



# UK INNOVATION REPORT 2023

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

Institute for Manufacturing, University of Cambridge

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Special  
theme

# 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* aims to make 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 of 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** and **regional** 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.

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## 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.
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# Introduction

The *UK Innovation Report 2022* reported last year a new [Innovation Strategy](#), a new [Office for Science and Technology Strategy](#) and a new [National Science and Technology Council](#). This year, the major institutional change has been the ministerial restructure in February 2023.

A new [Department for Science, Innovation and Technology \(DSIT\)](#) was created with the mandate to ensure the UK is “the most innovative economy in the world” and a “science and technology superpower”. DSIT published its [Science and Technology Framework](#) in March 2023 which identifies five critical technologies that the UK should focus on to build strategic advantage and commits £250m to ‘technology missions’ in three of them: *artificial intelligence*, *quantum technologies* and *engineering biology*. Among other changes, a new [Department for Business and Trade](#) has been created bringing together the business focused functions of the former Department for Business, Energy and Industrial Strategy (BEIS) and the Department for International Trade (DIT).

In November 2022 the Office for National Statistics (ONS) introduced a major [revision](#) to the methodology used to estimate R&D expenditure in the UK to give better coverage of smaller businesses, which have accounted for a growing amount of R&D activity.

## What is new in this edition of the report?

Against this changing institutional context, the *UK Innovation Report 2023* maintains last year’s core policy guiding questions but uses new datasets to address them from different angles. The report uses new indicators and longer time series, integrates additional data sources, and deep dives into different sectors.

- **Section 1** explores how productivity trends vary across UK regions and countries and the role of sector dynamics in these differences.
- **Section 2** analyses the latest data on R&D expenditure in the UK, discussing the implications of recent methodological changes introduced by the ONS.
- **Section 3** focuses on the performance of the aerospace and food & beverages sectors, incorporating insights from consultations with industry experts.
- **Section 4** updates the analysis of UK graduates in science, technology, engineering and mathematics (STEM) comparing the UK with international peers.
- **Section 5** analyses the UK’s economic and innovation performance in the environmental goods and services sector.

# 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 (IfM), 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 practices. This report was delivered through IfM Engage, the knowledge transfer arm of the Institute for Manufacturing (IfM), University of Cambridge

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# Executive summary

UK INNOVATION REPORT 2023

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# Executive summary (1/3)

Theme	Key policy questions addressed	Key findings
1 Structure and performance of the UK economy	<ul style="list-style-type: none"><li>How does productivity vary across UK regions and countries?</li><li>How has the economic structure of the UK regions changed in the last few years?</li><li>Are these changes affecting economic performance?</li></ul>	<ul style="list-style-type: none"><li>Disparities between UK <b>regions and countries</b> are large and widening: in <b>1999</b> labour productivity in <b>Wales</b> represented <b>65%</b> of that observed in <b>London</b>; however, in <b>2019</b> <b>Wales'</b> productivity was only <b>58%</b> of that of <b>London</b>.</li><li>Regional analysis confirms that in the last two decades, the expansion of <b>service sectors</b> at the expense of higher productivity sectors, such as <b>manufacturing</b>, has slowed overall productivity growth and contributed to <b>widening productivity gaps across the UK</b>.</li></ul>
2 Investment in innovation	<ul style="list-style-type: none"><li>Is the UK spending enough on R&amp;D?</li><li>How do the public and private sectors contribute to national expenditure on innovation?</li><li>How does the UK compare with other countries?</li></ul>	<ul style="list-style-type: none"><li>A new methodology introduced by the Office for National Statistics (ONS) has pushed the estimated UK expenditure on R&amp;D as percentage of GDP for 2019 from <b>1.7%</b> to <b>2.7%</b>.</li><li>While this means that the <b>2.4%</b> target has been achieved, the <b>UK</b> remains well behind countries such as <b>Germany</b>, the <b>United States</b> and <b>South Korea</b>, which invested between <b>3.2%</b> and <b>4.6%</b> of GDP on R&amp;D.</li><li>At <b>0.12%</b> the <b>UK</b> government's expenditure on R&amp;D in 2019 was still <b>half</b> the <b>OECD</b> average of <b>0.24%</b>.</li></ul>

# Executive summary (2/3)

Theme	Key policy questions addressed	Key findings
<p>3.1 Industrial performance – focus on the <b>aerospace manufacturing sector</b></p>	<ul style="list-style-type: none"> <li>Are UK sectors becoming more or less competitive internationally?</li> <li>How are UK sectors performing in terms of productivity, value added and employment?</li> <li>Are UK sectors investing enough in R&amp;D compared to their international competitors?</li> </ul>	<ul style="list-style-type: none"> <li>The UK's <b>aerospace manufacturing sector</b> was the <b>third largest</b> in the OECD in 2019, behind only the <b>United States and France</b>.</li> <li>The UK's <b>aerospace manufacturing sector</b> specialises in <b>engines</b> and other <b>aircraft components</b> such as <b>wings</b>; its trade surplus (<b>US\$14.7 billion</b>) was the <b>third largest in the world in 2021</b>.</li> <li><b>14,000 jobs</b> were lost in the sector in <b>2020–21</b> due a collapse in demand driven by the Covid-19 pandemic, which led to company restructuring and accelerated supply chain consolidation.</li> <li>UK aerospace competitiveness is underpinned by advanced <b>R&amp;D and innovation capabilities</b>, with <b>UK business expenditure on aerospace R&amp;D</b> ranking <b>third</b> among OECD countries and growing steadily in the last decade.</li> </ul>
<p>3.2 Industrial performance – focus on the <b>food and beverages manufacturing sector</b></p>	<ul style="list-style-type: none"> <li>Are UK sectors becoming more or less competitive internationally?</li> <li>How are UK sectors performing in terms of productivity, value added and employment?</li> <li>Are UK sectors investing enough in R&amp;D compared to their international competitors?</li> </ul>	<ul style="list-style-type: none"> <li>The UK's <b>food and beverages manufacturing sector</b> was the <b>sixth largest</b> in the OECD in 2019, behind the <b>United States, Japan, Mexico, France and Germany</b>.</li> <li>Demand in the <b>food and beverages sector</b> has proven to be <b>highly resilient</b> to recessions and disruptive events, including the financial crisis, the COVID-19 pandemic and Brexit, as reflected by the sector's <b>growth in value added</b> over the last decade and its <b>stable productivity</b> levels during this period.</li> <li>Most <b>food and beverages</b> manufacturers are focused on meeting domestic UK demand and have limited incentives to export. The UK produces around <b>60%</b> of its domestic food consumption by economic value though imports are an essential part of the industry due to geography, weather and land availability. The UK's food and beverage sector has <b>one of the largest trade deficits in the world</b>, though it remains a <b>leading exporter in high value niches</b> such as <b>whiskey</b>.</li> <li><b>UK business expenditure on food and beverages R&amp;D</b> has increased steadily during the last decade, reaching levels comparable to other leading OECD nations.</li> <li><b>Product innovation</b> is a key focus of the <b>UK food and beverages</b> sector. However, economic and demand uncertainty may be hindering investment in innovation. Industry consultations suggest that opportunities exist to increase the adoption of <b>digital and automation solutions</b>, particularly among SMEs.</li> <li><b>Unfilled vacancies</b> have been a long-standing issue in the sector, with <b>vacancies per 100 employees</b> increasing to <b>9.1</b> in Q3 2022, from <b>6.3</b> in Q2 2022, which is <b>more than double</b> the UK average of <b>4.1</b>.</li> </ul>

# Executive summary (3/3)

Theme	Key policy questions addressed	Key findings
4 Science and engineering workforce	<ul style="list-style-type: none"><li>Is the UK producing enough scientists and engineers?</li><li>Is the UK government investing enough in technical and vocational education?</li><li>How does this compare with other countries?</li></ul>	<ul style="list-style-type: none"><li>Although science, technology, engineering, and mathematics (STEM) graduates in the UK accounted for 41% of total graduates – above countries such as France and Canada, and similar to the United States – the share of graduates in the STEM sub-discipline of engineering, manufacturing and construction represented only 9% of graduates, well below comparator countries such as Germany (26%) and Korea (21%).</li><li>The UK had a relatively low share of researchers working in the business sector in 2020 (42%), below Korea (82%), Japan (75%), the United States (72%), France (63%) and Germany (60%).</li><li>Although women account for 39% of total researchers, placing the UK in the top 10 of OECD countries, female graduates are under-represented in some STEM disciplines in the UK, particularly in engineering, manufacturing and construction.</li></ul>
5 Environmental Innovation	<ul style="list-style-type: none"><li>How does the UK compare in environmental and energy technology research and development (R&amp;D) investment?</li><li>How is R&amp;D expenditure translating into patenting performance?</li><li>Is the UK capturing the economic potential of the transition towards environmental sustainability?</li></ul>	<ul style="list-style-type: none"><li>Gross value added in the UK environmental goods and services sector (EGSS), as defined by the ONS, was estimated to be £45.2 billion in 2019 (up 5.4% from 2018). The sector's employment is estimated at 394,900 full-time equivalent employees in 2019 (down 4.7% from 2018).</li><li>The OECD estimates that at 6%, the UK had the sixth highest government budget allocation for R&amp;D in environment and energy innovation among OECD countries in 2020. This is higher than that of the United States (3%), but lower than Japan (8%), Germany (8%), Korea (8%), and France (9%).</li><li>The UK ranks seventh among OECD countries in patent applications for the group of technologies defined by the OECD as “environment-related technologies”.</li></ul>

# Theme 1: Structure and performance of the UK economy

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# Theme 1: Structure and performance of the UK economy

## Key policy questions addressed

- How does productivity vary across UK regions and countries?
- How has the economic structure of the UK regions changed in the last few years?
- Are these changes affecting economic performance?

## Key findings

### Substantial and widening productivity gaps are observed between London and the rest of the UK.

- London and the South East of England are the UK regions with the highest labour productivity levels, showing annual values of £80,034 and £59,709 value added per job in 2019. In contrast, Wales, the North East of England, and Yorkshire and the Humber have among the lowest productivity levels, around £47,000 in 2019.
- In 1999 labour productivity in Wales represented 65% of that observed in London; however, in 2019 Wales' productivity accounted for only 58% of that of London.

### Spatial disparities in sectoral productivity levels are particularly large in agriculture, forestry and fishing; arts, entertainment and recreation; professional, scientific and technical activities; and financial and insurance activities.

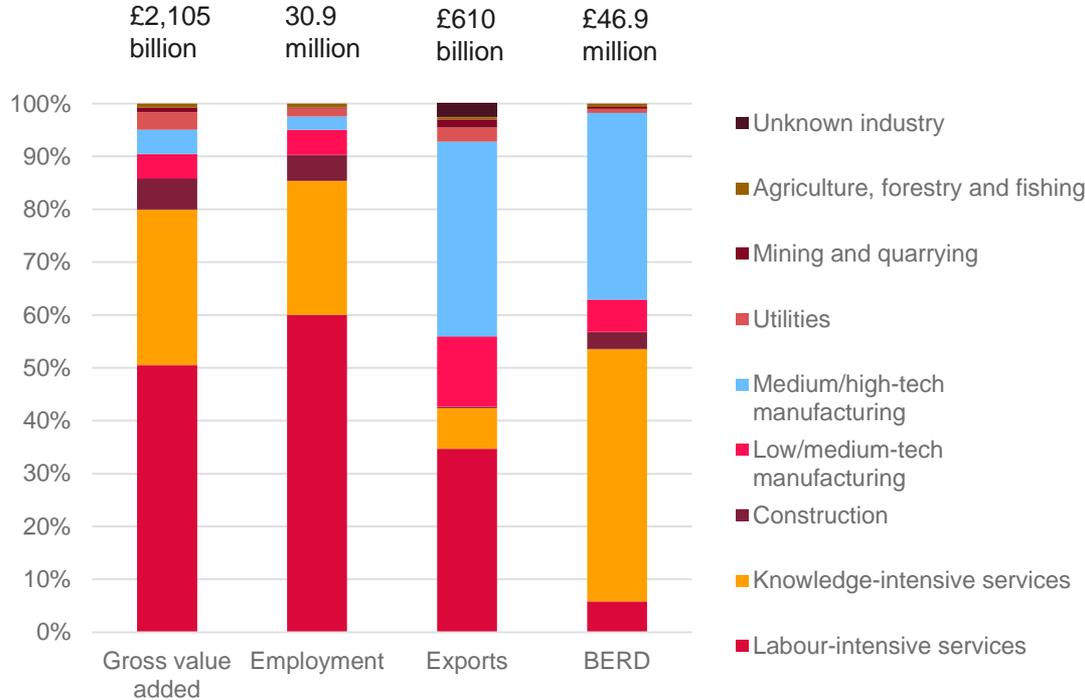
- London's sectoral productivity levels are above the UK average for all sectors except manufacturing and agriculture. The productivity of London's professional, scientific and technical activities is 2.4 times larger than that observed in Wales, the UK area with the lowest productivity level in this sector.
- Substantial gaps are also observed in the pace of productivity growth in the information and communication sector. The North East of England (16.2%) and Wales (13.6%) saw the fastest growth between 1999 and 2019. In contrast, London saw the slowest growth (6.0%).

### In the last two decades, the expansion of service sectors at the expense of higher productivity sectors, such as manufacturing, has slowed down overall productivity growth and contributed to widening productivity gaps across the UK.

- Between 1999 and 2019 knowledge- and labour-intensive services expanded, while manufacturing reduced its participation in the UK economy. However, since service activities tend to have productivity levels below the average of the total economy and show slower productivity growth, their expansion has slowed down productivity growth.
- The most negative impacts from the shrinkage of manufacturing are observed in the East Midlands, the North West, the North East and the West Midlands, where the decline of manufacturing cost these regions a percentage point, on average per year, between 1999 and 2019.

# Chart 1.1. Structure of the UK economy, 2021

Gross value added, employment, exports and business R&D expenditure (BERD)<sup>[1]</sup>

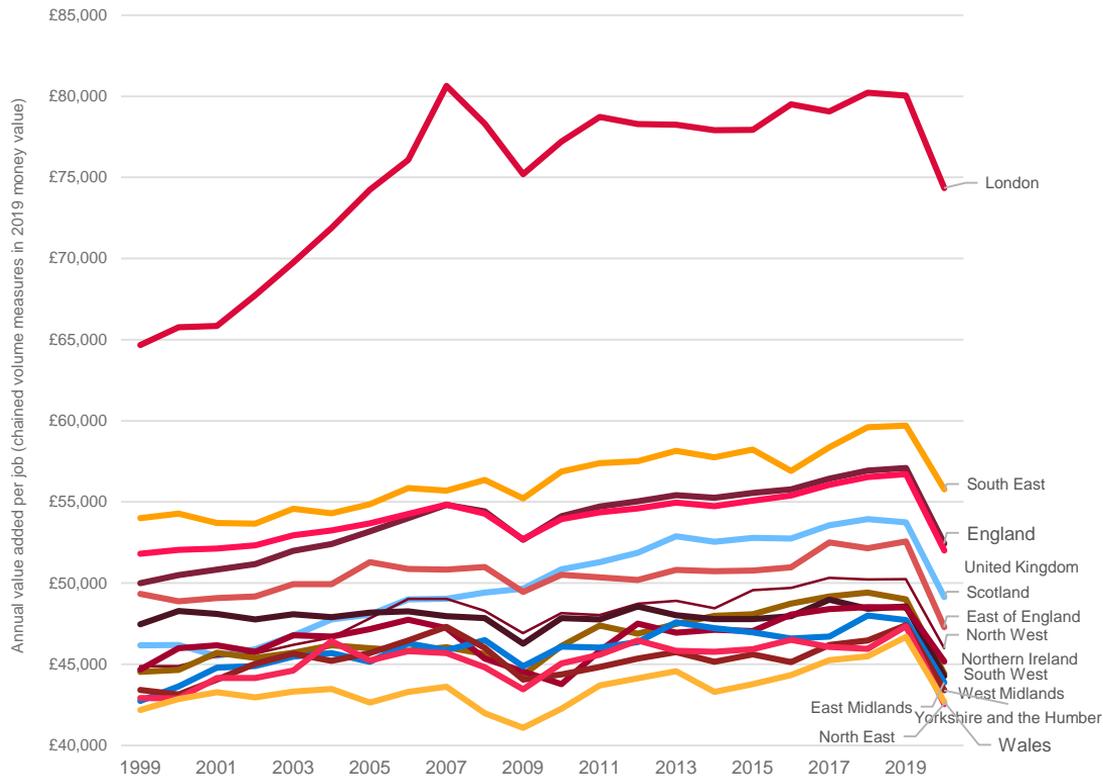


- Both **knowledge-intensive**<sup>[1]</sup> and **labour-intensive services**<sup>[1]</sup> represented around 80% of the gross value added and employment of the UK economy in 2021.
- Although **medium/high-tech manufacturing**<sup>[1]</sup> accounts for 5% of the gross value added and 3% of employment, this sector accounts for the largest share of exports: 37% in 2020 and the second largest share of business R&D expenditure, around 35%, in 2021.
- The **manufacturing** sector as a whole accounts for less than 10% of the UK's value added. However, the size of the manufacturing sector varies across UK regions and countries.

Note: <sup>[1]</sup> Appendix 1.1 presents definitions of these classifications of sectors.

## Chart 1.2. Labour productivity by country and region

Gross value added per job, 1999–2020



- Substantial productivity gaps are observed between UK regions and countries. In 2019 **London and the South East of England** were the UK regions with the highest labour productivity levels, with annual values of £80,034 and £59,709 per job. In contrast, **Wales, the North East of England, and Yorkshire and the Humber** had the lowest productivity levels, at around £47,000.
- Productivity gaps have widened in the last two decades. In 1999 labour productivity in **Wales** represented 65% of that observed in **London**; however, in 2019 productivity in **Wales** accounted for only 58% of that of **London**.
- Between 1999 and 2019 **London and Scotland** were the regions and countries that experienced the fastest productivity growth, with rates of 1% and 0.8%, respectively.
- Scotland** also fared better during the financial crisis of 2008/9; it did not experience a fall in productivity levels in this period like **the rest of the UK** did.
- A reduction in productivity levels was observed across the board in 2020, as a result of the COVID-19 pandemic and related impacts.

