technology, engineering and mathematics (STEM) disciplines, and 155,831 graduates in health and welfare, together representing 39% of total graduates.[1]
- In 2022 graduates in STEM plus health and welfare disciplines represented between 36% and 44% of total graduates across **G7** countries.
- In 2022 the **UK** had a lower share of graduates in the STEM sub-discipline of engineering, manufacturing and construction (9.3%) than **G7** countries such as **Germany** (22.5%), **Japan** (18.3%), **Italy** (14.2%) and **France** (13.8%)**,** while staying above the **USA** (6.9%).

[1] **Note**: There is no accepted definition of STEM disciplines, including whether the category should include health and related disciplines. Differences across data sources may depend on the chosen definition.

Chart 4.4. Science and technology workforce in the UK

Employment, 2023





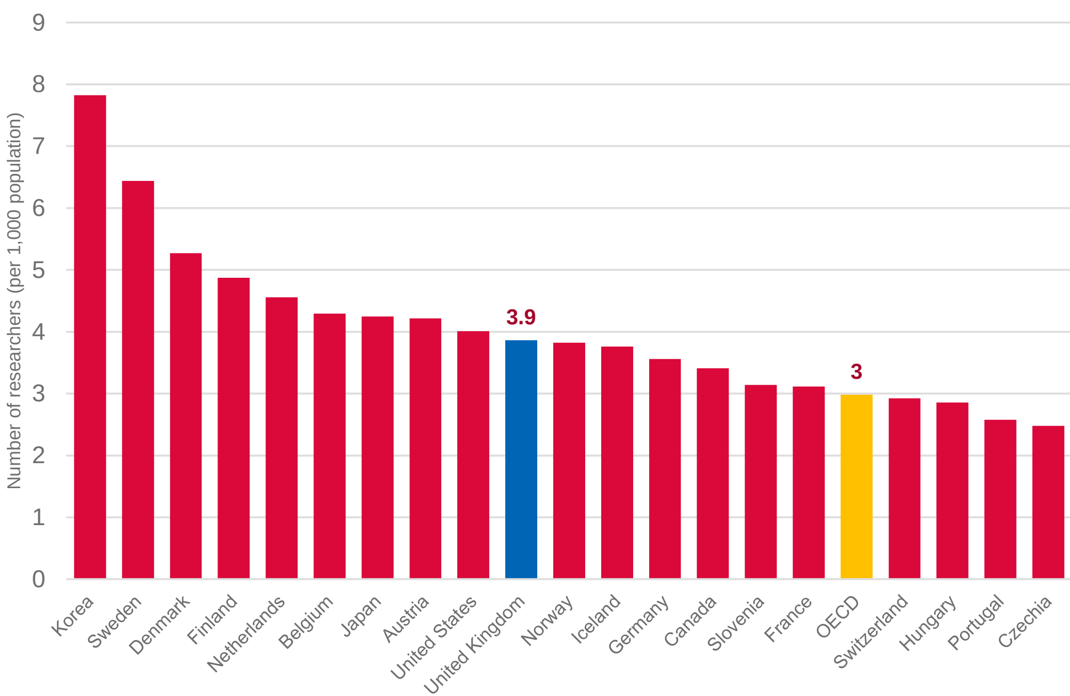
Note: Baseline growth scenario: assumes growth by 4% between 2023 and 2030, following past trends; Technological growth scenario: assumes growth by 6% between 2023 and 2030, accounting for faster technological change and adoption of automation technologies; High growth scenario: assumes growth by 10% between 2023 and 2030; Population growth scenario: assumes growth by 2% between 2023 and 2030, growing at the same rate as the population.
Source: Department for Education (2024). Supply of skills for jobs in science and technology.