## Chart 1.3. Sectoral labour productivity by country and region

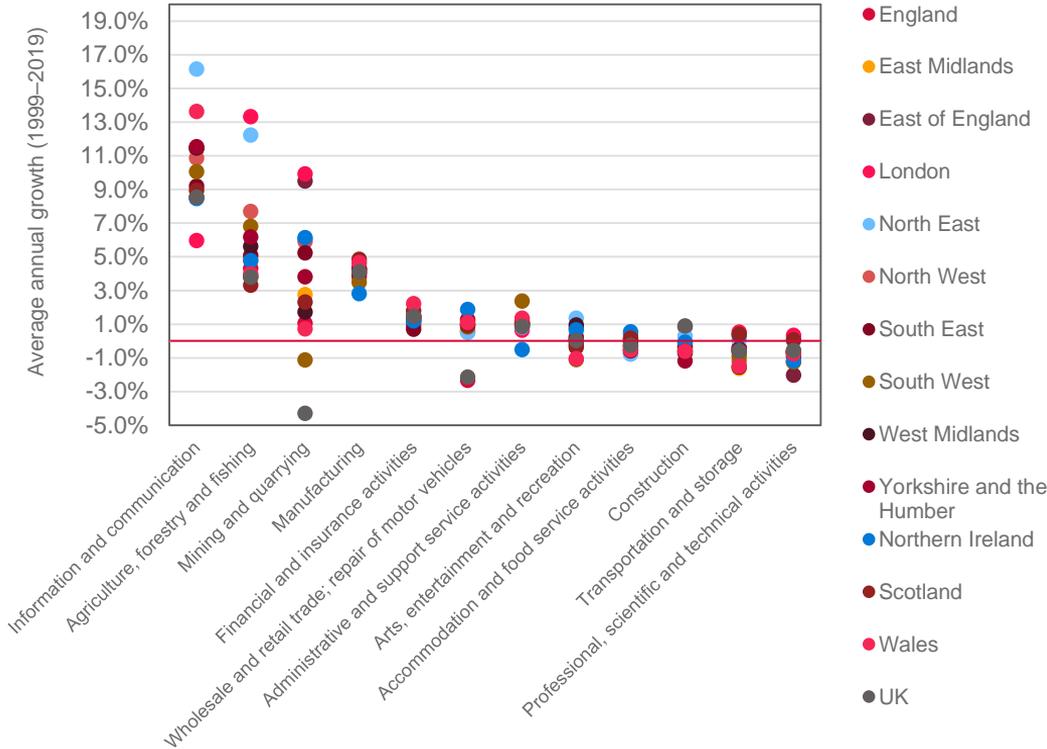
GVA per job of market sectors (excluding utilities), thousand £ per job per year, 2019

Sector	England	East Midlands	East of England	London	North East	North West	South East	South West	West Midlands	Yorkshire and the Humber	Northern Ireland	Scotland	Wales	UK <sup>(1)</sup>
Financial and insurance activities	148.3	92.1	110.4	207.1	110.8	111.0	112.6	109.0	108.7	100.2	86.8	134.9	111.6	145.1
Manufacturing	74.0	68.1	80.8	68.7	73.3	81.2	86.2	66.5	70.4	66.2	62.8	84.3	77.2	74.4
Mining and quarrying	76.8	102.0	58.2	80.0	97.3	66.9	69.3	102.9	35.1	68.9	66.5	46.0	67.3	353.6
Information and communication	85.9	58.9	69.9	105.5	68.0	69.3	92.2	58.5	78.8	59.5	57.7	59.3	59.9	83.1
Construction	56.1	52.7	63.5	72.8	48.9	52.6	58.4	45.3	46.3	46.1	57.1	51.0	45.6	55.3
Transportation and storage	44.6	35.3	41.9	62.0	36.3	38.1	52.5	37.5	33.2	39.8	48.2	47.5	35.8	44.6
Wholesale and retail trade; repair of motor vehicles	42.7	37.7	42.8	53.8	32.0	38.0	50.7	36.7	38.3	37.4	45.1	39.8	33.0	42.1
Professional, scientific and technical activities	47.7	33.3	35.0	71.0	36.5	36.9	48.6	35.2	35.1	35.2	39.7	44.6	29.1	46.9
Agriculture, forestry and fishing	36.1	48.6	39.5	16.3	57.1	28.3	25.5	37.7	33.0	43.5	24.5	47.7	14.8	34.5
Other service activities	36.7	32.9	33.7	47.8	33.6	33.4	38.7	33.3	37.2	25.7	24.4	33.7	37.9	36.2
Administrative and support-service activities	34.8	28.1	31.5	46.6	26.1	32.5	36.3	35.4	27.1	25.8	22.4	28.8	27.0	33.9
Arts, entertainment and recreation	33.2	26.6	30.5	52.4	25.4	28.7	32.1	17.4	29.9	24.2	26.0	21.4	19.4	31.4
Accommodation and food-service activities	24.1	20.2	22.8	32.1	17.2	22.3	23.5	21.0	23.2	20.4	22.9	23.1	19.5	23.7
Total	57.1	47.7	52.6	80.0	47.3	50.3	59.7	48.6	49.0	47.4	48.5	53.7	46.7	56.7

- Chart 1.3 presents labour productivity levels across the UK regions and countries of sectors where transactions occur predominantly in the market, excluding **electricity, gas and water supply**.
- Across the UK regions and countries, **financial and insurance activities, information and communication, manufacturing and construction** have among the highest productivity levels.
- In comparison, **labour-intensive services**, such as **accommodation and food-service activities, entertainment and recreation, and administrative and support-service activities**, tend to have some of the lowest productivity levels.
- Spatial disparities are particularly large in **agriculture, forestry and fishing** (38% of the UK value); **arts, entertainment and recreation** (28% of the UK value); **professional, scientific and technical activities** (23% of the UK value); and **financial and insurance activities** (21% of the UK value).<sup>[1]</sup>
- London** stands out for productivity levels above the UK average with between 27% (**information and communication**) and 67% (**arts, entertainment and recreation**) across most sectors, with the exception of **manufacturing and agriculture**, which have productivity levels below the UK average.
- The productivity of **London's professional, scientific and technical activities** is 2.4 times larger than that observed in **Wales**, the UK area with the lowest productivity level in this sector.
- The North East of England** has the highest productivity levels in **agriculture, forestry and fishing**, 2.3 times larger than those in **Northern Ireland**. Meanwhile, **the South East of England and Scotland** have the highest productivity levels in **manufacturing**, more than 30% higher than those observed in **Northern Ireland**.

## Chart 1.4. Sectoral labour productivity growth by country and region

Average annual growth of output per job of market sectors (excluding utilities), 1999–2019



- Among market sectors, and excluding electricity, gas and water supply, **information and communication, agriculture, mining and quarrying, and manufacturing** tend to show faster labour productivity growth, while **construction, transportation and storage, and professional, scientific and technical activities** show weaker and even negative growth rates.
- Differences are observed across UK countries and regions, particularly in the pace of productivity growth in **information and communication, agriculture, and mining and quarrying**. However, the contribution of the latter is negligible across most of the UK regions and countries, since most mining activities are assigned to specific regions in official statistics.
- Between 1999 and 2019 **the UK** areas that saw the fastest productivity growth rates of the **information and communication** sector include **the North East of England** (16.2%) and **Wales** (13.6%). In contrast, **London** saw the slowest growth (6.0%).
- During the same period, the fastest labour productivity growth in **agriculture** was observed in **London** (13.3%) and **the North East** (12.2%). However, as presented in Chart 1.3, London's labour productivity in agriculture was the lowest across regions. In comparison, **Scotland** had the most modest growth (3.3%).

## Chart 1.5. Value-added and employment shares by sector, country and region, 2019

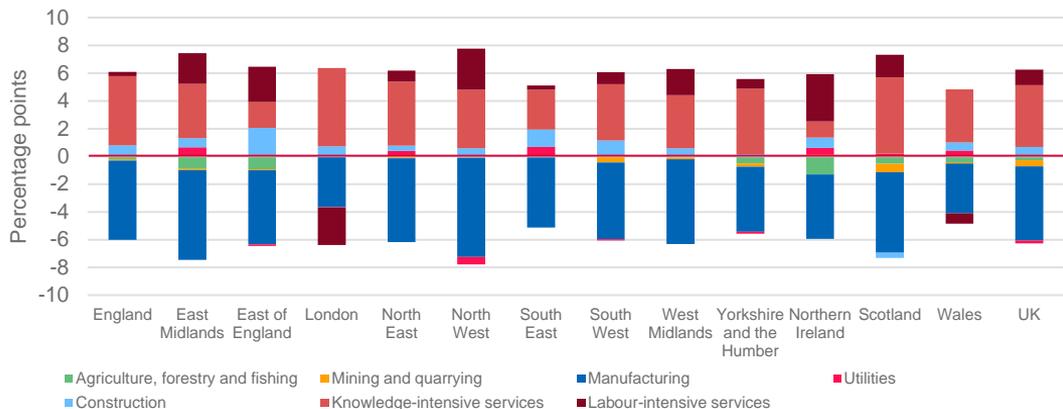
Value-added shares of sectors in each UK country and region, 2019							
Country/region	Agriculture, forestry and fishing	Mining and quarrying	Manufacturing	Utilities	Construction	Knowledge-intensive services	Labour-intensive services
<b>England</b>	0.6%	0.1%	9.6%	2.5%	6.5%	29.0%	51.7%
<i>East Midlands</i>	1.3%	0.4%	16.8%	3.6%	7.3%	18.6%	52.1%
<i>East of England</i>	1.0%	0.1%	10.9%	2.4%	9.2%	22.8%	53.6%
<i>London</i>	0.0%	0.0%	2.0%	1.0%	4.9%	44.9%	47.2%
<i>North East</i>	0.6%	0.3%	14.6%	4.1%	6.4%	20.7%	53.3%
<i>North West</i>	0.4%	0.1%	14.4%	2.5%	6.3%	22.2%	54.1%
<i>South East</i>	0.4%	0.1%	8.7%	3.1%	7.0%	26.9%	53.8%
<i>South West</i>	1.4%	0.2%	11.1%	3.4%	7.0%	22.1%	54.8%
<i>West Midlands</i>	0.8%	0.1%	15.5%	3.5%	6.4%	21.1%	52.5%
<i>Yorkshire and the Humber</i>	0.9%	0.1%	14.9%	3.2%	6.5%	22.4%	52.1%
<b>Northern Ireland</b>	1.7%	0.3%	13.7%	3.0%	7.7%	17.2%	56.5%
<b>Scotland</b>	1.7%	1.0%	10.4%	4.4%	6.0%	24.1%	52.5%
<b>Wales</b>	0.9%	0.3%	16.9%	4.3%	6.4%	18.5%	52.8%
<b>United Kingdom</b>	0.7%	1.1%	9.3%	3.1%	6.2%	27.8%	51.8%

Employment shares of sectors in each UK country and region, 2019							
Region	Agriculture, forestry and fishing	Mining and quarrying	Manufacturing	Utilities	Construction	Knowledge-intensive services	Labour-intensive services
<b>England</b>	0.9%	0.1%	7.4%	1.0%	6.6%	25.4%	58.6%
<i>East Midlands</i>	1.3%	0.2%	11.8%	1.3%	6.6%	20.5%	58.5%
<i>East of England</i>	1.3%	0.1%	7.1%	1.0%	7.7%	24.8%	58.1%
<i>London</i>	0.1%	0.0%	2.3%	0.5%	5.4%	35.3%	56.4%
<i>North East</i>	0.5%	0.1%	9.4%	1.4%	6.2%	20.0%	62.3%
<i>North West</i>	0.8%	0.1%	8.9%	1.1%	6.1%	22.2%	60.9%
<i>South East</i>	1.0%	0.1%	6.0%	1.1%	7.2%	26.9%	57.8%
<i>South West</i>	1.8%	0.1%	8.1%	1.1%	7.5%	22.4%	58.9%
<i>West Midlands</i>	1.2%	0.1%	10.8%	1.1%	6.8%	20.3%	59.7%
<i>Yorkshire and the Humber</i>	0.9%	0.1%	10.7%	1.0%	6.7%	21.8%	58.8%
<b>Northern Ireland</b>	3.3%	0.2%	10.6%	1.0%	6.5%	18.4%	60.0%
<b>Scotland</b>	1.9%	1.1%	6.6%	1.2%	6.3%	21.7%	61.1%
<b>Wales</b>	2.7%	0.2%	10.2%	1.4%	6.6%	19.5%	59.4%
<b>United Kingdom</b>	0.7%	0.2%	7.7%	1.5%	4.8%	25.0%	60.0%

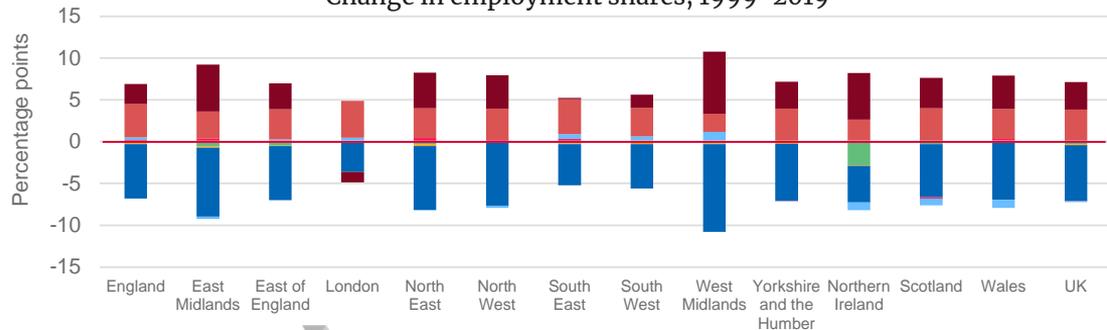
- Across countries and regions, **labour-intensive services**<sup>[1]</sup> account for around half of the total UK value added and employment. This category groups together activities such as **accommodation and food services, entertainment and recreation, and administrative and support-service activities**, which, as shown in Charts 1.3 and 1.4, tend to have among the lowest productivity levels and slower productivity growth.
- In 2019 **Northern Ireland** saw the largest share of value added (56.5%) of these activities, while **London** saw the smallest share (47.2%). In terms of employment, the largest shares of these services are seen in **the North East of England** (62.3%) and **Scotland** (61.1%).
- Knowledge-intensive services**<sup>[1]</sup> account for around a quarter of the value added and employment of the total economy across regions and countries. Larger **financial, and professional and scientific sectors**, in comparison with other UK areas, mean that **London** has the largest share of these activities (44.9% value added and 35.3% employment). In comparison, **Northern Ireland, Wales and the East Midlands** have particularly low shares of these activities.
- Manufacturing** is the third largest contributor to UK value added and employment among the economic activity groups examined. In terms of value added, it is particularly important in **Wales** (16.9%), **the East Midlands** (16.8%), and **the West Midlands** (15.5%); meanwhile, in terms of employment, the largest shares are seen in **the East** (11.8%) and **West Midlands** (10.8%), and in **Yorkshire and the Humber** (10.7%). In comparison, **London** has the lowest shares of manufacturing in the UK (2.0% value added and 2.3% employment).

# Chart 1.6. Change in value-added and employment shares by sector, country and region, 1999–2019

Change in value-added shares, 1999–2019



Change in employment shares, 1999–2019



- As highlighted in the 2022 edition of the *UK Innovation Report*, a key change observed in the structure of **the UK economy** in recent decades is the decline in the participation of **manufacturing** and the consequent increase in the size of **service** activities.
- The regions that saw the greatest decline in **manufacturing** activities between 1999 and 2019 include: **the North West of England** (-7.2 pp. in value added and -7.5 pp. in employment); **the East Midlands** (-6.4 pp. in value added and -8.2 pp. in employment); and **the West Midlands** (-6.1 pp. in value added and -10.5 pp. in employment).
- Knowledge-intensive services**<sup>[1]</sup> experienced a substantial expansion between 1999 and 2019, particularly in **London** (5.6 pp. in value added and 4.4 pp. in employment) and **Scotland** (5.5 pp. in value added and 4.0 pp. in employment). This expansion was mainly driven by the growth of **professional, scientific and technical activities**.
- The second largest expansion across sectors is observed in **labour-intensive services**<sup>[1]</sup> and explained by the growth of **human health and social work activities and administrative and support-service activities**. This trend is especially pronounced in **Northern Ireland** in terms of value added (3.4 pp.) and in **the West Midlands** in terms of employment (7.4 pp.).
- In comparison, the shrinkage of **wholesale and retail trade** in **London** has meant the largest decline in the contribution of these activities (-2.7 pp. value added and -1.2 pp. employment).
- Northern Ireland** experienced the fastest decline in the participation of **agriculture** in the regional economy (-1.3 pp. in terms of value added and -2.8 pp. in employment shares).

# Chart 1.7. Intra-industry productivity growth effect: top and bottom five sectors in the UK

Percentage points, average 1999–2019

Sector	England	East Midlands	East of England	London	North East	North West	South East	South West	West Midlands	Yorkshire and the Humber	Northern Ireland	Scotland	Wales	UK	
Top five sectors	Manufacturing	0.53	0.89	0.58	0.15	0.81	0.81	0.44	0.51	0.77	0.74	0.43	0.64	0.81	0.53
	Information and communication	0.57	0.27	0.62	0.66	0.75	0.47	0.78	0.40	0.46	0.41	0.27	0.32	0.38	0.53
	Wholesale and retail trade; repair of motor vehicles	0.10	0.07	0.16	0.04	0.06	0.12	0.13	0.09	0.13	0.15	0.24	0.09	0.11	0.10
	Financial and insurance activities	0.09	0.03	0.04	0.18	0.04	0.06	0.03	0.06	0.06	0.04	0.02	0.13	0.09	0.09
	Public administration and defence	0.08	0.07	0.10	0.06	0.11	0.10	0.05	0.10	0.08	0.08	0.09	0.11	0.14	0.08
Bottom five sectors	Professional, scientific and technical activities	-0.05	-0.06	-0.14	0.03	0.00	-0.06	-0.07	-0.08	-0.04	-0.03	-0.05	-0.01	-0.03	-0.04
	Construction	-0.05	-0.06	-0.03	-0.01	0.00	-0.05	-0.04	-0.06	-0.07	-0.09	-0.05	-0.05	-0.04	-0.05
	Education	-0.08	-0.06	-0.08	-0.06	-0.09	-0.09	-0.10	-0.07	-0.07	-0.08	-0.13	-0.08	-0.12	-0.08
	Mining and quarrying	0.00	0.01	0.01	0.00	0.02	0.01	0.01	-0.01	0.00	0.01	0.01	0.03	0.00	-0.09
	Real-estate activities	-0.17	-0.28	-0.34	0.08	-0.29	-0.10	-0.16	-0.19	-0.21	-0.12	-0.53	-0.17	-0.65	-0.20
<b>Intra-industry productivity growth effect of the total economy</b>	<b>0.99</b>	<b>0.93</b>	<b>0.95</b>	<b>1.20</b>	<b>1.32</b>	<b>1.23</b>	<b>1.06</b>	<b>0.76</b>	<b>1.14</b>	<b>1.12</b>	<b>0.48</b>	<b>1.11</b>	<b>0.65</b>	<b>0.85</b>	

- Chart 1.7 shows the top and bottom five sectors by their contributions to labour productivity growth in **the UK** via the intra-industry productivity growth effect. The intra-industry productivity growth effect measures how fast the productivity of a sector grows weighted by its value-added share (see Appendix 1.2).
- Between 1999 and 2019 **the North East, North West and London** regions stood out for having the largest intra-industry productivity growth effects in **the UK**.
- Across countries and regions, **manufacturing and information and communication** account for the largest contributions to productivity growth via intra-industry growth effect.
- In relative terms, that is, as a percentage of the intra-industry growth effect of the total economy, the largest contributions to aggregate productivity growth from manufacturing are observed in **Wales** (124.7%) and **the East Midlands** (95.8%).
- In the case of information and communication, the largest contributions via intra-industry productivity growth effect are observed in **the South East of England** (73%) and **the North East** (56.9%).
- In some countries and regions, such as **Northern Ireland** (0.12 pp., 24.8% in relative terms), **the South West of England** (0.08 pp., 10.8% in relative terms) and **the East Midlands** (0.09 pp., 10.2% in relative terms), **agriculture** – a sector that has shown fast productivity growth in recent decades (Chart 1.4) – also appears among the top five sectors based on its intra-industry productivity growth effect.
- In comparison, with the exception of **London**, where they account for 0.08 pp., **real-estate activities** have made negative contributions to labour productivity growth across **the UK**. Caution is needed, however, when analysing this sector, since imputed rents from owner-occupied dwellings are included in the value added.

## Chart 1.8. Allocation effect: top and bottom five sectors in the UK

Percentage points, average 1999–2019

Sector	England	East Midlands	East of England	London	North East	North West	South East	South West	West Midlands	Yorkshire and The Humber	Northern Ireland	Scotland	Wales	UK	
Top five sectors	Real-estate activities	0.20	0.24	0.33	0.15	0.26	0.05	0.11	0.09	0.15	0.06	0.42	0.22	0.34	0.19
	Professional, scientific and technical activities	0.18	0.14	0.20	0.19	0.07	0.18	0.16	0.17	0.12	0.13	0.11	0.14	0.08	0.16
	Education	0.17	0.18	0.18	0.14	0.21	0.16	0.19	0.14	0.18	0.21	0.12	0.17	0.20	0.16
	Human health and social-work activities	0.16	0.17	0.18	0.10	0.23	0.21	0.14	0.15	0.21	0.20	0.18	0.18	0.21	0.15
	Construction	0.15	0.15	0.19	0.10	0.09	0.12	0.16	0.16	0.15	0.16	0.15	0.11	0.11	0.13
Bottom five sectors	Agriculture, forestry and fishing	-0.04	-0.14	-0.12	0.00	-0.06	-0.03	-0.02	-0.08	-0.04	-0.09	-0.19	-0.08	-0.05	-0.05
	Public administration and defence	-0.05	-0.05	-0.06	-0.04	-0.06	-0.06	-0.08	-0.11	-0.03	-0.04	-0.15	-0.01	-0.01	-0.06
	Wholesale and retail trade; repair of motor vehicles	-0.11	-0.03	-0.14	-0.16	-0.05	-0.08	-0.13	-0.11	-0.11	-0.12	-0.04	-0.11	-0.08	-0.13
	Information and communication	-0.50	-0.24	-0.64	-0.58	-0.69	-0.41	-0.68	-0.40	-0.41	-0.36	-0.24	-0.28	-0.33	-0.47
	Manufacturing	-0.74	-1.10	-0.83	-0.29	-1.03	-1.05	-0.66	-0.75	-1.02	-0.91	-0.59	-0.88	-0.94	-0.77
<b>Allocation effect of the total economy</b>	<b>-0.31</b>	<b>-0.38</b>	<b>-0.54</b>	<b>-0.23</b>	<b>-0.69</b>	<b>-0.65</b>	<b>-0.59</b>	<b>-0.54</b>	<b>-0.54</b>	<b>-0.57</b>	<b>0.01</b>	<b>-0.32</b>	<b>-0.18</b>	<b>-0.38</b>	

- Chart 1.8 shows the top and bottom five sectors by their relative contributions to labour productivity growth in **the UK** via the allocation effect. The allocation effect measures how the expansion or reduction of sectors contributes to productivity growth. Sectors with higher productivity levels receive higher weights in this measure (see Appendix 1.2).
- Between 1999 and 2019, except for **Northern Ireland**, all of **the UK** countries and regions experienced negative allocation effects. In other words, shifts in the size of sectors had a negative net effect on overall labour productivity growth. The decline in the size of **manufacturing** (employment) and **information and communication** (relative prices) account for most of this negative effect.
- The most negative impacts from the shrinkage of **manufacturing** between 1999 and 2019 are observed in **the East Midlands, the North West, the North East and the West Midlands**, where the decline of manufacturing cost these regions a percentage point, on average per year, between 1999 and 2019.
- Other sectors that have shrunk in the last 2 decades, and thus reduced their contributions to overall labour productivity growth, include: **wholesale and retail**, particularly in **London** (-0.16 pp.), **public administration and defence**, and **agriculture**, particularly in **Northern Ireland** (-0.15 pp. and -0.19 pp.).
- In comparison, sectors such as **real estate, professional, scientific and technical activities, education, human health and construction** saw their contributions to aggregate productivity growth increase from 1999 to 2019. However, as these sectors tend to show productivity levels below the average, their expansion has not compensated for the contraction of **manufacturing and information and communication** and thus the negative total allocation effect.

## Chart 1.9. Total sectors' contribution to aggregate labour productivity growth: top and bottom five sectors in the UK

Percentage points, average 1999–2019

Sector		England	East Midlands	East of England	London	North East	North West	South East	South West	West Midlands	Yorkshire and the Humber	Northern Ireland	Scotland	Wales	UK
Top five sectors	Human health and social-work activities	0.14	0.17	0.13	0.10	0.20	0.19	0.13	0.11	0.17	0.16	0.17	0.21	0.19	0.13
	Professional, scientific and technical activities	0.14	0.08	0.07	0.22	0.07	0.13	0.09	0.09	0.08	0.10	0.06	0.14	0.05	0.12
	Financial and insurance activities	0.13	0.03	0.03	0.28	0.09	0.08	0.03	0.07	0.08	0.08	0.07	0.18	0.14	0.12
	Construction	0.10	0.10	0.16	0.09	0.09	0.07	0.12	0.10	0.08	0.07	0.10	0.06	0.07	0.08
	Administrative and support-service activities	0.09	0.09	0.11	0.06	0.07	0.10	0.07	0.11	0.10	0.10	0.06	0.09	0.07	0.08
Bottom five sectors	Real-estate activities	0.03	-0.05	-0.01	0.23	-0.04	-0.05	-0.05	-0.10	-0.06	-0.06	-0.11	0.05	-0.31	-0.01
	Mining and quarrying	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	-0.02	-0.01	-0.01	0.00	-0.03	0.00	-0.01
	Agriculture, forestry and fishing	-0.01	-0.05	-0.05	0.00	0.00	0.00	0.00	0.00	0.00	-0.03	-0.07	-0.02	-0.02	-0.02
	Wholesale and retail trade; repair of motor vehicles	-0.01	0.03	0.02	-0.11	0.00	0.04	0.00	-0.03	0.02	0.02	0.20	-0.01	0.03	-0.03
	Manufacturing	-0.22	-0.21	-0.25	-0.14	-0.22	-0.24	-0.21	-0.24	-0.25	-0.17	-0.16	-0.24	-0.13	-0.24
<b>Average annual growth rate</b>		0.68	0.55	0.41	0.97	0.64	0.58	0.48	0.22	0.60	0.55	0.49	0.79	0.47	0.47

- Chart 1.9 shows the top and bottom five sectors by their total contributions to aggregate labour productivity growth in **the UK**. This is the sum of the intra-industry productivity growth effect (Chart 1.7) and the allocation effect (Chart 1.8) (see Appendix 1.2).
- Between 1999 and 2019 sectors such as **human health and social-work activities, professional, scientific and technical activities, and administrative and support-service activities**, with slower productivity growth (Chart 1.4) and productivity levels below the average of the total economy (Chart 1.3), were among the top five sectors contributing to productivity growth. The largest relative contributions of these sectors are observed in **the South West of England**, the region with the slowest labour productivity growth in **the UK** between 1999 and 2019.
- Because of its reduction in size, **manufacturing** has contributed negatively to aggregate productivity growth, despite having relatively high productivity levels (Chart 1.3) and experiencing fast productivity growth (Chart 1.4). The most negative contributions (relative to the productivity growth of the total economy) are observed in **the South West of England** (-108.7%) and **the East of England** (-61.4%). This means that, in the case of **the South West**, if manufacturing had not declined, labour productivity in this region would have grown more than twice as fast.

# Appendix 1.1

## Sectors' classification and statistical codes

Classification of sectors based on the UK Standard Industrial Classification (SIC)							
Section	Division	Description		Section	Division	Description	
<b>Low/medium-tech manufacturing</b>	C	10–12	Food products, beverages and tobacco	<b>Knowledge-intensive services</b>	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		M	69–82	Professional, scientific and technical activities
	C	22–23	Rubber and plastics products, and other non-metallic mineral products		P	85	Education
	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	
<b>Medium/high-tech manufacturing</b>	C	19	Coke and refined petroleum products	<b>Labour-intensive services</b>	I	55–56	Accommodation and food service activities
	C	20	Chemicals and chemical products		L	68	Real-estate activities
	C	21	Basic pharmaceutical products and pharmaceutical preparations		N	77–82	Administrative and support service activities
	C	26	Computer, electronic and optical products		O	84	Public administration and defence; compulsory social security
	C	27	Electrical equipment		Q	86–88	Human health and social work activities
	C	28	Machinery and equipment n.e.c.		R	90–93	Arts, entertainment and recreation
	C	29	Motor vehicles, trailers and semi-trailers		S	94–96	Other service activities
C	30	Other transport equipment	T	97–98	Activities of households as employers; undifferentiated activities of households for own use		
<b>Other production</b>	A	01–03	Agriculture, hunting, forestry and fishing				
	B	05–09	Mining and quarrying				
	D	35	Electricity, gas, steam and air conditioning supply				
	E	36–39	Water supply; sewerage, waste management and remediation activities				
	F	41–43	Construction				

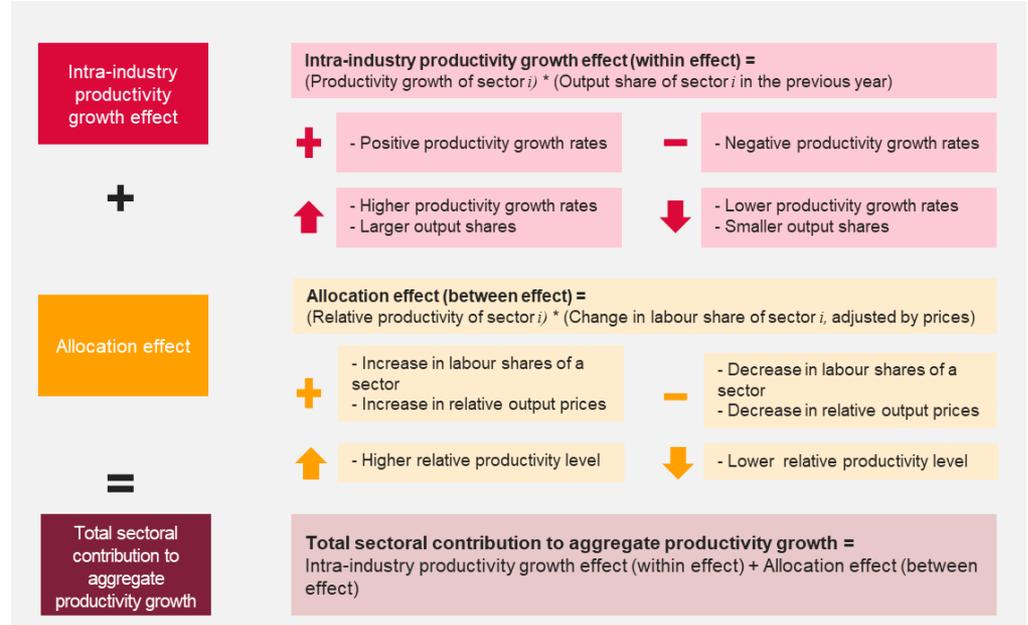
# Appendix 1.2

## Decomposition of productivity growth

Economic sectors contribute disparately to aggregate productivity growth, depending on their productivity gains over time, as well as their relative weight in the total economy and relative productivity differences.

In order to understand the extent and nature of these contributions, we decompose labour productivity growth rates into sectoral contribution effects, as described in Tang and Wang (2004):

- An **intra-industry productivity growth effect** that captures the productivity growth of each economic sector, given the relative importance in the economy (within effect). The intra-industry productivity growth effect of a given sector  $i$  takes positive (negative) values whenever the sector shows positive (negative) productivity growth. Its magnitude depends on the productivity growth rate and how large the sector is in relation to other sectors in the economy.
- An **allocation effect** (between-industries effect) that captures the effects of changes in the relative size of sectors. The allocation effect takes positive (negative) values if the sector increases (decreases) in size. The relative size is determined by changes in labour shares and relative output prices of sector  $i$ . By changes in relative output prices, we mean how much the output prices in sector  $i$  change in relation to changes in the output prices of the whole economy.



# Theme 2: Investment in innovation

UK INNOVATION REPORT

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# Theme 2: Investment in innovation

## Key policy questions addressed

- Is the UK spending enough on R&D?
- How do the public and private sectors contribute to national expenditure on innovation?
- How does the UK compare with other countries?

## Key findings

### A new methodology introduced by ONS has pushed the estimate of UK expenditure on R&D up by 55%

- The UK's gross domestic expenditure on R&D (GERD) as a percentage of GDP was thought to be around 1.7%.
- The Office for National Statistics (ONS) has introduced a major revision, which has pushed this figure up to 2.7%.
- The UK still lags behind Germany, the US and South Korea, which invested between 3.2% and 4.6% of GDP on R&D.

### The UK government's expenditure on R&D remains relatively low compared to OECD countries

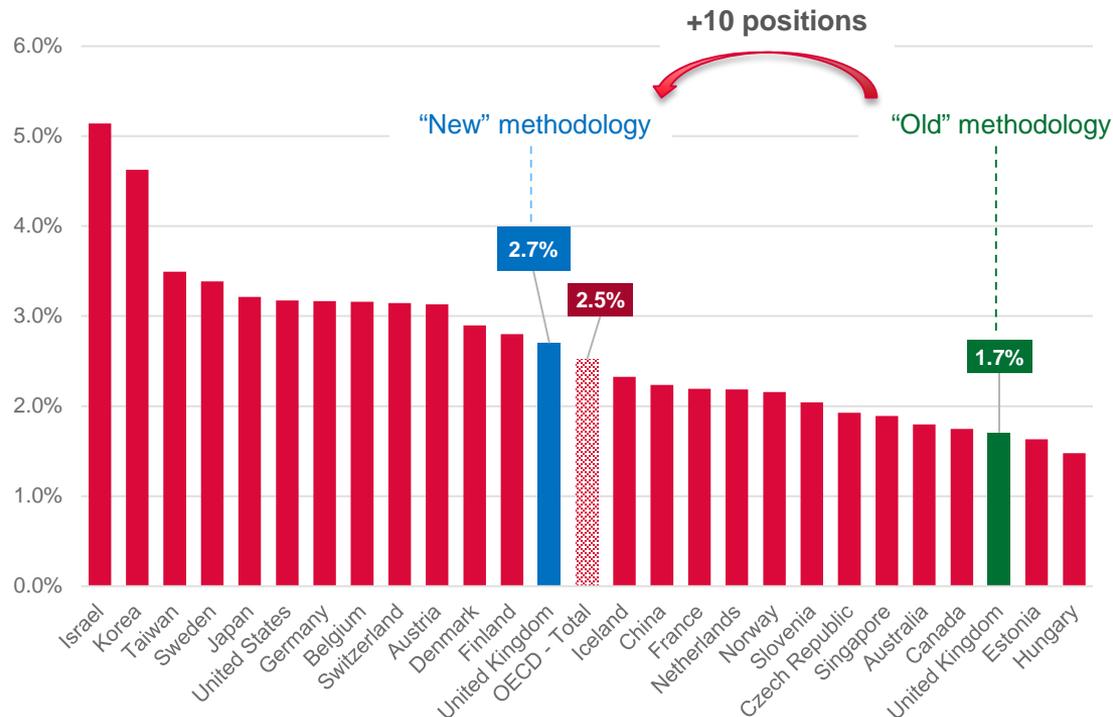
- The ONS revised methodology has not impacted the estimate of R&D performed by the UK government.
- In 2019 UK government expenditure on R&D as a share of GDP was 0.12%, well below the OECD average of 0.24%.
- In the UK the **business sector** is the main contributor to R&D performance (71.2% in 2020), and **non-business R&D** is concentrated around the **higher education sector** (22.5% in 2020).

### Few firms with headquarters in the UK are among the world's top R&D investors and patent applicants

- In 2021, 95 of the world's 2,500 top R&D-investing companies were headquartered in the UK, behind the US (822), China (678), Japan (233) and Germany (114).
- The UK hosted only 3 of the top 100 R&D-investing firms in the world in 2021.
- In 2021 there were no UK-headquartered applicants among the top 100 applicants at the United States Patent and Trademark Office (USPTO) and only 1 among the top 100 applicants at the European Patent Office (EPO).

## Chart 2.1. R&D intensity: international comparison (1/2)

Gross domestic expenditure on R&D (GERD) as a share of GDP, 2019



- The UK's gross domestic expenditure on R&D (GERD) as a percentage of GDP was thought for many years to be around 1.7%.
- In November 2022 the **Office for National Statistics (ONS)** introduced a **major revision** to the methodology used to estimate R&D performed by businesses and the **higher education sector**.<sup>[1]</sup>
- Using the **“new” revised methodology**, for 2019:
  - UK GERD goes up to **£59.7 billion (55% more than using the “old” methodology)**.
  - UK GERD as a share of GDP for 2019 goes up to **2.7%** (above the **OECD average of 2.5%**).
  - The UK gains **10 positions** in the OECD ranking of R&D intensity for 2019.<sup>[2]</sup>
  - The UK still lags behind **Germany, the US and South Korea**, which invested between **3.2% and 4.6%** of GDP on R&D.

**Note:** For the UK, the value of gross domestic expenditure on R&D as a share of GDP was estimated by the Department for Science, Innovation and Technology (DSIT) to be between 2.6% and 2.7% in 2019, based on the ONS methodological revision of BERD methodology. (For 2020, DSIT estimated UK R&D intensity to be between 2.9% and 3.0%, a value that is relatively high as a result of the contraction of GDP associated with COVID-19 lockdowns).

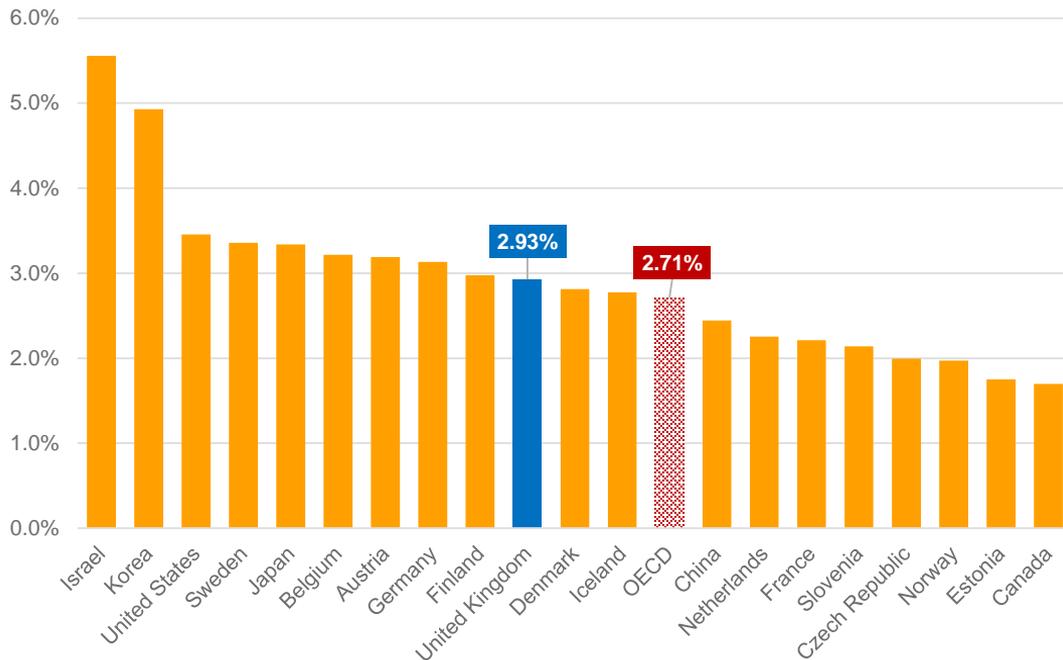
**Source:** OECD (2022). Main Science and Technology Indicators. For the DSIT estimate of UK R&D as a share of GDP value, see Nurse P. (2023). Independent Review of the Research, Development and Innovation Organisational Landscape – Final Report and Recommendations.

**Note:** <sup>[1]</sup>ONS (2022). Gross domestic expenditure on research and development, UK: 2020 (published on 22 November 2022).

<sup>[2]</sup> OECD (2022). Main Science and Technology Indicators.

## Chart 2.2. R&D intensity: international comparison (2/2)

Gross domestic expenditure on R&D (GERD) as a share of GDP, 2021 or latest available



**Note:** Data for the United Kingdom refer to 2020.

**Source:** OECD (2023). OECD Science, Technology and Innovation Outlook 2023: Enabling Transitions in Times of Disruption, OECD Publishing, Paris.

- The latest edition of the *OECD Science, Technology and Innovation Outlook 2023*, released in March 2023, provides updated estimates of gross domestic expenditure on R&D (GERD) as a share of GDP for **OECD member states** and partner countries.
- Taking into account the ONS methodological revisions, the **OECD** estimated the value of **UK GERD** as a share of GDP to be **2.93%** for 2020, above the **OECD** average of **2.71%**.
- This is in line with the estimation provided by the **UK's Department for Science, Innovation and Technology** (DSIT), which is between **2.9%** and **3.0%** for 2020.<sup>[1]</sup>
- The relatively large values for **2020** reflect the contraction of UK GDP associated with COVID-19 lockdowns.