- In 2023 the **UK** STEM workforce comprised 9.4 million workers, including 2.6 million workers in the occupations most relevant to critical technologies such as artificial intelligence, engineering biology, quantum technologies, future telecommunication and semiconductors. [1]
- Following publication of the *UK Science and Technology Framework*, the Department for Education assessed different scenarios for the supply of STEM workforce in the **UK** by 2030.[1]
- Between 2013 and 2023, the STEM workforce had already experienced higher growth rates than the average of all occupations in the **UK**: 22% employment growth in STEM occupations against 11% in all occupations in the **UK.**[1]
- **Two scenarios** were considered where STEM employment will grow more than the baseline scenario, at 4% between 2023 and 2030:
  - **Technological growth scenario**: assumes a growth rate of 6%, accounting for faster technological change and adoption of automation technologies, and assumes the creation of new jobs related to the management of technologies, the transition to a low-carbon economy, and the provision of improved education, health and care services.
  - **High growth scenario**: assumes that STEM employment will increase by 10%, and it is modelled around the projections conducted by the *US Bureau of Labor Statistics.*

[1] **Source**: Department for Education (2024). Supply of skills for jobs in science and technology; DSIT (2023). UK Science and Technology Framework;

Chart 4.5. Researchers in the business sector

Per 1,000 population, full-time equivalent, top 20 OECD countries, 2022 or latest available



Note: Data for Canada, Iceland, OECD (average), the USA and Switzerland refers to 2021.
Source: OECD (2024). Main Science and Technology Indicators.

- Researchers are "*professionals engaged in the conception or creation of new knowledge. They conduct research and improve or develop concepts, theories, models, techniques, instrumentation, software or operational methods.*"[1]
- The **UK** ranked 10th in the **OECD** per number of researchers working in the business sector in 2022 (measured in researchers per 1,000 population), with 3.9 researchers, below **Japan** (4.2) and the **USA** (4) but above other G7 countries such as **Germany** (3.6), **Canada** (3.4) and **France** (3.1), as well as the OECD average (3).

[1] **Source**: OECD (2015). Frascati Manual 2015.

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THEME FIVE

Net-zero innovation

Is the UK on track to meet its national carbon reduction targets?

How does the UK's investment in low-carbon and renewable energy technology research and development (R&D) stand in comparison to other countries?

How does the UK’s innovation performance in low-carbon and renewable energy technology compare to other countries?

Theme 5: Net-zero innovation

KEY FINDINGS

The UK has decoupled GDP growth from greenhouse-gas (GHG) emissions, achieving its legally binding targets to date:

- While the UK's GDP nearly doubled between 1990 and 2023, the country achieved a 52% reduction in territorial GHG emissions in this period (i.e. emissions that occur within the UK borders and which are used to track national progress towards international targets).
- The UK has now achieved all three of its previous carbon budgets (i.e. legally binding 5-year greenhouse gas emissions cap set by the government under the Climate Change Act), with more than half of the emissions reductions over the first three carbon budgets being from energy supply sectors.
- Looking ahead, emissions reductions for the next three carbon budgets are expected to come from other sectors, particularly transport, buildings and agriculture.

Based on data from the International Energy Agency, the UK had the fourth-highest public research, development and demonstration (RD&D) expenditure on low-carbon renewable energy technologies between 2013 and 2023, below the USA, France and Japan:

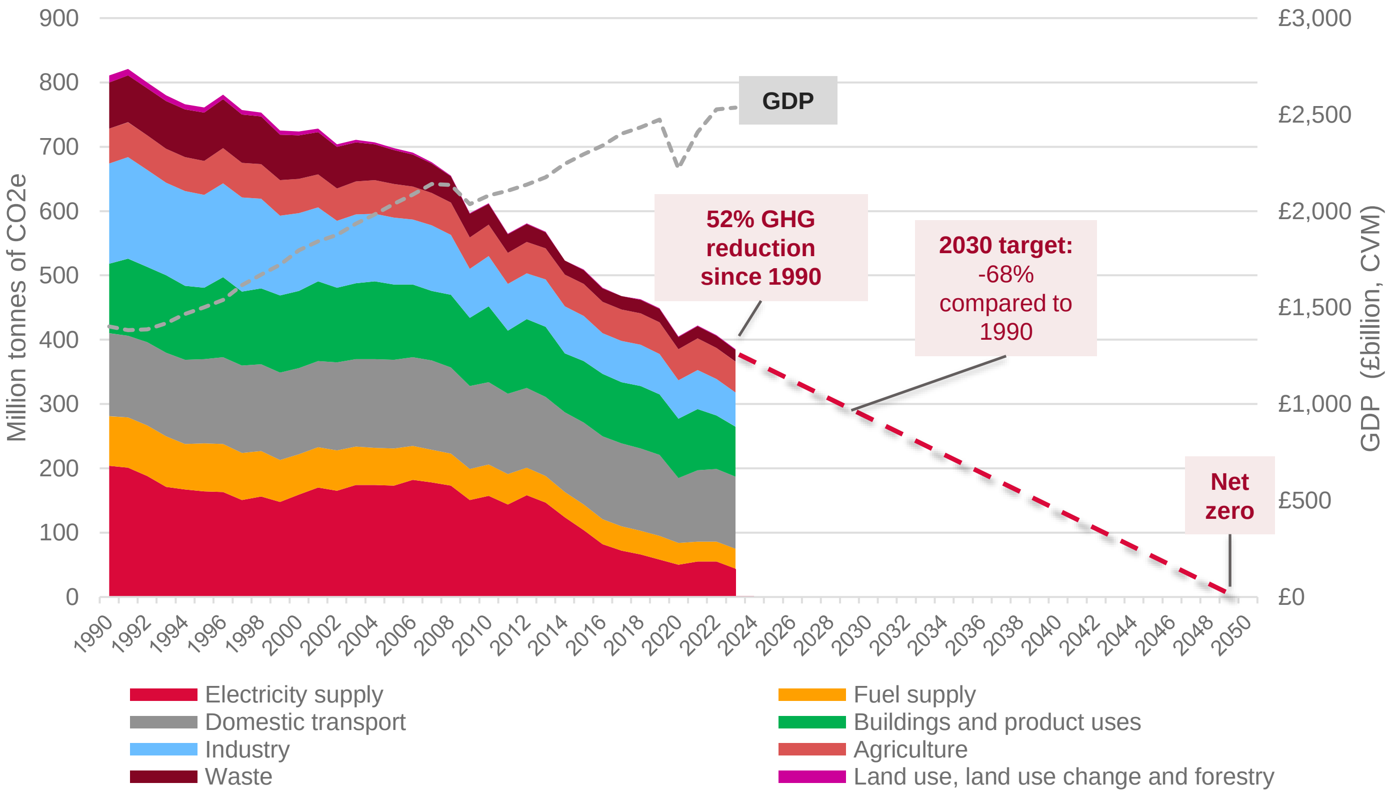
- At US$1.8 billion, the UK's public RD&D budget in low-carbon and renewable energy technologies in 2023 was lower than Japan (US$2.9 billion), France (US$4 billion) and the USA (US$10.3 billion) but higher than Germany (US$1.5 billion) and Canada (US$1.4 billion).
- Among low-carbon technologies, the highest public R&D expenditure in the UK in 2023 was on nuclear power technologies, followed by energy efficiency and renewables.

The UK was among the top 10 economies in the world by number of environment-related patent applications between 2010 and 2021:

- The UK ranked seventh in the world by number of environment-related patent applications filed between 2010 and 2021, behind Japan, the USA, Korea, China, Germany and France but ahead of Taiwan, Canada and Italy.
- In terms of patent technology specialisation, between 2001 and 2021 the UK demonstrated high specialisation in offshore wind power, greener buildings, new and advanced nuclear power, greener vehicles and carbon capture, usage and storage.

Chart 5.1. UK annual territorial greenhouse-gas emissions by source sector

Million tonnes carbon dioxide equivalent (MtCO2e) (left axis); GDP in chained volume measures (CVM), £bn (right axis); 1990-2023



-74%
decrease in oil production achieved from 1999 to 2023

-97%
reduction in electricity generation from coal achieved from 2013 to 2023

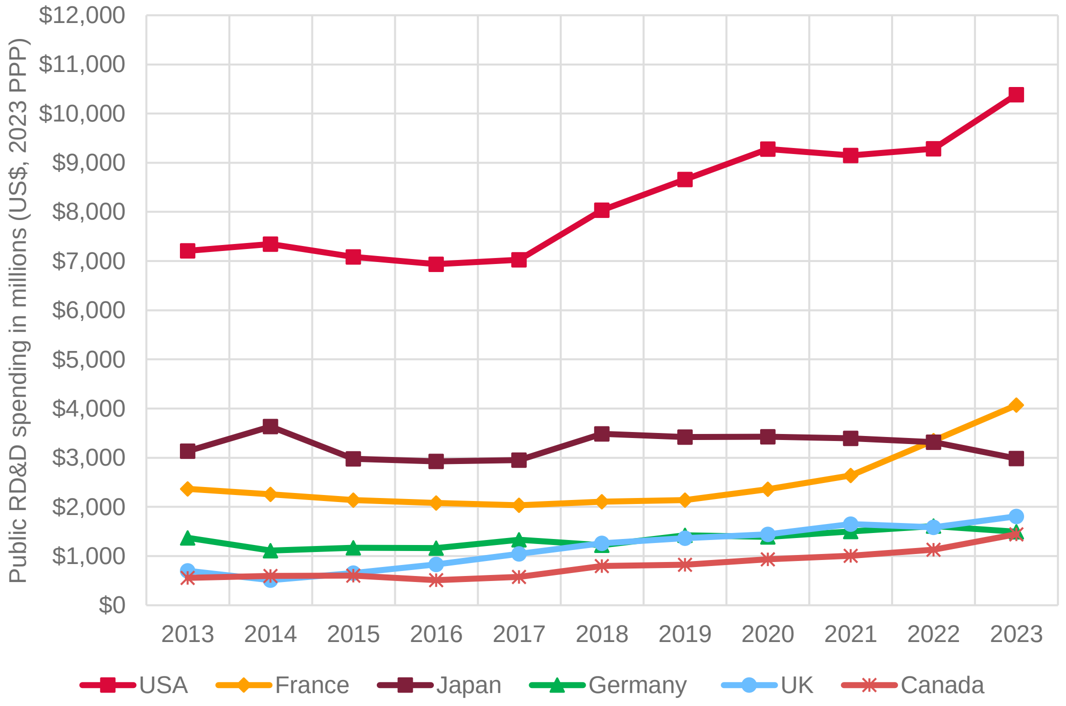
100%
target share of electric car vehicles in car sales by 2035 (i.e. full internal combustion engine phase-out)

600,000+
target for heat pumps sold per year by 2028

Source: DESNZ (2024). Provisional UK greenhouse gas emissions national statistics, 2023; IEA (2024).United Kingdom 2024 Energy Policy review.

Chart 5.2. Public R&D spending on low-carbon and renewable energy technologies – total budgets

Top six spenders in the IEA's Energy Technology RD&D Budgets database, US$ million PPP, 2023



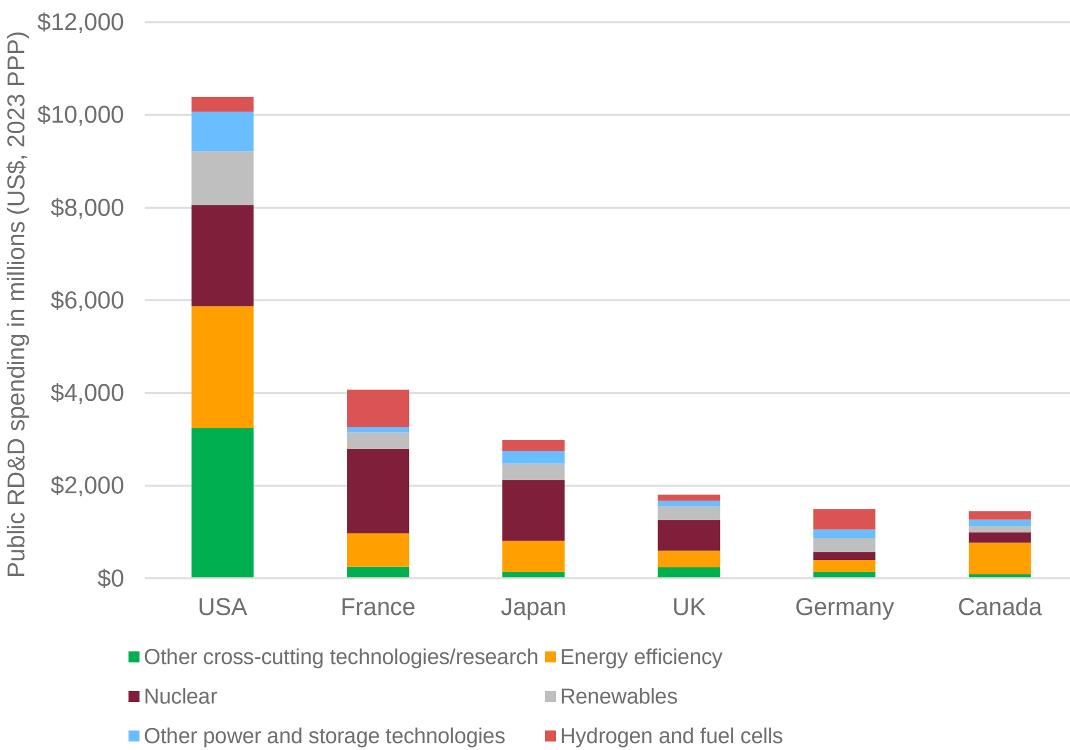
Note: Data for China unavailable. IEA categories included are energy efficiency, renewables, nuclear, hydrogen and fuel cells, other power and storage technologies, and other cross-cutting technologies/research.
Source: IEA (2024). IEA Energy Technology RD&D Budgets - October 2024.