### Related insight

The ONS methodological revisions to estimate the gross domestic expenditure on R&D performed in the UK were also justified by the need to be aligned to methodologies used by other countries, particularly with respect to the sampling method used.<sup>[2]</sup> Following the ONS revisions effective from 2018, data series for previous years related to the UK R&D were suppressed from the data available to OECD.<sup>[3]</sup>

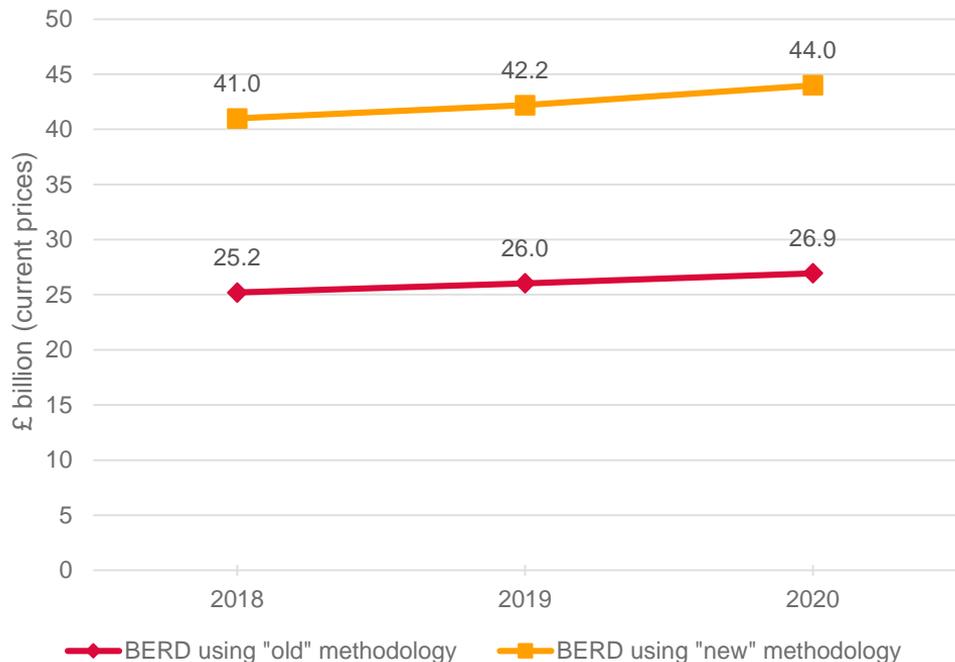
**Note:** <sup>[1]</sup> Nurse: P. (2023). Independent Review of the Research, Development and Innovation Organisational Landscape – Final Report and Recommendations.

<sup>[2]</sup> ONS (2022). Options for transformation of business enterprise research and development statistics (published on 22 November 2022).

<sup>[3]</sup> OECD (2023). OECD Science, Technology and Innovation Outlook 2023: Enabling Transitions in Times of Disruption, OECD Publishing, Paris.

## Chart 2.3. ONS revision of BERD methodology

Business expenditure on R&D (BERD), the United Kingdom, 2018–2020

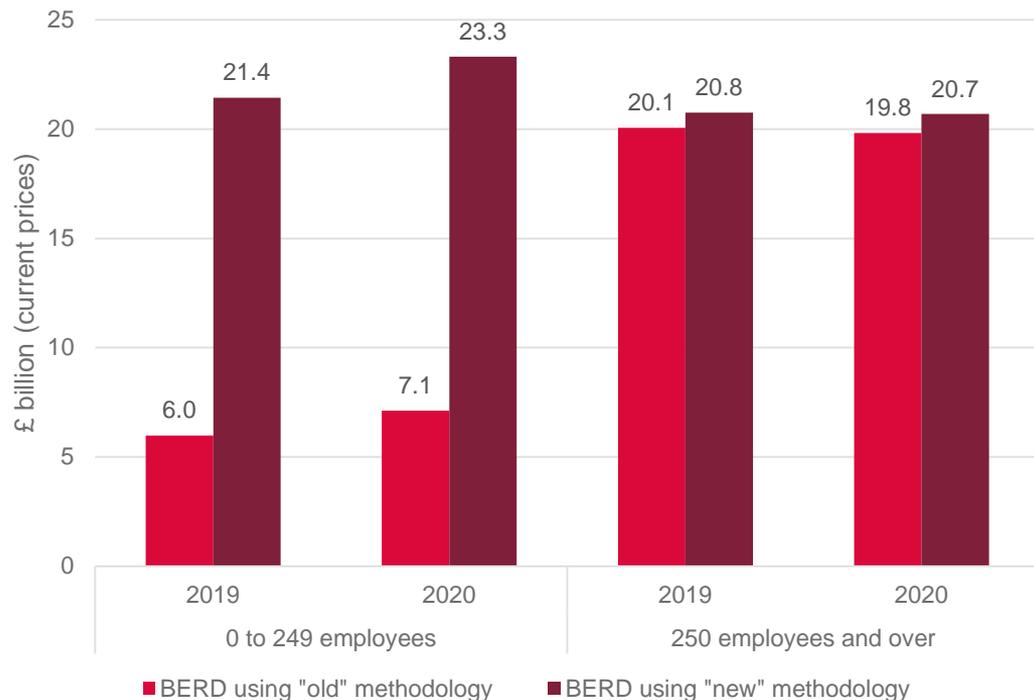


- Using the **new ONS methodology**, expenditure on R&D performed by UK businesses in **2018, 2019 and 2020** was **£15.8 billion, £16.1 billion and £17.1 billion (respectively)** higher than previously published.

**Source:** ONS (2022). Business enterprise research and development (R&D), UK: 2021 (published on 22 November 2022); and ONS (2021). Research and development in UK Businesses, 2020 – Datasets.

## Chart 2.4. UK BERD by company employment size

Business expenditure on R&D (BERD), the United Kingdom, 2019–2020

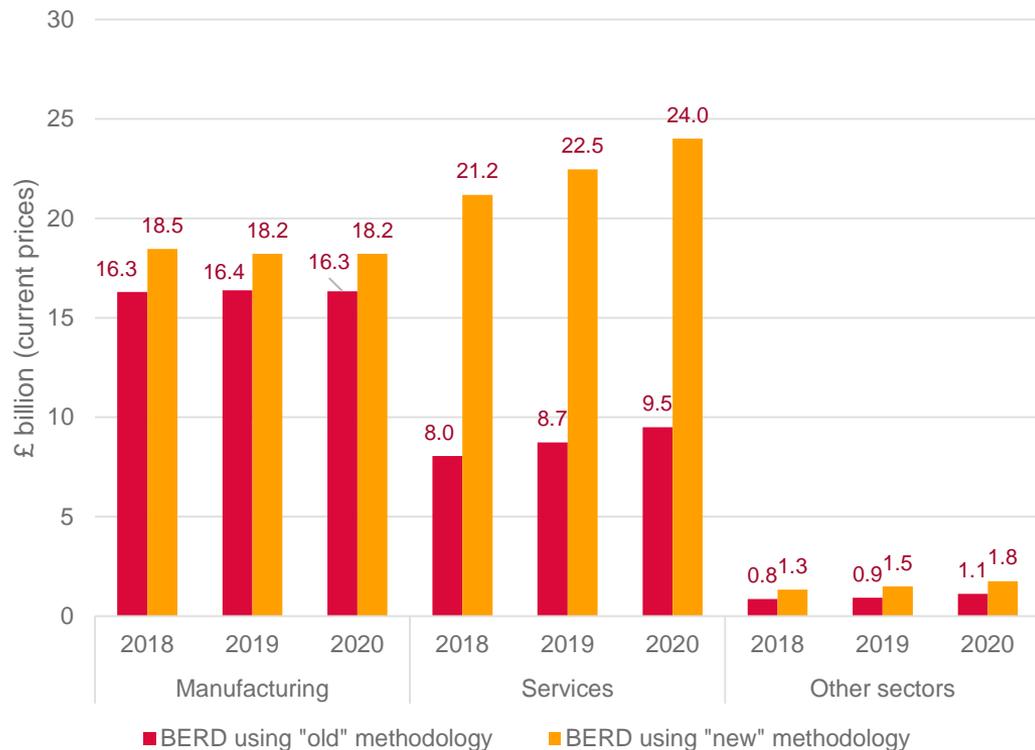


- **Small and medium enterprises** (0–249 employees) account for more than **95%** of the increase in R&D expenditure using the new ONS methodology.

**Source:** ONS (2022). Business enterprise research and development (R&D), UK: 2021 (published on 22 November 2022); and ONS (2021). Research and development in UK Businesses, 2020 (Table b: Additional datasets).

## Chart 2.5. UK BERD by broad product group

Business expenditure on R&D (BERD), the United Kingdom, 2018–2020



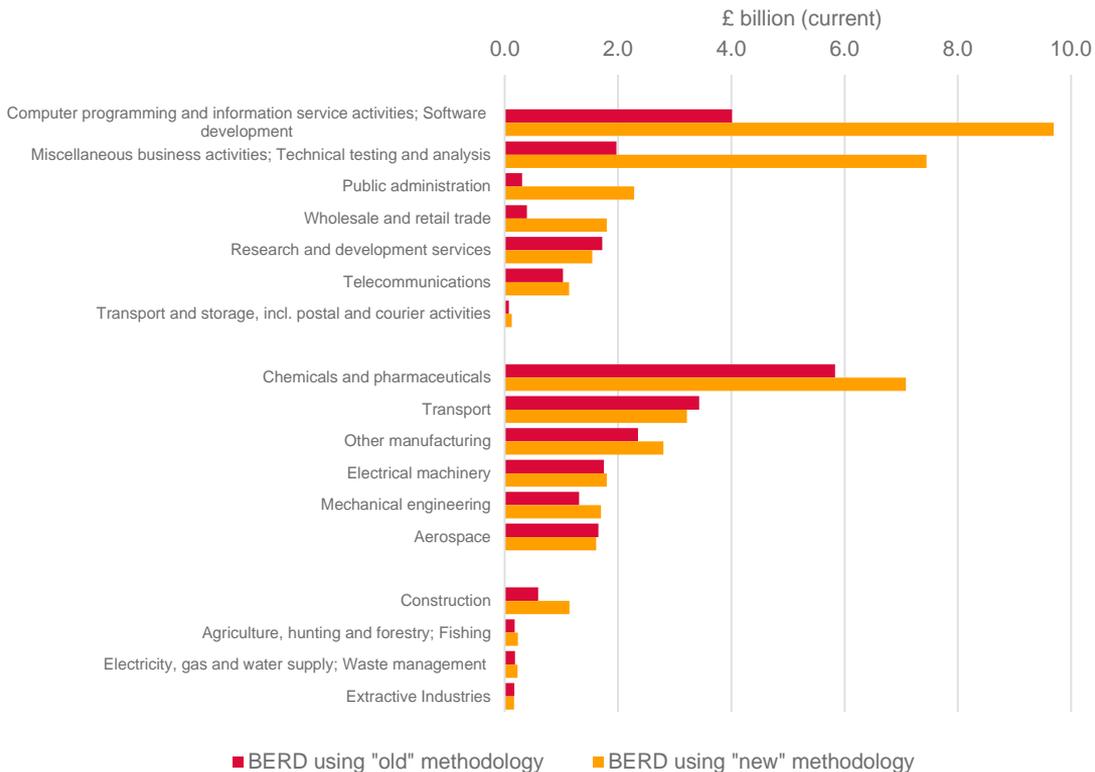
- **Services** account for **85%** of the total increase in R&D expenditure under the **ONS revised methodology** for **2020**, while manufacturing accounts for **11%** and other sectors for **4%**.
- Whereas R&D expenditure in **services** used to be around **half** of **manufacturing** R&D expenditure using the old methodology, it is roughly **one-third** higher under the new methodology.

**Note:** Other sectors include: agriculture, hunting and forestry; fishing, extractive industries, electricity, gas and water supply; waste management; and construction.

**Source:** ONS (2022). Business enterprise research and development (R&D), UK: 2021 (published on 22 November 2022); and ONS (2021). Research and development in UK Businesses, 2020 – Datasets.

## Chart 2.6. UK BERD by detailed product group

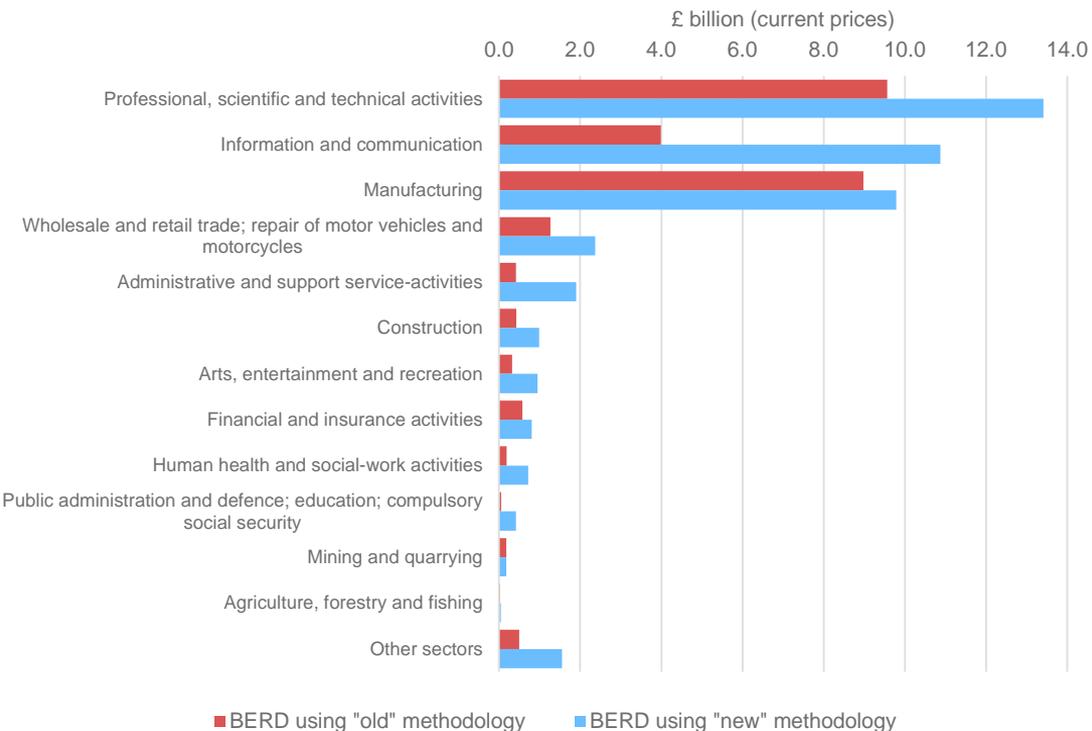
Business expenditure on R&D (BERD), the United Kingdom, 2020



- Four service product groups account for **85%** of the **£17.1 billion** increase in R&D expenditure under the “new” ONS methodology for **2020**:
  - **computer programming and information-service activities, software development;**
  - **miscellaneous business activities, technical testing and analysis;**
  - **public administration;** and
  - **wholesale and retail trade.**

## Chart 2.7. UK BERD by Standard Industry Classification

Business expenditure on R&D (BERD), the United Kingdom, 2020



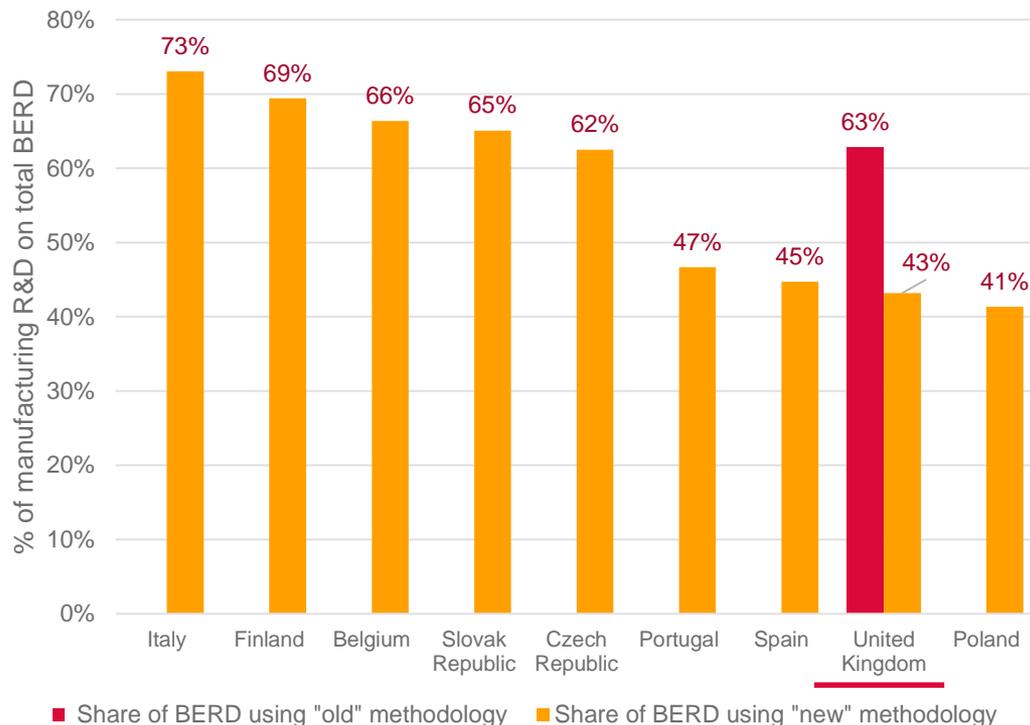
**Note:** Other sectors include: accommodation and food-service activities; real-estate activities; water supply, sewerage, waste management and remediation activities; transportation and storage; electricity, gas, steam and air conditioning supply; other service activities; activities of households as employers and of extraterritorial organisations and bodies.

**Source:** ONS (2022). Business enterprise research and development (R&D), UK: 2021 (published on 22 November 2022); and ONS (2021). Research and development in UK Businesses, 2020 (Table b: Additional datasets).

- Two sectors explain over **60%** of the increase in business R&D expenditure under the “new” methodology:
  - **Information and communication activities** account for **39%** of the increase (**£6.9 billion**).
  - **Professional, scientific and technical activities** account for **22%** of the increase (**£3.9 billion**).

## Chart 2.8. Manufacturing R&D: international comparison

Business expenditure on R&D (BERD), by product, selected countries, 2019 or latest available



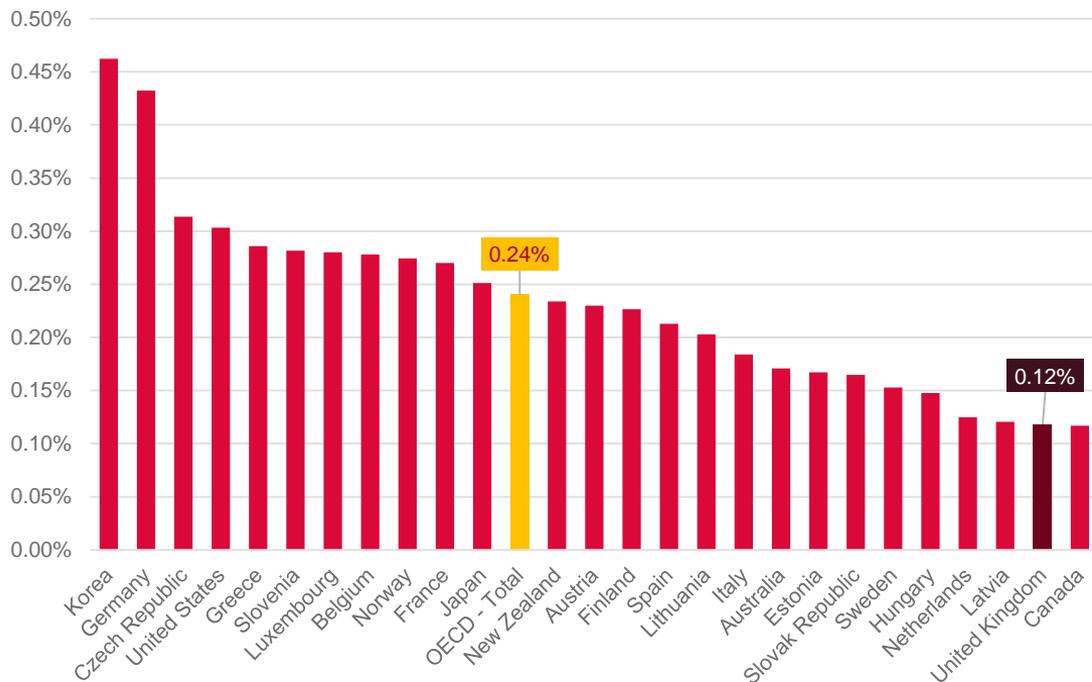
**Note:** Data for Italy, Poland, and Spain refer to 2018

**Source:** OECD (2022). Business enterprise R&D expenditure by industry – Dataset; ONS (2022). Business enterprise research and development (R&D), UK: 2021 (published on 22 November 2022); and ONS (2021). Research and development in UK Businesses, 2020 (Table b: Additional datasets)

- Following ONS revisions of methodology to estimate R&D conducted by businesses in the **UK**, **manufacturing** is not anymore the main contributor to business R&D performed in the country.
- In 2019, the contribution of **manufacturing** to total business R&D conducted in the **UK** was 43%, equivalent to 20 percentage points below what previously published.

## Chart 2.9. Government expenditure on R&D

Government expenditure on R&D (GOVERD) as a share of GDP, selected countries, 2019



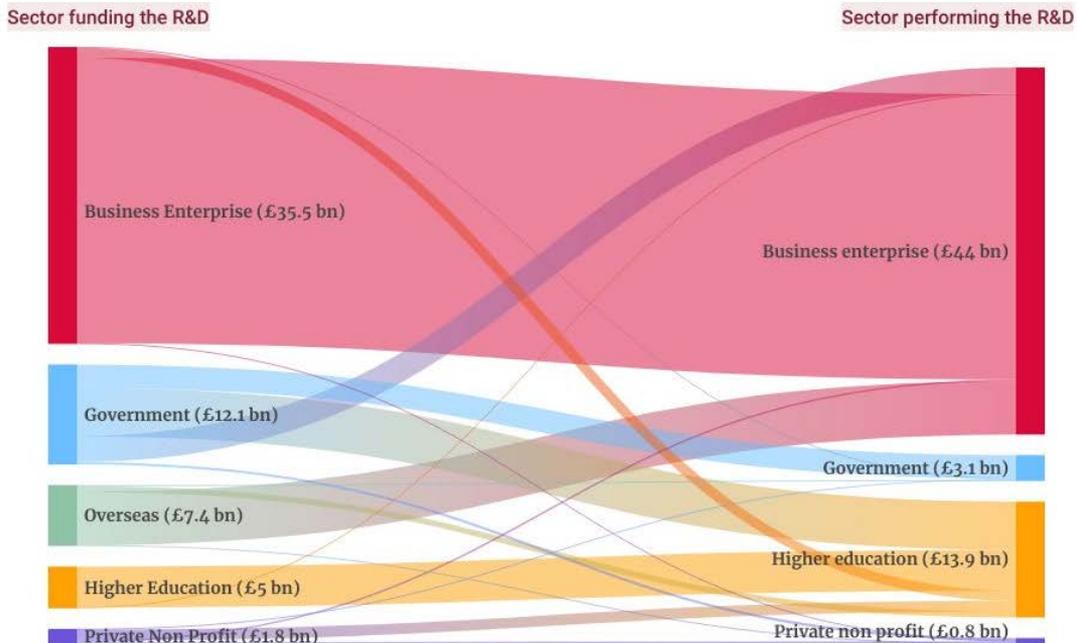
Source: OECD (2022). Main Science and Technology Indicators.

- The recent methodological revisions have not impacted the estimate of **the UK government's** spend on R&D.<sup>[1]</sup>
- In 2019 **UK government expenditure** on R&D as a share of GDP was **0.12%**, well below the **OECD** average of **0.24%**.

**Note:** <sup>[1]</sup>ONS (2022). Gross domestic expenditure on research and development, UK: 2020 (published on 22 November 2022).

The ONS has indicated that official GOVERD figures will be published by the end of 2023.

## Chart 2.10. Flows of research and development funding in the United Kingdom, 2020



**Note:** The chart is based on the ONS revised methodology to estimate research and development expenditure in the UK introduced in November 2022; government includes government, UK Research and Innovation and Higher Education Funding Councils.

**Source:** ONS (2022). UK gross domestic expenditure on research and development (R&D), 2020, published on 22 November 2022.

- In **2020** the business sector performed **71.2% (£44 billion)** of the total R&D in **the UK**, based on the **ONS** revised methodology to estimate R&D expenditure.
- In **the UK** non-business R&D is concentrated in the **higher education sector (22.5%)**, while **the UK government** performs only **5%** of total R&D.



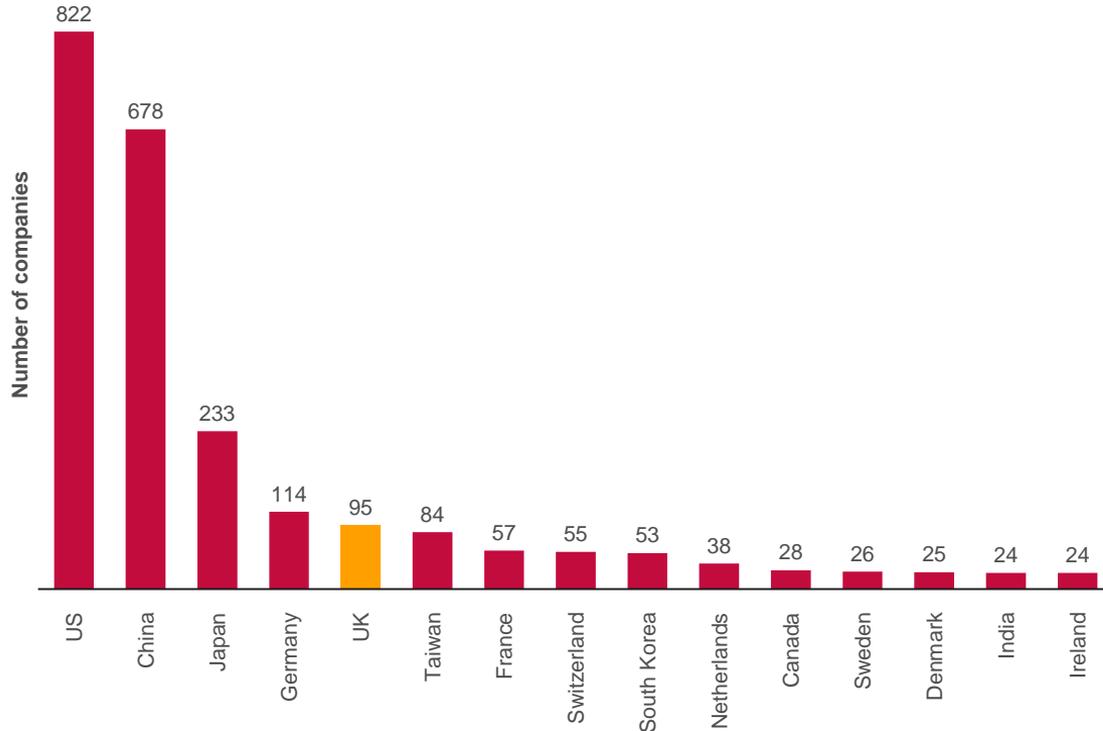
### Related insight

According to Sir Paul Nurse's *Independent Review of the UK's Research, Development and Innovation Organisational Landscape*, many factors explain the concentration of non-business R&D in the higher education in the UK, but a major reason is "past policy choices by government to channel R&D funding through universities, rather than a wider set of Government funded Research Performing Organisations".<sup>[1]</sup>

**Note:** <sup>[1]</sup>Nurse P. (2023, p. 37). [Independent Review of the Research, Development and Innovation Organisational Landscape](#) - Final Report and Recommendations.

## Chart 2.11. Top R&D-investing companies in the world

Number of companies, countries by headquarters, top 15 countries, 2021



Source: European Commission (2022). The 2022 EU Industrial R&D Investment Scoreboard.

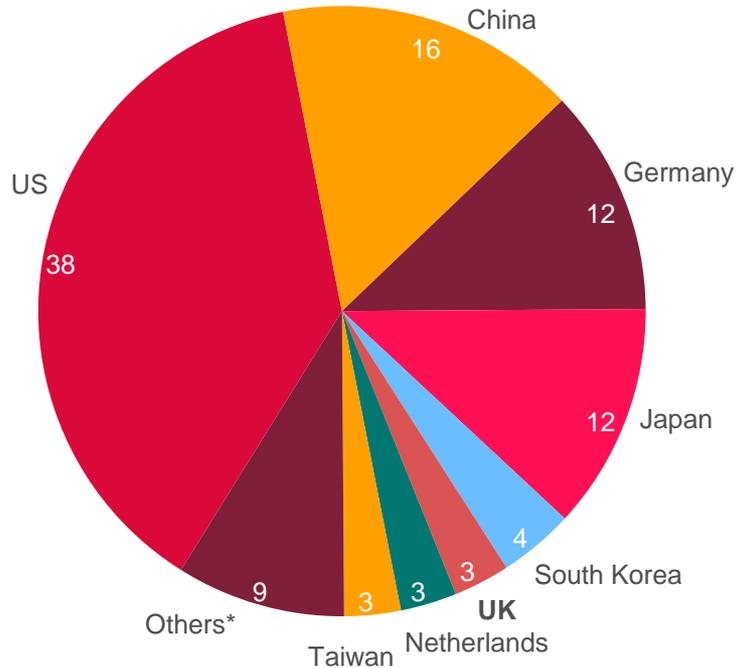
- A total of **95** of the world's **2,500** top R&D-investing companies are headquartered in **the UK**, behind **the US (822)**, **China (678)**, **Japan (233)** and **Germany (114)**. <sup>[1]</sup>
- Together, **the US and China's** headquartered firms account for **60%** of the world's top **2,500** R&D-investing companies.
- **Pharmaceuticals and biotechnology and software and computer service firms** account for **19.5%** and **18.3%**, respectively, of the total R&D expenditure conducted by the **2,500** top R&D-investing companies in 2021. <sup>[2]</sup>

**Note:** <sup>[1]</sup> The 2022 EU Industrial R&D Investment Scoreboard provides economic and financial information on the world's top 2,500 firms investing in R&D. These companies have headquarters in 41 countries and represented 86.3% of the world's expenditure in R&D funded by the business sector in 2021. See European Commission (2022). The 2022 EU Industrial R&D Investment Scoreboard.

<sup>[2]</sup> Industries are defined according to the Industry Classification Benchmark (ICB) FTSE International.

## Chart 2.12. Top 100 companies investing in R&D

Number of companies, countries by headquarters, 2021



- The **UK** hosted only **3** of the top **100** R&D-investing firms in the world in **2021**.<sup>[1]</sup>
- Together, **the US and China** hosted more than half of these firms.



### Related insight

In **2021** the top three R&D-investing companies in the world were based in **the US**, namely, **Alphabet** (the parent company of **Google**), **Meta** (formerly **Facebook**) and **Microsoft**, which that year invested **€27.9 billion**, **€1.8 billion** and **€1.6 billion**, respectively.

The top three R&D-investing firms headquartered in the UK in 2021 were **AstraZeneca** and **GSK** (pharmaceuticals and biotechnology) and **HSBC** (banking).

**Note:** <sup>[1]</sup>R&D-investing companies are the 2,500 firms that invested the largest sums in R&D worldwide in 2021, as defined in the *2022 EU Industrial R&D Investment Scoreboard*. Those companies have headquarters in 41 countries and represented 86.3% of the world's expenditure in R&D funded by the business sector in 2021.

**Note:** Others include: Switzerland and France (two companies each); Finland, Sweden, India, Ireland, Denmark (one company each).

**Source:** European Commission (2022). The *2022 EU Industrial R&D Investment Scoreboard*.

## Chart 2.13. Top origins of patent applications

Top 20 countries of origin\* of patent applications\*\*, 2021

Rank by total	Origin	Resident <sup>^</sup>	Abroad <sup>^</sup>	Share of abroad	Total
1	China	1,426,644	111,905	7.3%	1,538,549
2	US	262,244	247,609	48.6%	509,853
3	Japan	222,452	190,399	46.1%	412,851
4	Republic of Korea	186,245	81,272	30.4%	267,517
5	Germany	65,757	99,899	60.3%	165,656
6	France	24,036	42,051	63.6%	66,087
7	UK	17,215	36,393	67.9%	53,608
8	Switzerland	9,732	38,512	79.8%	48,244
9	India	26,267	16,866	39.1%	43,133
10	Italy	15,205	18,961	55.5%	34,166
11	Netherlands	8,648	24,122	73.6%	32,770
12	Sweden	6,721	21,080	75.8%	27,801
13	Canada	4,710	21,794	82.2%	26,504
14	Russian	20,001	5,880	22.7%	25,881
15	Israel	1,592	15,749	90.8%	17,341
16	Denmark	3,710	10,373	73.7%	14,083
17	Belgium	3,285	10,674	76.5%	13,959
18	Finland	3,665	9,157	71.4%	12,822
19	Australia	2,966	9,855	76.9%	12,821
20	Spain	3,258	7,617	70.0%	10,875

- In **2021 UK-based** applicants filed **53,608 patents** globally, behind **Germany (165,656 applications)** and **France (66,087 applications)** but more than **Switzerland, Italy, the Netherlands and Sweden.**
- The top five origins in **2021** were **China, the United States, Japan, the Republic of Korea and Germany.** These have been the top **five** origins for almost **20 years.**
- While **China** is the top origin of patent applications in the world, its share of applications filed abroad is much lower than other top origins, at **7.3%.**

### Note:

<sup>^</sup>Applications filed by applicants at a national or regional office (resident applications) or at a foreign office (applications abroad) are referred to as origin data. Here, patent statistics based on the origin of residence of the first named applicant are reported in order to complement the picture of patent activity worldwide.

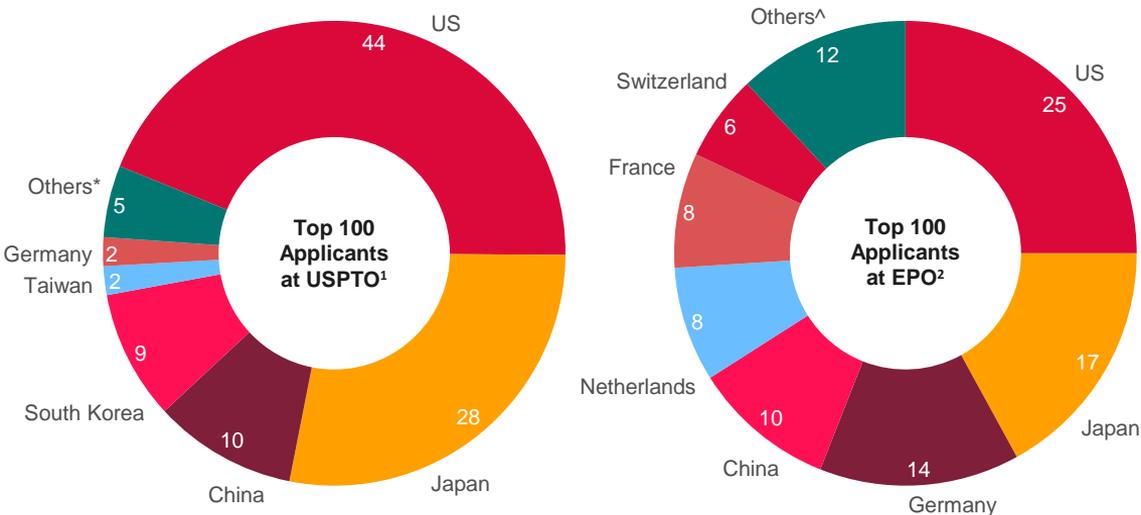
\*Origin: the country of residence (or nationality, in the absence of a valid residence) of the first-named applicant of an IP application. Country of origin is used to determine the origin of the IP application.

\*\*Applications filed at regional offices (e.g. European Patent Office (EPO)) are considered equivalent to multiple applications in the relevant member states. Hence, the data for patent applications in this table is based on equivalent, not absolute, counts. For example, because the UK is one of EPO's member states, the resident application data for the UK (17,215) is the sum of the number of patent applications filed with the UK's Intellectual Property Office by the UK resident patent applicants (11,592) and the number of patent applications filed with EPO by the UK resident patent applicants (5,623).

Source: World Intellectual Property Office (September 2022). *World Intellectual Property Indicators 2022.*

## Chart 2.14. Top 100 patent applicants at USPTO and EPO

Number of firms, country by headquarters, top patent applicants by the number of patents filed in 2021, United States Patent and Trademark Office (USPTO) and European Patent Office (EPO)



Others\*:  
Saudi Arabia, Ireland, Cayman Islands, Sweden, Finland (1 each)

Others^:  
South Korea, Sweden, Saudi Arabia (2 each)  
Finland, UK, Liechtenstein, Ireland, Belgium,  
India (1 each)

- In 2021 there were no UK-headquartered applicants among the top 100 applicants at the United States Patent and Trademark Office (USPTO); and only 1 among the top 100 applicants at the European Patent Office (EPO).

### Note: USPTO

- The ranking of top 100 applicants at USPTO in 2021 is based on the number of patent applications filed with USPTO in 2021 (first-named applicant principle).
- The applicants in this ranking are not consolidated.
- If a subsidiary company is located in a different country from its parent company, it is separately allocated to the countries where its headquarters are.
- The countries refer to the country of residence of the headquarters.

### EPO

- The ranking of top 100 consolidated applicants at EPO in 2021 (first-named applicant principle).
- The EPO ranking is based on European patent applications filed with EPO, which include direct European applications and international (PCT) applications that entered the European phase during the reporting period.
- Applications by identifiable subsidiaries, not necessarily located in the same country, are allocated to the consolidated applicants.
- The countries refer to the country of residence of the headquarters.

### Patent application in 2021

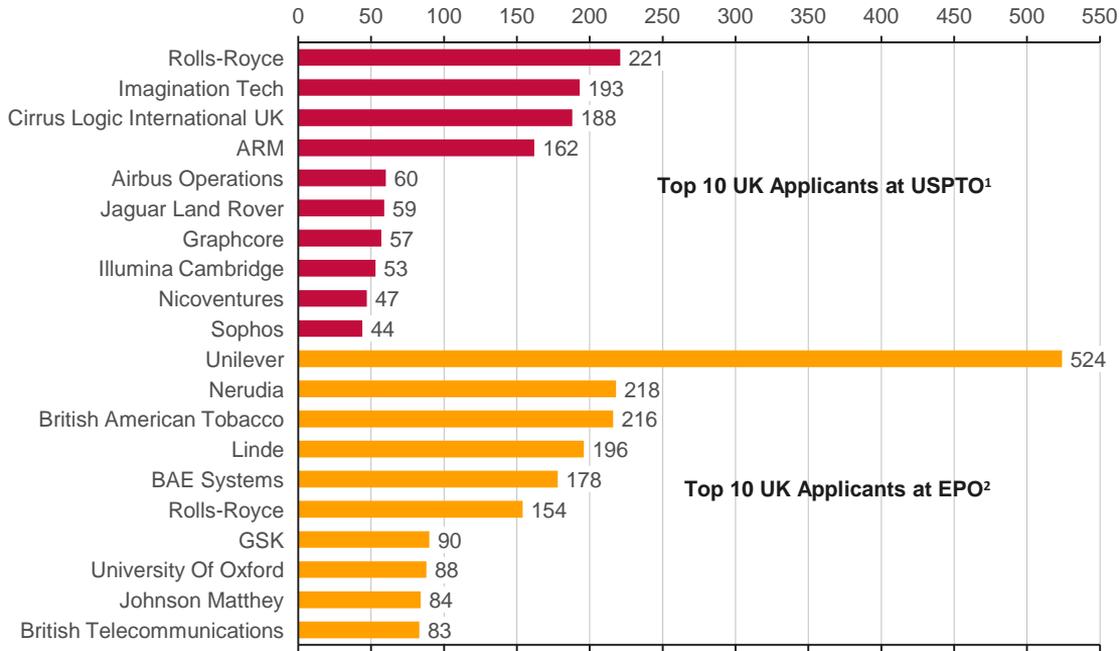
- There is an 18-month publication lag between the earliest filing date of a patent and its publication date. However, the patent can be published earlier upon request from the applicant.
- There might be some patents that were filed in 2021 but which have not been published by the cut-off date for data extraction.

Source: European Patent Office (cut-off date for data: 24 Jan 2022), *Top 100 applicants 2021*; the patent data for USPTO was retrieved from Lens.org on 22 February 2023.

## Chart 2.15. Top 10 UK patent applicants at USPTO and EPO

Firms with headquarters in the United Kingdom, top 10 applicants by the number of patents filed in 2021, United States Patent and Trademark Office (USPTO) and European Patent Office (EPO)

Number of patent applications



**Source:** European Patent Office (cut-off date for data: 1 February 2022), *Key data for selected countries United Kingdom 2021*. The patent data for USPTO was retrieved from Lens.org on 22 February 2023.