- **The UK** was consistently among the top six countries with the highest public R&D expenditure on low-carbon renewable energy technologies between 2013 and 2023 in the data set compiled by the International Energy Agency (IEA).
- The IEA estimates that in 2023 **the UK's** public R&D budget in low-carbon and renewable energy technologies was US$1.8 billion, lower than **Japan** (US$2.9 billion), **France** (US$4 billion) and **the USA** (US$10.3 billion) but higher than **Germany** (US$1.5 billion) and **Canada** (US$1.4 billion).[1]
- Technologies in the IEA R&D expenditure analysis include: **energy efficiency**; **renewable energy sources**; **nuclear fission and fusion**; **hydrogen and fuel cells**; other **power and storage technologies**; and other **cross-cutting technologies or research**.

[1] **Note:** Prices are in 2023 US$ and purchasing power parity (PPP).
Source: IEA (2024). IEA Energy Technology RD&D Budgets - October 2024.

Chart 5.3. Public R&D spending on low-carbon and renewable energy technologies – by technology

Technology breakdown in the IEA's Energy Technology RD&D Budgets database, top six country spenders, US$ million PPP, 2023

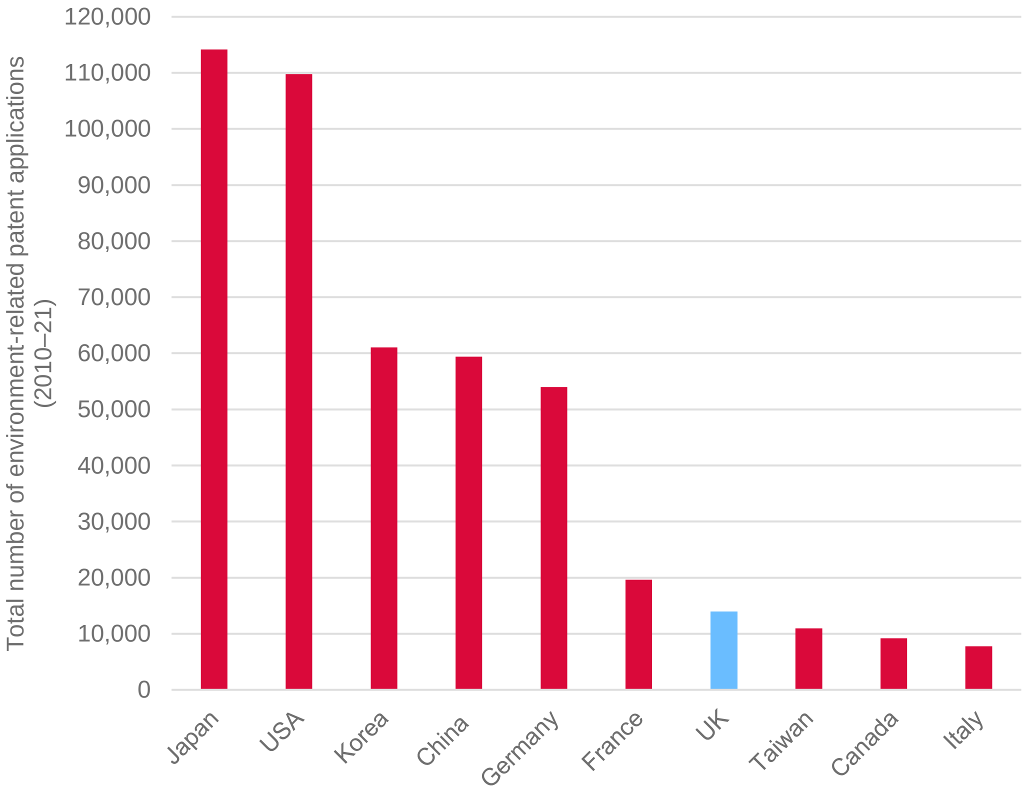


Source: IEA (2024). IEA Energy Technology RD&D Budgets - October 2024.

- Based on data from the IEA, the research area that received the highest public RD&D expenditure in **the UK** in 2023 was **nuclear power technologies**. This was followed by **energy efficiency**, **renewables**, **other cross-cutting technologies**, **hydrogen and fuel cells** and **other power and storage technologies.**
- Different specialisations can be seen among top public RD&D spenders, based on which research categories observed the highest expenditure:
  - **the USA**: **other cross-cutting technologies** (including energy system analysis and basic energy research that cannot be allocated to a specific category)
  - **Germany**: **hydrogen** and **fuel cells**
  - **France and Japan**: **nuclear power** technologies
  - **Canada**: **energy efficiency.**

Chart 5.4. Innovation in environment-related technologies

Top economies by total number of environment-related patent applications, 2010–2021



Source: OECD Data Explorer. Accessed on 9 January 2025.

- The **UK** ranked seventh in the OECD database by the total number of environment-related patent applications between 2010 and 2021, behind **Japan, the USA, Korea, China, Germany and France** but ahead of **Taiwan**, **Canada** and **Italy**.[1]