- Rolls-Royce (aerospace) was the UK-based company that filed the most patents with the **United States Patent and Trademark Office (USPTO)** in **2021**, followed by **Imagination Tech (Semiconductor)**, **Cirrus Logic Int. UK (Semiconductor)** and **ARM (semiconductors)**.
- Unilever (consumer goods)** was the UK-based company that submitted the most patent applications with the European Patent Office (EPO) in **2021**, way ahead of **Nerudia (tobacco)** and **British American Tobacco (tobacco)**.
- Rolls-Royce** was the only company to appear in both rankings, filing **67 more patents with USPTO** compared to **EPO**.
- The **University of Oxford** was the only research institute across both the USPTO and EPO rankings.

### Note: USPTO

- The ranking of top 100 applicants at USPTO in 2021 is based on the number of patent applications filed with USPTO in 2021 (first-named applicant principle).
- The applicants in this ranking are not consolidated.
- If a subsidiary company is located in a different country from its parent company, it is separately allocated to the countries where its headquarters are.
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- Applications by identifiable subsidiaries, not necessarily located in the same country, are allocated to the consolidated applicants.
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### Patent application in 2021

- There is an 18-month publication lag between the earliest filing date of a patent and its publication date. However, the patent can be published earlier upon request from the applicant.
- There might be some patents that were filed in 2021 but which have not been published by the cut-off date for data extraction.

# Explainer: The “new” ONS methodology to calculate R&D expenditure in the United Kingdom (1/2)

- In November 2022, the **Office for National Statistics (ONS)** introduced a major revision to the methodology used to estimate R&D performed by businesses and the higher education sector.
- The rationale behind ONS methodological revisions of business R&D relies on the need to take into account **R&D activities** conducted by small and medium enterprises (SMEs), underestimated under the methodology that was previously employed.
- Discrepancies were found between **ONS Business Enterprise Research and Development (BERD)** statistics and **HM Revenue and Customs (HMRC)** research and development (R&D) statistics, which are based on a different population of companies and use different methodologies.
- The revisions introduced align ONS methodology to methodologies used by other countries, particularly with respect to the sampling method employed. <sup>[1]</sup> While **HMRC R&D** statistics are based on administrative data provided by both large companies and SMEs claiming R&D tax relief, the population of **ONS BERD** statistics is composed of large companies (with more than 250 employees) and a random sample of SMEs. Therefore, under ONS BERD statistics, many SMEs conducting R&D activities risk being under-represented. <sup>[2]</sup>
- **The ONS** also introduced methodological improvements to better capture the R&D performed by the **higher education** sector. Methods previously employed focused on assessing the flow of funding into higher education for R&D to be performed, but they were unable to capture the R&D actually performed (and funded) within the sector. Using a new methodology that also relies on a new data source – the [Transparent Approach to Costing \(TRAC\)](#) – the ONS is now also able to account for R&D performed within **higher education** and funded within the sector using its own funding sources. <sup>[3]</sup>

<sup>[1]</sup> ONS (2022). Options for transformation of business enterprise research and development statistics (published on 22 November 2022).

<sup>[2]</sup> ONS (2022). Comparison of ONS business enterprise research and development statistics with HMRC research and development tax credit statistics (published on 29 September 2022).

<sup>[3]</sup> ONS (2022). Gross domestic expenditure on research and development, UK: 2020 (published on 22 November 2022).

# Explainer: The “new” ONS methodology to calculate R&D expenditure in the United Kingdom (2/2)

## Comparing UK GERD using ONS “old” and “new” methodology, 2019 (£ billion, current prices)

Sector performing the R&D	GERD using "old" methodology	GERD using "new" methodology	Difference	Difference on total (%)
<b>Government and UKRI (GOVERD)</b>	2.7	2.7	0.0	0.0%
<b>Business enterprise (BERD)</b>	26.0	42.2	16.2	76.7%
<b>Higher education (HERD)</b>	9.1	14.0	4.9	23.4%
<b>Private non-profit (PNPRD)</b>	0.84	0.82	-0.02	-0.1%
<b>TOTAL</b>	<b>38.6</b>	<b>59.7</b>	<b>21.1</b>	<b>100%</b>

**Source:** ONS (2022). UK gross domestic expenditure on research and development (R&D), 2020, published on 22 November 2022; ONS (2021). UK gross domestic expenditure on research and development (R&D), 2019 (published on 4 August 2021).

- According to the [OECD’s Frascati Manual](#) that sets up the guidelines to collect and report R&D data, the gross domestic expenditure on R&D (GERD) is the total in-house expenditure on R&D performed in the national territory in a given time period.
- GERD measures the total domestic R&D performed by the following sectors:
  - The business enterprise sector (BERD)
  - The government sector (GOVERD)
  - The higher education sector (HERD)
  - The private non-profit sector (PNPRD)

# **Theme 3: Industrial performance – focus on the aerospace and food and beverages manufacturing sectors**

UK INNOVATION REPORT 2023

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# The aerospace manufacturing sector

UK INNOVATION REPORT 2023

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# Theme 3a: Industrial performance – focus on the aerospace manufacturing sector

## Key policy questions addressed

- Are UK sectors becoming more or less competitive internationally?
- How are UK sectors performing in terms of productivity, value added and employment?
- Are UK sectors investing enough in R&D compared to their international competitors?

## Key UK aerospace manufacturing trends in the last decade

- **Value added for UK aerospace manufacturing experienced a fall between 2006 and 2015, followed by a partial recovery until 2021.** The UK ranked third among OECD member countries for aerospace manufacturing by value added in 2019, behind the US and France.
- **Value added for maintenance, repair and operations (MRO) has decreased by around two-thirds since 2010.** MRO value added had previously remained stable between 1990 and 2010.
- **A decrease of 14,000 employees was observed in 2020–21 for aerospace manufacturing.** Employee numbers had remained stable at around 90,000 employees between 2012 and 2020.
- **Labour productivity in UK aerospace manufacturing increased between 2012 and 2021.** Sector productivity is the third highest in the OECD, behind France and the US.
- **The UK has one of the highest aerospace trade surpluses among comparator countries.** The UK was the third largest net exporter of aerospace products in 2021, with a surplus of US\$14.7 billion.
- **UK business R&D expenditure grew steadily between 2010 and 2019.** The sector spent 37% more in 2019 than it did in 2010, compared to increases of 199% in Japan and 15% in Italy. The US and Germany had negative growth, while France remained stable.

## Drivers identified in literature review and sector expert consultations

### Value added and productivity

- **The aerospace market** is typically cyclical and sensitive to global crises, with the cycles closely linked to global economic performance.
- Long-term order and contract pipelines shape investment planning and add resilience to the sector.
- Demand from a handful of mostly foreign-owned OEMs has a significant effect on the whole UK aerospace supply chain, while investment decisions are often made abroad.
- Company restructuring and supply chain consolidation were responsible for the recent fall in the number of sector employees.
- Workforce know-how and closeness to leading R&D hubs anchors operations to the UK.
- Competitive challenges and opportunities driving policy and industrial strategies include the market shift towards single-aisle aircraft, competition from low-cost economies, domestic supply chain development needs, trade restrictions, geopolitical issues, and input cost pressure on margins.

### Trade

- **The UK's specialisation in engines and aircraft components** drives its high exports.

### R&D and innovation

- Sector competitiveness is underpinned by its advanced **R&D and innovation** capabilities.
- Government is a key enabler of sectoral R&D, innovation and competitiveness.
- Continuous investment in innovation will be needed to seize the opportunities arising from emerging market and technology trends such as the transition from fossil fuels to zero-carbon aircraft, the emergence of new aircraft segments, industrial digitalisation, and space tourism.

# Chart 3.1. Aerospace manufacturing – value added and employees

Top OECD countries by value added in 2019, aerospace manufacturing only, excluding maintenance, repair and operations (MRO)

Rank	Country	Value added <sup>^</sup>	Employees	Productivity <sup>[2]</sup> (value added per employee)
		Billions US\$, 2019	Thousand persons, 2019	Thousand US\$, 2019
1	United States	134.1	533.0	251.6
2	France	18.3	64.0	285.9
3	<b>United Kingdom<sup>[1]</sup></b>	<b>13</b>	<b>86.9</b>	<b>149.6</b>
4	Germany	12.6	86.0	146.5
5	Canada	8.0	60.8	131.7
6	Japan	6.9	56.0	123.2
7	Italy	4.7	42.8	109.8

**Note:** <sup>[1]</sup> United Kingdom employee data for 2018.

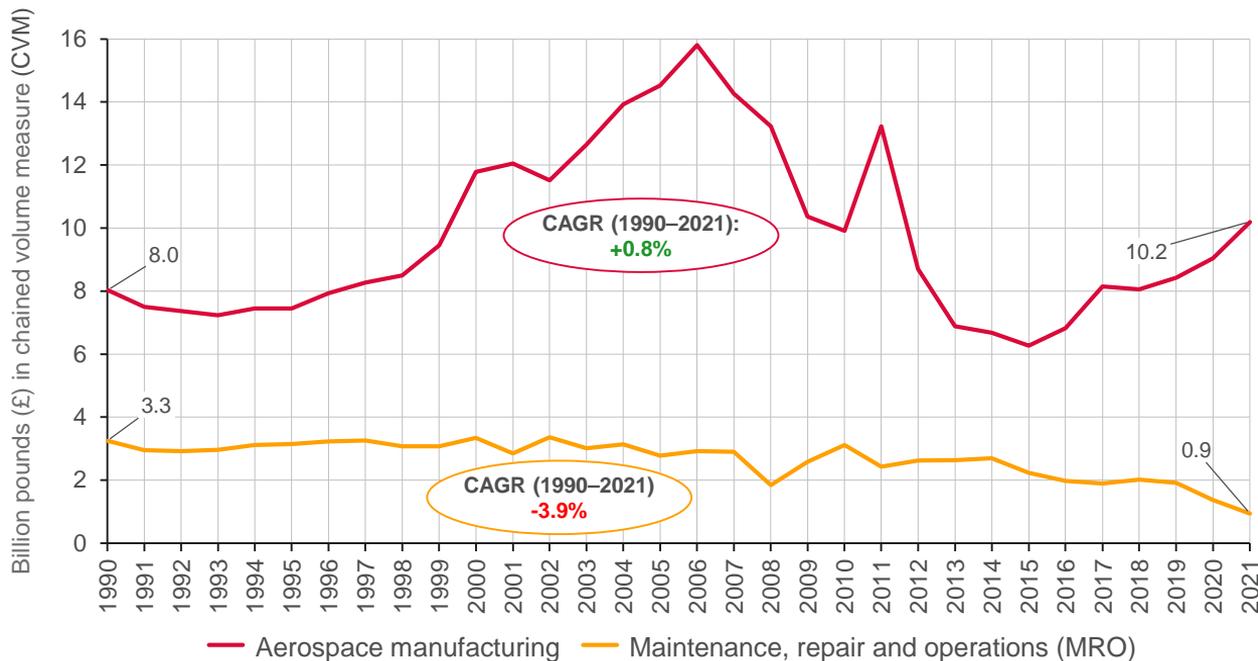
<sup>[2]</sup> OECD provides the value added for each country in its national currency; these were converted into USD by referring to annual exchange rates provided by OECD.

**Source:** OECD STAN, ISIC4, Code D303 – air and spacecraft and related machinery; OECD, MEI, exchange rates (USD monthly averages). Accessed February 2023.

- Based on **OECD** data, **the UK** ranked third among member countries for **aerospace manufacturing** by value added in **2019**. This is roughly **10** times lower than the value added reported by **the United States** at the top of the ranking.
- **France** takes second place in this ranking, with total value added of **US\$18.3 billion**, while **Germany** ranks just below **the UK** with a value added of **US\$12.6 billion**.
- **The UK** has the second-largest number of employees among top-performing countries, at **86,900** employees, below **the United States (533,000)** and above **Germany (86,000)** and **France (64,000)**.
- **France** reported the highest level of productivity, measured by value added per employee (**US\$285,900**), followed by the **US (US\$251,600)** and the **UK (US\$149,600)**.

## Chart 3.2. UK aerospace – value added

Aerospace manufacturing and maintenance, repair and operations (MRO) (£ billion in Chained Volume Measure – CVM)

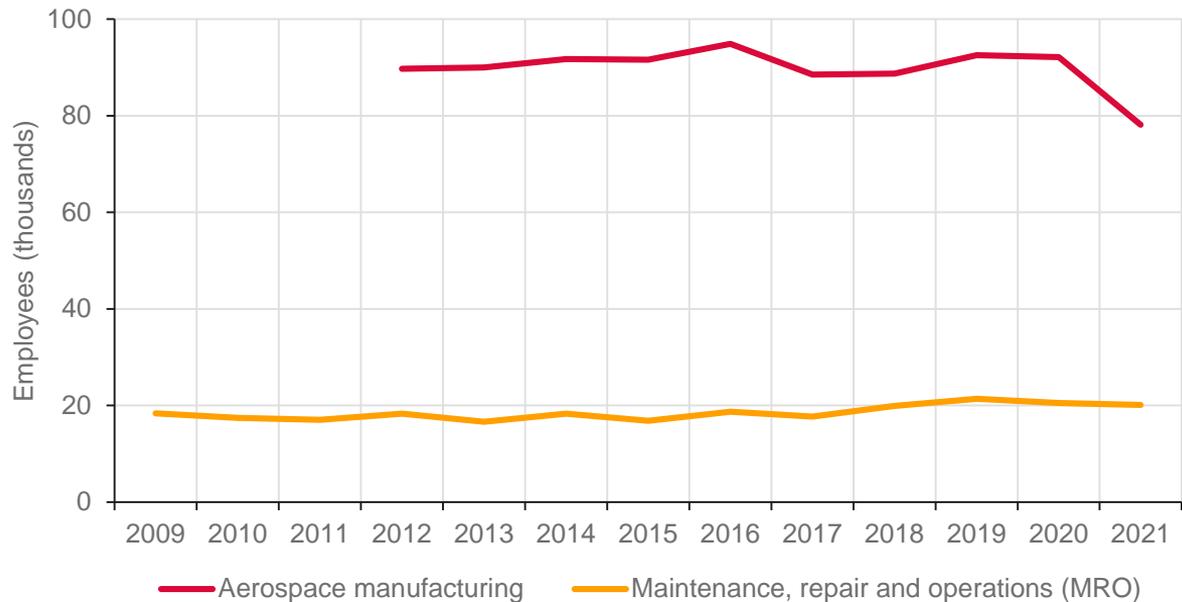


**Source:** ONS, *GDP output approach – low-level aggregates* (updated version: 22 December 2022); aerospace manufacturing (SIC 2007 Code 3030 for the manufacture of air and spacecraft and related machinery), MRO (SIC 2007 Code 3316 for the repair and maintenance of aircraft and spacecraft).

- According to **ONS data**, value added for **UK aerospace manufacturing** experienced a fall between 2006 and 2015, followed by a partial recovery between 2015 and 2021.
- Value added for **maintenance, repair and operations (MRO)** remained stable between 1990 and 2010, despite a short-term decrease during the 2008 financial crisis. **MRO value added** decreased by around two-thirds after 2010, reaching £0.9 billion in 2021, compared to £3.3 billion in 1990.
- As suggested by consulted stakeholders, the demand for air travel drives the demand for aircraft, and this can easily be disrupted by external events.
- For example, the demand for aircraft fell as a result of the 2001 global economic slowdown, further affected by events such as the **conflict in the Middle East**, the **SARS crisis in Asia** and the **9/11 terrorist attacks** [[House of Commons, 2005](#)].
- The 2008 financial crisis generated a lower impact in **UK aerospace manufacturing**, potentially due to a combination of government support and historically large order books from the larger manufacturers [[House of Commons, 2017](#)].
- Data from civil aircraft manufacturers shows that both **Boeing** and **Airbus** had fewer aircraft deliveries during the COVID-19 pandemic, although this trend started to recover in 2021 [[JADC, 2022](#)].

## Chart 3.3. UK aerospace – employees

Aerospace manufacturing and maintenance, repair and operations (MRO)<sup>[1]</sup>



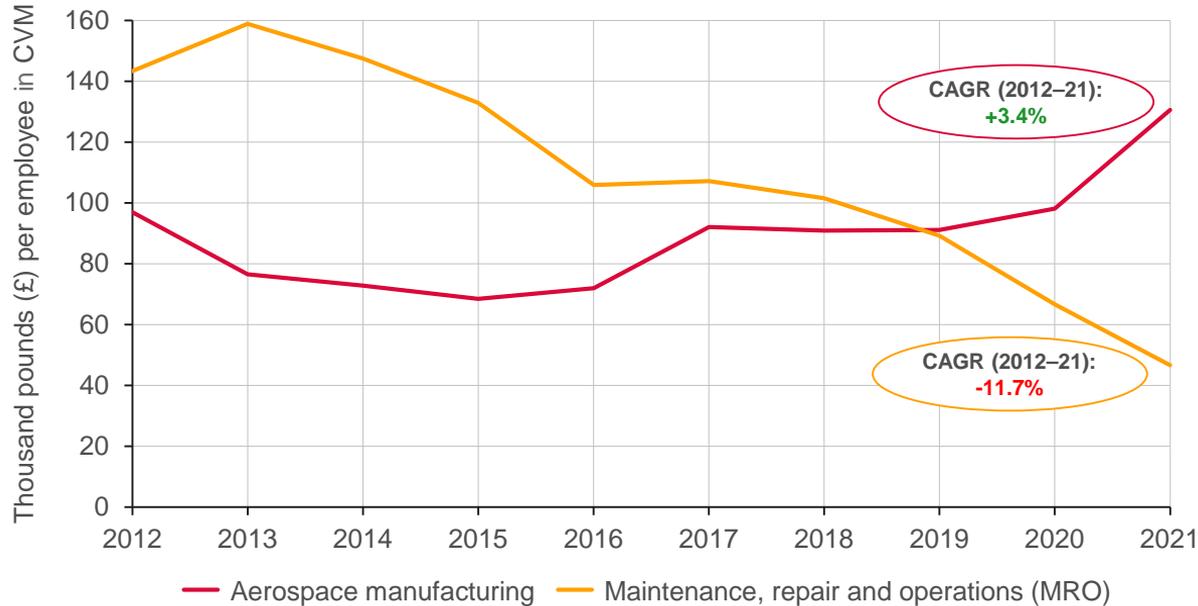
Note: <sup>[1]</sup> Data for aerospace manufacturing is at UK level; data for MRO is at GB level.

Source: ONS, *Business Register and Employment Survey (BRES) in thousands*; aerospace manufacturing (SIC 2007 Code 3030 for the manufacture of air and spacecraft and related machinery), MRO (SIC 2007 Code 3316 for the repair and maintenance of aircraft and spacecraft). Accessed February 2023.

- The number of employees in the **UK's aerospace manufacturing** sector remained stable at around 90,000 employees between 2012 and 2020.
- The number of employees in **maintenance, repair and operations (MRO)** saw little change between 2009 and 2021, remaining just below 20,000 employees until 2019.
- A decrease of 14,000 employees was observed in 2020–21 for **aerospace manufacturing**, attributed by the consulted stakeholders to redundancies in OEMs such as Airbus and Rolls-Royce, among others, due to company restructuring associated with lower production levels during the COVID-19 pandemic in 2020–21 [[BusinessLive, 2021](#); [BBC, 2020](#)].
- Despite OEMs cutting jobs in response to external events, the impact on direct employment is potentially limited, as firms aim to retain their skills base and manufacturing capacity. For example, **Airbus**' 2021 revenue was 30% below that realised in 2019, but its workforce was only 15% smaller [[Airbus, 2022](#)].

## Chart 3.4. UK aerospace – productivity

Aerospace manufacturing and maintenance, repair and operations (MRO), value added (VA) per employee (£ thousand in Chained Volume Measure – CVM)



- Based on the value added and number of employee trends observed in Charts 3.2 and 3.3, the following productivity trends can be observed (measured in value added per employee):
  - Productivity in **maintenance, repair and operations (MRO)** activities in the UK decreased between 2012 and 2021, presenting a compound annual growth rate (CAGR) of -11.7% during this time period.
  - In contrast, productivity in **aerospace manufacturing** increased between 2012 and 2021, with a 3.4% CAGR, from a lower baseline in 2012 compared to **MRO**.

Source: ONS, *GDP output approach – low-level aggregates* (updated version: 22 December 2022), ONS, *Business Register and Employment Survey (BRES)*; Aerospace Manufacturing (SIC 2007 Code 3030 for the manufacture of air and spacecraft and related machinery), MRO (SIC 2007 Code 3316 for the repair and maintenance of aircraft and spacecraft).

## Chart 3.5. Aerospace manufacturing – trade balance

Global ranking by trade balance in aerospace manufacturing (excluding MRO)

2011		
Rank	Country	US\$ billion
1	USA	53.8
2	France	23.9
3	Germany	11.1
4	<b>United Kingdom</b>	<b>10.7</b>
5	Canada	4.1
6	Italy	3.0
7	Spain	2.4
8	Israel	1.3
9	Ukraine	0.7
10	Russian Federation	0.6
11	Mexico	0.5
12	Netherlands	0.5
13	India	0.4
14	Poland	0.2
15	Belgium	0.2

UK exports		
2011 (US\$ billion)	2021 (US\$ billion)	CAGR (2011–21)
32.4	34.8	0.7%

2021		
Rank	Country	US\$ billion
1	USA	48.8
2	France	22.9
3	<b>United Kingdom</b>	<b>14.7</b>
4	Germany	9.4
5	Canada	4.4
6	Italy	2.6
7	Russian Federation	1.9
8	Israel	1.7
9	Spain	1.5
10	Poland	1.2
11	Mexico	0.8
12	India	0.5
13	Austria	0.5
14	Finland	0.4
15	Czechia	0.2

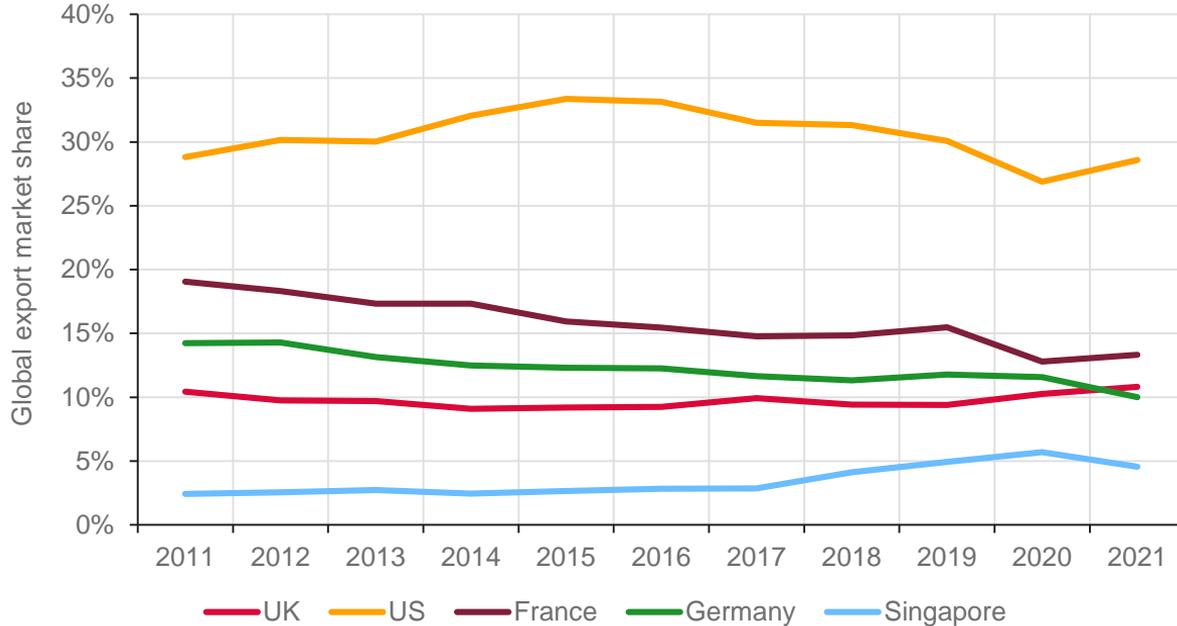
UK imports		
2011 (US\$ billion)	2021 (US\$ billion)	CAGR (2011–21)
21.7	20.1	-0.8%

- **The UK** maintained its trade competitiveness in **aerospace products** from the perspective of trade balance over the 2011–21 period.
- **The UK** moved up in the ranking as a net exporter of **aerospace products**, from fourth place in 2011, with a surplus of US\$10.7 billion, to third place in 2021, with a surplus of US\$14.7 billion.
- The top five net exporters coincide with the top five manufacturers presented in Chart 3.1.
- The improvement of **the UK's** position in the trade balance ranking is driven by a slight increase in exports (US\$2.4 billion) and a small decrease in imports (US\$-1.6 billion) between 2011 and 2021.
- The UK's specialisation in **engines and aircraft parts** is reflected in exports, accounting for 79% of all **UK aerospace** overseas sales in 2016 (with 35% of those parts being wings, fuselage, doors, control surfaces, landing gear and fuel tanks, 23% being turbojet engines and 20% engine parts) [[Make UK, 2019](#)].

**Source:** UN Comtrade (accessed in December 2022), HS 2017. Aircraft, spacecraft and parts thereof (Code 88); aircraft engines and parts thereof (Code 840710, 840910, 841111, 841112, 841121, 841122, 841191, 841210); aircraft seats and parts thereof (Code 940110).

## Chart 3.6. Aerospace manufacturing – global export market share

Top countries by export market share in 2021, excluding MRO (worldwide share = 100%)



- **The US** had the largest **aerospace products** global export market share between 2011 and 2021, with a total share of 28.6% in the last recorded year.
- Although **France** maintained its second place during the same time period, it experienced a fall from 19% in 2011 to 13.3% in 2021.
- **The UK** surpassed **Germany** to occupy third place in this ranking in 2021, with a 10.8% export market share, while **Germany's** share diminished from 14.2% in 2011 to 10% in 2021.
- **Singapore's** export market share grew from 2.4% in 2011 to 4.6% in 2021, occupying fifth position in this ranking. Breaking down the **aerospace product** categories exported by **Singapore**, the value of aircraft engines was US\$10.5 billion in 2021, accounting for 71.4% of the total value of its aerospace exports that year.

**Source:** UN Comtrade (accessed in December 2022), HS 2017. Aircraft, spacecraft and parts thereof (Code 88); aircraft engines and parts thereof (Code 840710, 840910, 841111, 841112, 841121, 841122, 841191, 841210); aircraft seats and parts thereof (Code 940110).

## Chart 3.7. UK aerospace – trade balance

UK aerospace manufacturing, £ billion in CVM (excluding MRO)

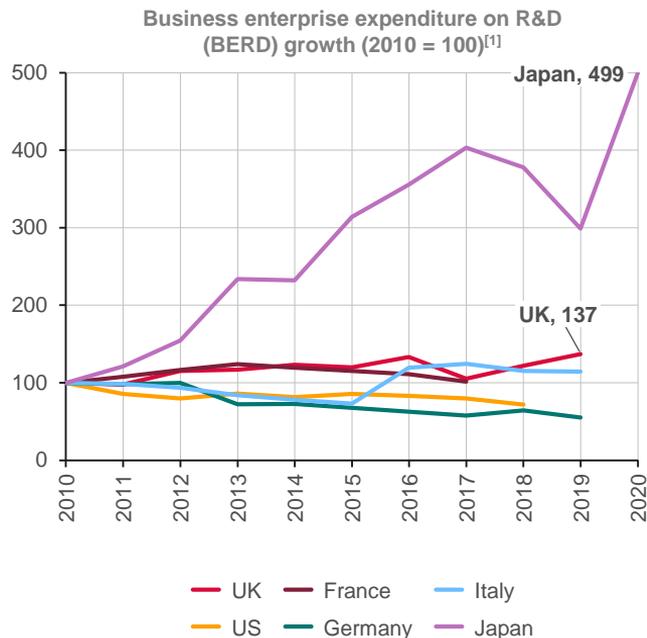
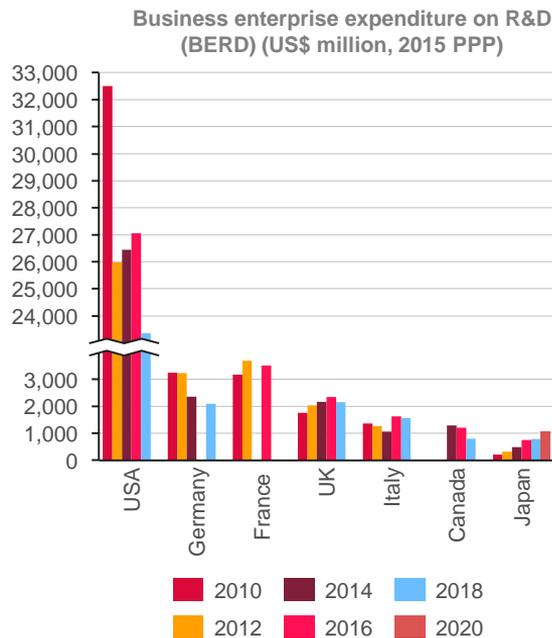


- **The UK** recorded positive trade balances in **aerospace products** between 2005 and 2021.
- Despite two low points in 2010 and 2016, **the UK** recorded a more positive trade balance in **aerospace products** in 2021 than in 2005.
- The outbreak of **COVID-19** hindered the positive trend in trade balance, which was driven by the reduction of imports and the growth of exports.
- Exports peaked in 2019, whereas the highest imports were recorded in 2016.
- The value of **aerospace exports** in 2021 (£25.46 billion) was lower than a decade before, whereas the value of **aerospace imports** in 2021 (£15.93 billion) was only £0.76 billion higher than a decade before.

Source: ONS, *UK trade in goods by classification of product by activity time series* (updated version: 15 December 2022); aerospace manufacturing (SIC 2007 Code 3030 for the manufacture of air and spacecraft and related machinery).

## Chart 3.8. Aerospace – business spending on R&D (a)

Business enterprise expenditure on R&D (BERD) in air and spacecraft and related machinery, top OECD countries

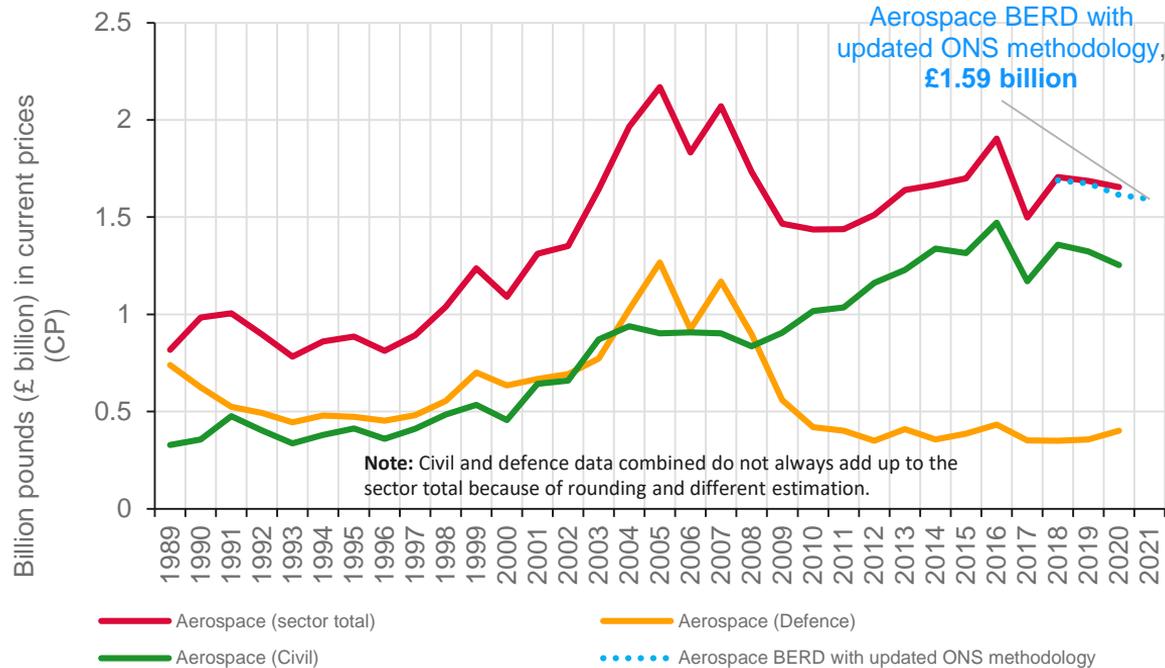


- As suggested by the consulted stakeholders, **UK aerospace** is a high-value sector driven by innovation. The ability to innovate has ensured the international competitiveness of the sector by staying at the forefront of technological development.
- In absolute terms, business enterprise R&D expenditure in **UK aerospace** was the third highest in the **OECD** ranking in 2018, behind **the US** and **France** but ahead of **Germany**, **Italy**, **Canada** and **Japan**.
- The US** maintains a dominant position with **aerospace business R&D** expenditure in a different order of magnitude than comparator countries.
- Using 2010 as the reference year, **the UK** had the second-largest growth in BERD among the examined countries in 2019 (37%). **Japan** had the largest BERD expansion in 2019 (199%), while **Italy** had the third-largest growth (14%). In contrast, **the US and Germany** experienced reductions in **business R&D expenditure** between 2010 and 2018–19, while **France** had near-zero growth in 2017 after a few years of positive BERD expansion.

Note: <sup>[1]</sup>Data for Canada starts in 2014 and has been excluded from the BERD growth chart on the right, which takes 2010 as the reference year.  
Source: OECD Research and Development Statistics, ISIC Rev. 4, Code D303: air and spacecraft and related machinery. Accessed in March 2023.

## Chart 3.9. Aerospace – business spending on R&D (b)

UK business enterprise expenditure on R&D (BERD) by product group classification<sup>[1]</sup>  
(£ billion in current prices)



- ONS sectoral BERD data by product group classification shows that there was an overall reduction in **UK aerospace** BERD between 2005 and 2010, mostly driven by a fall in **defence** BERD.
- BERD in **defence aerospace** diminished from £1.3 billion in 2005 to £0.4 billion in 2010, and has remained roughly stable after that.
- In contrast, BERD in **civil aerospace** has shown a positive trend since 2000, with the **overall aerospace sector** BERD trend (in red) mirroring the **civil aerospace** trend (in green) since 2011.
- ONS sectoral BERD data estimated with an updated methodology for 2018–21 shows a similar trend (dotted blue line) to data calculated using the previous methodology. The overall **aerospace sector** BERD was £1.59 billion in 2021.

Source: ONS, total intramural R&D – aerospace, total intramural R&D – civil aerospace, total intramural R&D – defence aerospace, business enterprise research and development, UK (designated as national statistics).

Note: <sup>[1]</sup> Developed by ONS, the term "product group" refers to business R&D expenditure allocated to the product group that best describes the subject type of R&D activities carried out by firms, rather than being based on the economic activities SIC classification.

# Drivers behind the trends in the aerospace manufacturing sector

Insights from the literature review and consultations with sector experts

# What is driving value added, productivity and trade trends in aerospace manufacturing? (1)

## Key trend identified

- Value added for UK aerospace manufacturing experienced a fall between 2006 and 2015, followed by a partial recovery until 2021.
- A decrease of 14,000 employees was observed in 2020–21 for aerospace manufacturing.
- While productivity in aerospace manufacturing has increased slightly since 2012, productivity in MRO has deteriorated significantly.
- The UK has one of the highest aerospace trade surpluses among comparator countries.

## Potential drivers identified from the literature review and consultations with sector experts (see Appendix 3.1 for details)

### **The aerospace market is typically cyclical and sensitive to global crises, with the cycles closely linked to global economic performance**

- As suggested by the consulted stakeholders, the demand for air travel drives the demand for aircraft, and this can easily be disrupted by external events.
- For example, the demand for aircraft fell as a result of the 2001 global economic slowdown, further affected by events such as the **conflict in the Middle East**, the **SARS crisis in Asia** and the **9/11 terrorist attacks**. Together, these events led to a slowdown in passenger air travel and a decline in UK aerospace output [[House of Commons, 2005](#)].
- The 2008 financial crisis generated a lower impact in **UK aerospace manufacturing**, potentially due to a combination of government support and historically large order books from the larger manufacturers [[House of Commons, 2017](#)].
- Data from civil aircraft manufacturers shows that both Boeing and Airbus had fewer aircraft deliveries during the COVID-19 pandemic, although this trend started to recover in 2021 [[JADC, 2022](#)]. In the case of Boeing, aircraft deliveries fell substantially in 2018 and 2019, following the suspension of deliveries of the 737MAX as the result of a series of safety concerns.
- The **defence aerospace market** is typically less cyclical than civil aerospace, with performance more closely linked to a country's defence budget than its economy [[House of Commons, 2005](#)].

### **Long-term order and contract pipelines shape investment planning and add resilience to the sector**

- A key point expressed by the consulted stakeholders, who differentiate between aerospace and other manufacturing sectors, is the clear visibility of the long-term order pipeline. In this regard, the backlog for global jet production increased by 645 to 14,060 between 2020 and 2021 [[JADC, 2022](#)].
- New aircraft orders commit original equipment manufacturers (OEMs) and their key suppliers to long-term contracts, providing companies across the supply chain with the certainty to invest and innovate in the long term [[Make UK, 2019](#)]. Timeframes for aircraft development and production are long as a result of the complexity and safety requirements of modern commercial aircraft, with only a few aircraft development programmes running for decades within OEMs [[House of Commons, 2017](#)].

## What is driving value added, productivity and trade trends in aerospace manufacturing? (2)

### Key trend identified

- Value added for UK aerospace manufacturing experienced a fall between 2006 and 2015, followed by a partial recovery until 2021.
- A decrease of 14,000 employees was observed in 2020–21 for aerospace manufacturing.
- While productivity in aerospace manufacturing has increased slightly since 2012, productivity in MRO has deteriorated significantly.
- The UK has one of the highest aerospace trade surpluses among comparator countries.

### Potential drivers identified from the literature review and consultations with sector experts (see Appendix 3.1 for details)

#### **Demand from a handful of mostly foreign-owned OEMs has a significant effect on the whole UK aerospace supply chain, while investment decisions are often made abroad**

- As identified by the interviewees, the **UK aerospace sector** is dominated by clusters of companies that produce complex aircraft components for original equipment manufacturers (OEMs), both in the UK and overseas.
- A 2017 report by the House of Commons estimated that there were approximately 2,500 aerospace companies in the UK, 2,300 of which had fewer than 10 employees [[House of Commons, 2017](#)].
- Overall, **UK aerospace manufacturers** feed into Airbus, Boeing, Bombardier, GKN, BAE Systems and Leonardo for aircraft programmes, and Rolls-Royce for engines [[Make UK, 2019](#)].
- A key OEM for **UK aerospace** is Airbus, with an estimated contribution to the UK economy of £5.6 billion in 2021, working with more than 2,000 UK suppliers and supporting over 86,000 jobs across the supply chain [[Airbus, 2022](#)].
- Similarly, Boeing spent £1.4 billion with UK suppliers in 2014, supporting 12,700 jobs in the country, in addition to more than 2,000 direct jobs in early 2016 [[Boeing, 2017](#)].
- The consultees indicated that, given that many of the aerospace manufacturing firms based in the **UK** are foreign-owned, investment decisions are typically made in headquarters abroad (usually in **France, Germany or the US**).

#### **UK aerospace exports are driven by the sector's specialisation in engines and aircraft components such as wings**

- As highlighted by the consulted stakeholders, the sector is highly export-intensive, with 59% of production exported (by value), the highest of any manufacturing sector [[Make UK, 2019](#)].
- The UK's specialisation in **engines and parts of aircraft** is reflected in exports, accounting for 79% of all **UK aerospace** overseas sales in 2016 (with 35% of those parts being wings, fuselage, doors, control surfaces, landing gear and fuel tanks, 23% being turbojet engines and 20% engine parts) [[Make UK, 2019](#)].
- In contrast, 47% of the total supply into production was imported in 2014, highlighting the need for seamless trade in the sector [[Make UK, 2019](#)].

# What is driving value added, productivity and trade trends in aerospace manufacturing? (3)

## Key trend identified

- Value added for UK aerospace manufacturing experienced a fall between 2006 and 2015, followed by a partial recovery until 2021.
- A decrease of 14,000 employees was observed in 2020–21 for aerospace manufacturing.
- While productivity in aerospace manufacturing has increased slightly since 2012, productivity in MRO has deteriorated significantly.
- The UK has one of the highest aerospace trade surpluses among comparator countries.