- Technologies covered under the **OECD's "environment-related technologies"** group include:
  - environmental management
  - climate-change-mitigation technologies related to energy generation, transmission and distribution
  - the capture, storage, sequestration or disposal of greenhouse gases
  - climate-change mitigation for transport
  - climate-change mitigation for buildings
  - waste-water treatment and waste management
  - climate-change mitigation in the production or processing of goods
  - climate-change mitigation in information and communication technologies.

[1] **Note:** Consistent with other patent statistics provided in the OECD Data Explorer, only published applications for "patents of invention" are considered (i.e. excluding utility models, petty patents, etc.). The statistics presented here are based on the concept of a patent family, which is defined as all patent applications protecting the same "priority" (as defined by the Paris Convention), also referred to as "simple patent family". The patent family concept is applied to all statistics presented here, including counts of patent families by inventor country (as a measure of technology development) and by jurisdictions where patent protection for these inventions has been sought (as a measure of technology diffusion).The relevant patent documents are identified using search strategies for environment-related technologies.

Chart 5.5. Specialisation ranking matrix per technology area for top 10 patenting countries worldwide

Technology domains included in the UK's 2020 Ten Point Plan for a Green Industrial Revolution (2001–21)

Relative Specialisation Index ranking	Carbon capture, usage and storage	Flood and coastal defence	Greener buildings	Greener vehicles	Low-carbon hydrogen power	New and advanced nuclear power	Offshore wind power
1	Australia	South Korea	UK	Germany	Australia	France	UK
2	Canada	Australia	France	France	Canada	UK	France
3	India	Canada	Australia	UK	USA	Canada	South Korea
4	UK	Japan	Canada	USA	France	South Korea	India
5	South Korea	China	Germany	Canada	Germany	Japan	Australia
6	USA	France	India	India	Japan	USA	China
7	France	UK	USA	South Korea	UK	China	Germany
8	China	India	South Korea	China	South Korea	Australia	USA
9	Japan	USA	China	Australia	India	India	Canada
10	Germany	Germany	Japan	Japan	China	Germany	Japan

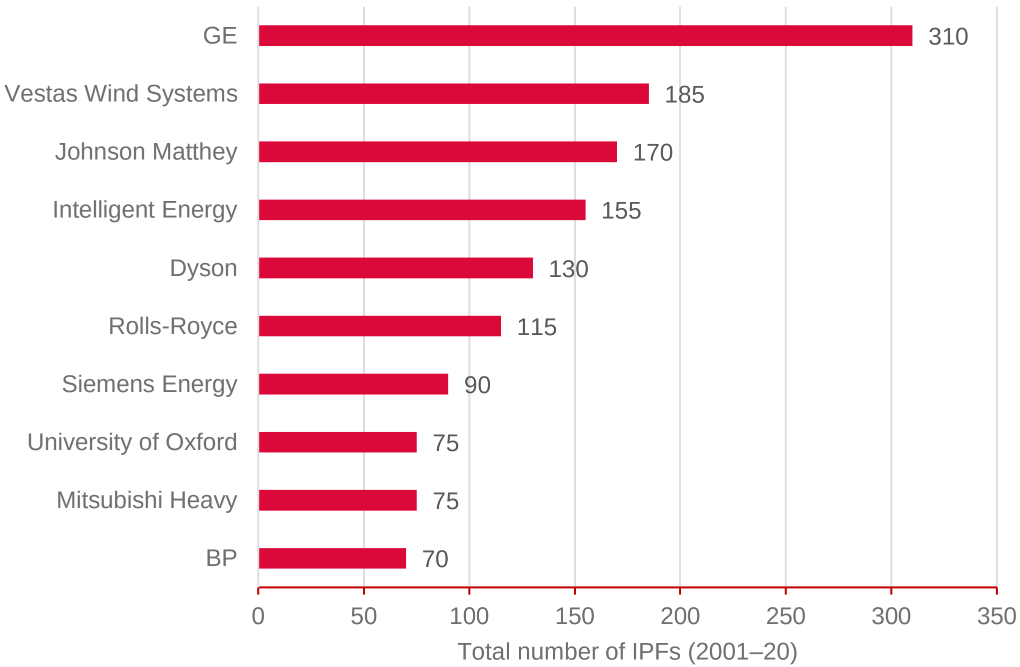
Source: Table extracted from UK IPO (2024). The race to net zero: Tracking the green industrial revolution through IP.

- The Relative Specialisation Index (RSI) is defined as a country's share of patent families in a particular field of technology as a fraction of that country's share of patent families in all fields of technology.[1]
- Using RSI, Chart 5.5. shows the relative specialisation for the technology areas included in **the UK's** *Ten Point Plan for a Green Industrial Revolution* (2020) for the top 10 patenting countries worldwide between 2001 and 2021.[2]
- **The UK** presents the highest specialisation in both **offshore wind power** and **greener buildings**.
- The country has also consistently been among the most specialised nations in terms of RSI for **new and advanced nuclear power**, **greener vehicles** and **carbon capture,** and **usage and storage**, with slightly lower specialisation in **flood and coastal defence technologies** and **low-carbon hydrogen power**.

[1] **Note:** For a full description of the UK IPO methodological approach on how the RSI is calculated, please refer to Appendix B in the following source: UK IPO (2024). The race to net zero: Tracking the green industrial revolution through IP. **Source:** [2] UK GOV (2020). The Ten Point Plan for a Green Industrial Revolution.

Chart 5.6. Top 10 owners of green technology international patent families (IPFs) invented in the UK

Number of green international patent families where at least one inventor has a UK address, 2001–2020



Source: UK IPO (2024). The race to net zero: Tracking the green industrial revolution through IP.

- To identify patents related to green technologies, **the UK** IPO established a methodology using a combination of full-text keyword searching, International Patent Classifications (IPC) and Cooperative Patent Classifications (CPC).
- Patents classified as green technologies include any international patent families (those where at least two different filing authorities are present in a patent family) related to renewable energy sources, clean energy generation, energy management, energy storage and water treatment.[1]
- Chart 5.6. shows the top 10 owners of green technology international patent families (IPFs) invented in **the UK** (i.e. where at least one inventor has a **UK** address).
- **GE** has the highest number of green-technology IPFs invented in the **UK**, at 310. These patent families account for less than 1% of **GE's** total portfolio.
- **Intelligent Energy** has a smaller number of IPFs overall, but green technology forms a much higher percentage of its total portfolio (roughly 32%), suggesting this company is more focused on green technology than **GE**.

[1] For a full description of the UK IPO methodological approach, please refer to Appendix A in the following source: UK IPO (2024). The race to net zero: Tracking the green industrial revolution through IP.

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