## Potential drivers identified from the literature review and consultations with sector experts (see Appendix 3.1 for details)

### The recent fall in aerospace manufacturing employees is mostly related to COVID-19 company restructuring and supply chain consolidation

- The consulted stakeholders highlighted that companies such as Rolls-Royce and Airbus underwent restructuring associated with lower production levels during the COVID-19 pandemic in 2020–21, reportedly cutting 8,500 and 1,700 jobs, respectively [[BusinessLive, 2021](#); [BBC, 2020](#)].
- OEMs seeking production efficiencies and cost reductions have started to outsource the development of entire sub-systems, as opposed to single components, in order to reduce the number of suppliers [[Make UK, 2019](#)]. Top-tier suppliers have consolidated the industry in recent years by offering manufacturing services that go from system to component level, largely eliminating the need for OEMs to seek out hundreds of suppliers to complete a new aircraft design [[Partstat, 2018](#)].

### Highly specialised workforce know-how and closeness to world-leading R&D hubs anchor operations to the UK

- The consulted stakeholders suggested that, although there are some benefits to overseas production, high costs and the risk of losing accumulated know-how could act as a disincentive for moving operations abroad. The high levels of technological skill involved in aerospace manufacturing mean that companies often benefit from keeping their manufacturing sites located close to where they do R&D, helping to anchor production in the UK in the near future [[House of Commons, 2017](#)].
- Despite OEMs cutting jobs in response to external events, the impact on direct employment is potentially limited, as firms aim to retain their skills base and manufacturing capacity. For example, Airbus' 2021 revenue was 30% below that realised in 2019, but its workforce was only 15% smaller [[Airbus, 2022](#)].

### The UK MRO industry is expected to see growth in the coming years, despite pressures from European competitors

- The UK has the largest MRO market share in Europe by revenue, above France, Germany, Russia and the rest of Europe, with UK-based Rolls-Royce and BAE Systems among the top five MRO market players in Europe [[Mordor Intelligence, 2023](#)].
- The fleet age of major airlines such as Jet2, British Airways, Eastern Airways and Loganair (13.5 years, 13.6 years, 18 years and 23.4 years, respectively) is expected to generate demand for new aircraft-maintenance contracts [[Mordor Intelligence, 2023](#)].
- The key challenge for the UK MRO sector is to prepare and position attractively for the more technology-intensive aircraft, for example: increased use of composites; increased use of electrical power; introduction of health monitoring, diagnostic and prognostic technologies; and enhanced cabin environment and interiors [[BIS, 2016](#)].

# What is driving value added, productivity and trade trends in aerospace manufacturing? (4)

## Key trend identified

- Value added for UK aerospace manufacturing experienced a fall between 2006 and 2015, followed by a partial recovery until 2021.
- A decrease of 14,000 employees was observed in 2020–21 for aerospace manufacturing.
- While productivity in aerospace manufacturing has increased slightly since 2012, productivity in MRO has deteriorated significantly.
- The UK has one of the highest aerospace trade surpluses among comparator countries.

## Potential drivers identified from the literature review and consultations with sector experts (see Appendix 3.1 for details)

### A number of challenges/opportunities are driving policy and industrial strategies to ensure future aerospace sector growth

#### Market shift towards single-aisle aircraft

- The consulted stakeholders recognised the need for UK suppliers to respond to a market shift towards narrow-bodied, single-aisle aircraft. Single-aisle orders placed in the first 10 months of 2022 were the highest year-to-date figure for single aisles since 2014, with wide-body aircraft orders behind the pre-COVID level [ADS, 2022; Make UK, 2019].

#### Competition from emerging markets and highly productive advanced economies

- A 2016 government study reported that, based on data from prime contractors and major Tier 1 suppliers, the procurement spend in the UK grew by 1.4% from 2013 to 2014, compared to 5.2% for the rest of the world, signalling an increasing challenge from emergent competitors in lower-cost and developing economies [BIS, 2016].
- Examples of emerging competitors in the civil aerospace market include Chinese, Japanese and Russian efforts to develop regional jet programmes [House of Commons, 2005].

#### Domestic supply chain development

- To compete with low-cost emerging markets and highly productive advanced economies, continuous improvements and investments in quality and productivity are needed in order to benefit from new technologically evolved aircraft programmes [BIS, 2016].
- Although the UK is known for its competence in areas such as engines and aerostructures, areas of opportunity exist in the development of capabilities and skills for other supply chain segments [Make UK, 2019].

#### Trade restrictions, geopolitical issues and input cost pressure on margins

- As indicated by the consulted stakeholders, rising energy prices and the depreciation in sterling is putting significant upward pressure on manufacturers' input costs and could put pressure on smaller companies that are less well positioned to absorb these increases.
- Geopolitical issues such as the Russia–Ukraine war could impact the purchase of raw materials and the sales of commercial airplanes. For example, the consulted stakeholders stated that the war in Ukraine has disrupted the supply chain of raw materials such as titanium.
- Competitors could try to encourage governments to find loopholes to raise the cost of production for UK businesses, for example, by removing EU exemptions for raw materials to raise the cost of production in the UK [Make UK, 2019].

# What is driving business R&D expenditure trends in aerospace manufacturing? (1)

Key trend identified

- UK business expenditure on aerospace R&D grew on average between 1990 and 2020

Potential drivers identified from the literature review and consultations with sector experts (see Appendix 3.1 for details)

## The competitiveness of the UK aerospace manufacturing sector is underpinned by its advanced R&D and innovation capabilities

- As suggested by the consulted stakeholders and other sources, UK aerospace is a high-value sector driven by innovation. The ability to innovate has ensured the international competitiveness of the sector by staying at the forefront of technological development.
- Moving forward, the UK's future competitiveness will depend on the sector's ability to maintain a technological advantage in areas such as engines, wings and advanced systems. In addition, the UK is one of the few nations with the capabilities to design and build advanced helicopters [[House of Commons, 2017](#)].

## The government has played a key role in supporting sectoral R&D, innovation and competitiveness

- Various government initiatives have been fundamental to maintaining competitiveness in the sector, including (non comprehensive list):
  - The UK Aerospace Research and Technology (UKART) Programme, also known as the ATI Programme, founded in 2012–13 with a £3.9 billion joint government and industry investment to 2026 [[ATI, 2021](#)].
  - The Aerospace Sector Deal (part of Industrial Strategy) focused on three grand challenges in the civil aerospace sector in December 2018 (i.e. artificial intelligence and data, clean growth and the future of mobility). The Industrial Strategy Challenge Fund committed a £125 million investment, backed by £175 million from industry, to support the Future Flight Challenge, aimed at exploring aircraft electrification and autonomy [[BEIS, 2020](#)].
  - The Aerospace Growth Partnership (AGP) is a strategic partnership between the UK government, industry and other key stakeholders to tackle the barriers to growth through working groups focused on four main themes: UK aerospace strategy; manufacturing and supply chain competitiveness; sector skills; and engagement and communications. The AGP also supports the Sharing in Growth Programme, which has helped SMEs to secure contracts worth over £1 billion [[Make UK, 2019](#)].

# What is driving business R&D expenditure trends in aerospace manufacturing? (2)

## Key trend identified

- UK business expenditure on aerospace R&D grew on average between 1990 and 2020

Potential drivers identified from the literature review and consultations with sector experts (see Appendix 3.1 for details)

### Continuous government support is needed to seize the opportunities from emerging technology trends

- A key message from the expert consultations is that government support programmes are critical for manufacturers to increase their competitiveness, and continuous support is needed to capture the opportunities related to emerging technologies and net-zero targets.
- The consulted stakeholders suggested that, despite its strong international position, the sector could reinforce training/education for new skills requirements (e.g. data security, composite manufacturing and telecommunications) arising from the introduction of new technologies.
- Similarly, the interviewees suggested that government support and funding for late-stage product development and commercialisation could be boosted, although support for early-stage technological innovation is strong with the help of AGP and ATI.

### Emerging market and technology trends have shaped the direction of innovation efforts in recent years

- **The transition from fossil fuels to zero-carbon aircraft:** The UK aerospace industry can seize nearly 18% of the global market for more energy-efficient commercial aircraft, potentially worth £4.3 trillion in 2050 [ATI, 2022b]. Sustainable aviation fuels (SAFs), electric batteries and hydrogen are three alternatives to fossil fuels that are being explored by the aviation industry to achieve its decarbonisation targets. Technologies relating to highly-efficient and lightweight aircraft and near-net-shape manufacturing are also key enablers of this target [ATI, 2022].
- **Emergence of new aircraft segments:** Drones for cargo or surveillance purposes, electric vertical take-off and landing (eVTOL) aircraft providing short journeys for fewer than 10 passengers, and regional air mobility providing short/medium trips for 10+ passengers are key emerging segments [ATI, 2022]. The ATI predicts that over the long term the **conventional aircraft market** will continue to retain the largest market share. However, this share is expected to gradually decline in volume and value with the electric aircraft, drone, eVTOL and regional air-mobility market growing. However, the consulted stakeholders suggested that the manufacturing of drones might not necessarily be conducted in the UK, as it is seen as a commoditised process.
- **Digitalisation of manufacturing:** Digitalisation could benefit the aerospace sector by supporting new product design and development and supply chain integration for **manufacturing and MRO**. For example, virtual certification can reduce the cost of new product development, and virtual reality (VR) technology helps engineers to verify the feasibility of the maintenance related to new product designs [Airbus, 2019].
- **Space tourism:** Despite being in its infancy, the **commercial spaceflight market** is expected to grow to £25 billion over the next 20 years. In 2017 the UK government announced that grants worth up to £10 million were being made available to help develop commercial launch capability for spaceflight to seize this opportunity [Make UK, 2019].

# The food and beverages manufacturing sector

UK INNOVATION REPORT

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# Theme 3b: Industrial performance – focus on the food and beverages manufacturing sector

## Key policy questions addressed

- Are UK sectors becoming more or less competitive internationally?
- How are UK sectors performing in terms of productivity, value added and employment?
- Are UK sectors investing enough in R&D compared to their international competitors?

## Key UK food and beverages manufacturing trends in the last decade

- **The value added of the UK food and beverages sector has increased during the last decade, while its productivity has remained roughly stable.** The UK ranked sixth among OECD member countries for food and beverages manufacturing in 2019 by value added.
- **The UK has one of the largest food trade deficits among comparator countries, while it remains a leading exporter of beverages.** The UK occupied the lower part of the global food trade balance ranking in 2021, with a total deficit in food trade balance of US\$24.6 billion in 2021. In contrast, the UK ranked ninth in the global beverages trade balance ranking in 2021, with a surplus of US\$1.25 billion.
- **UK business expenditure on food and beverages R&D has increased steadily during the last decade, comparable to other leading OECD nations.** R&D expenditure by UK food and beverages firms was 36% higher in 2019 than in 2008, compared to increases of 283% in China and 142% in Korea, whereas the Netherlands recorded growth below UK levels.

## Drivers identified in literature review and sector expert consultations

### Value added and productivity

- The demand for food and beverages is inherently resilient to recession and external events.
- Alcoholic beverages and other food products have been key to sector growth.
- Ready-meals market growth correlates positively to post-2008 financial crisis recovery.
- The long-term sustainability of the sector depends on its ability to tackle concerns such as inflation and rising energy costs, sterling depreciation, labour shortages, and threats such as climate change.

### Trade

- The sector's domestic orientation contributes to resilience and food security, while it diminishes the appetite for export markets.
- Food and drink exports reflect niche strengths in high-value segments for the UK.
- Imports are a necessary and inevitable part of the UK food and beverages sector.

### R&D and innovation

- Innovation is a key focus for the UK food and drink industry, with R&D investments driven by the need to create a more resilient and nutritious food supply.
- Emerging regulations and high-level policy targets have partly shaped the direction of innovation efforts (e.g. the sugar tax, sustainability and net-zero targets, plastic packaging tax and related initiatives, food-waste targets).
- Automation and digitalisation are seen as key to increasing sectoral productivity. However, economic uncertainty may diminish business confidence and investment in these solutions.

## Chart 3.10. Food and beverages manufacturing – value added and employees

Top OECD countries by value added in 2019

Rank	Country	Value added <sup>A</sup>	Employees	Productivity <sup>[3]</sup> Value added per employee
		Billions US\$, 2019	Thousand persons, 2019	Thousand US\$, 2019
1	United States	215.3	1,911.0	112.7
2	Japan	111.4	1,736.0	64.2
3	Mexico <sup>[1]</sup>	53.8	N/A	N/A
4	France	51.0	606.0	84.2
5	Germany	47.8	896.0	53.4
6	<b>United Kingdom<sup>[2]</sup></b>	<b>39.3</b>	<b>409.0</b>	<b>96.2</b>

**Note:** <sup>[1]</sup> Mexico value-added data for 2018, and Mexico employee data is unavailable.

<sup>[2]</sup> **United Kingdom** employee data for 2018.

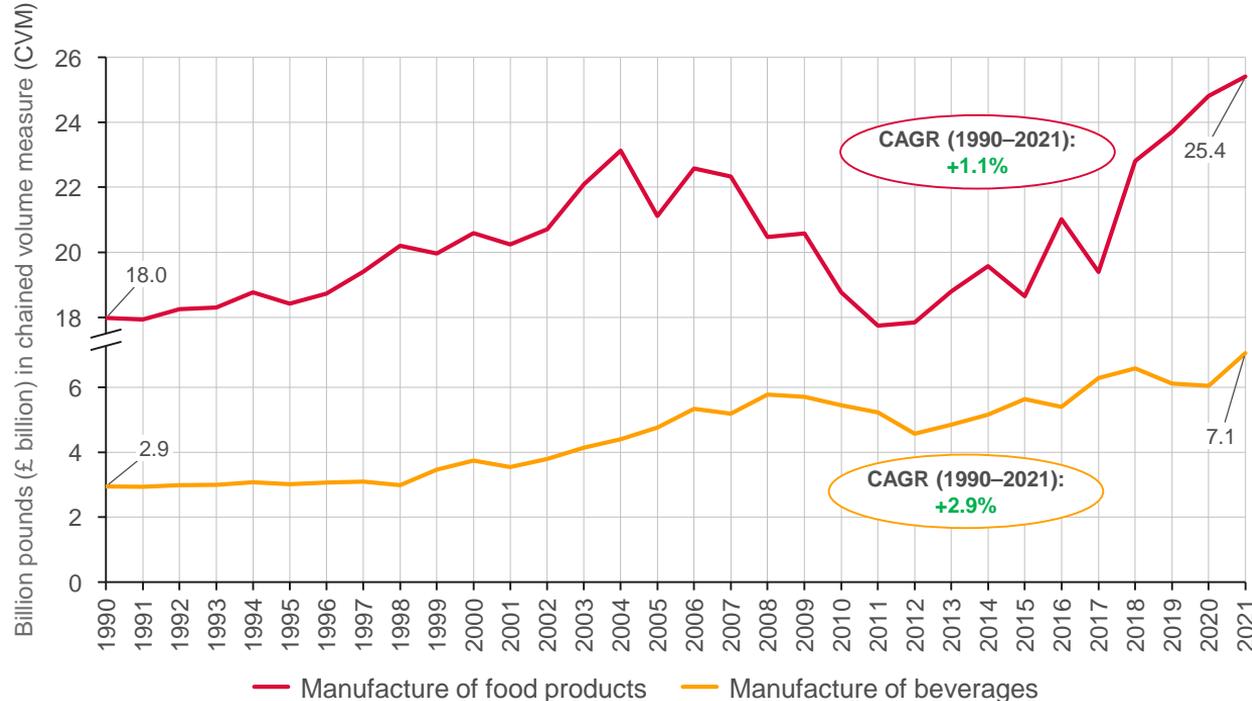
<sup>[3]</sup> OECD provides the value added for each country in its national currency; these value added were converted into USD by referring to annual exchange rates provided by OECD.

**Source:** OECD STAN, ISIC4, D10T11: food products and beverages; OECD, MEI, exchange rates (USD monthly averages). Accessed February 2023.

- **The UK** ranked sixth among **OECD** member countries for **food and beverages manufacturing** in 2019 by value added in US\$. This is nearly three times lower than the value added reported by **Japan** and more than five times lower than the **United States**, which leads the ranking.
- **The UK's food and beverages manufacturing** sector had the lowest number of employees among the top-performing countries, with 409,000 employees in 2019.
- **The UK's** productivity (i.e. value added per employee) in **food and beverages manufacturing** was the second highest among top **OECD** performers, at US\$96,200 per employee in 2019, below the US\$112,700 per employee reported by the **United States**.

## Chart 3.11. UK food and beverages manufacturing – value added

Food and beverages manufacturing (£ billion in CVM)

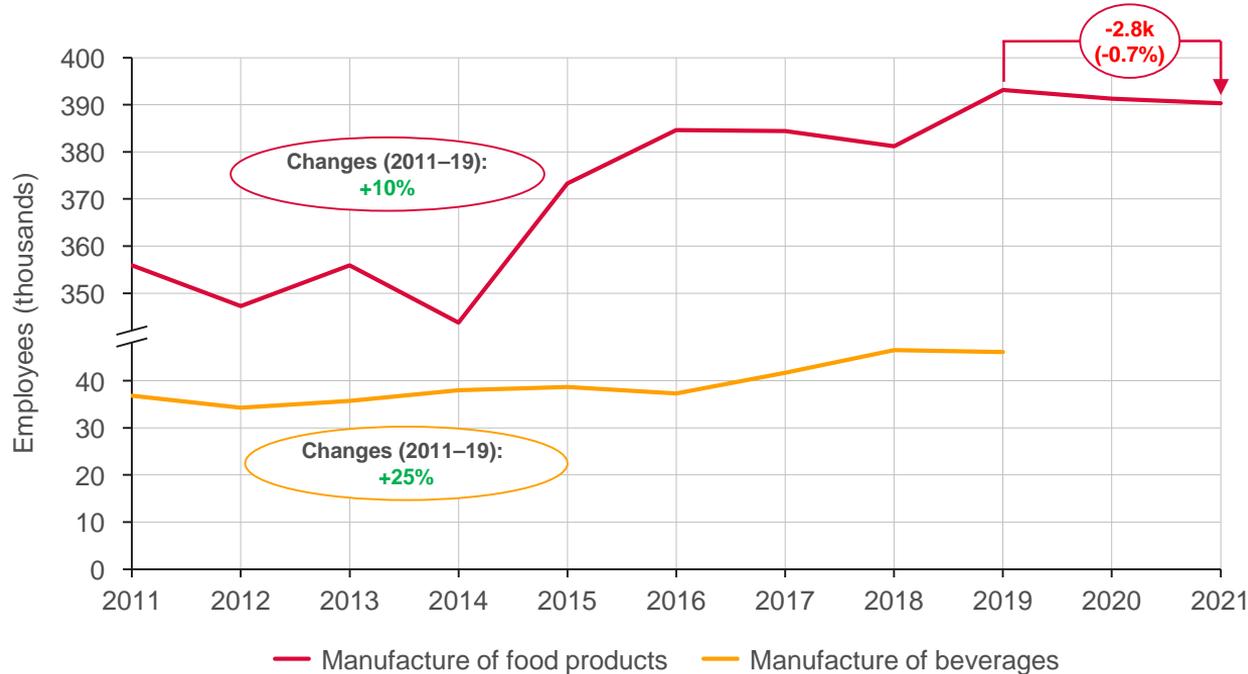


Source: ONS, *GDP output approach – low-level aggregates* (updated version: 22 December 2022); manufacture of food products (SIC 2007 Code 10), manufacture of beverages (SIC 2007 Code 11).

- According to **ONS** data, both the **manufacture of food products and the manufacture of beverages** have increased their overall value added since 2012 in **the UK**, after experiencing drops in value added between 2008 and 2012. Both sub-sectors reached their historical high points in 2021 (1990–2021 period of analysis).
- Value added for **food manufacturing** was £25.4 billion in 2021, with a compound annual growth rate (CAGR) of 1.1% between 1990 and 2021.
- Value added for **beverages manufacturing** was £7.1 billion in 2021, with a compound annual growth rate (CAGR) of 2.9% during the same time period.
- Sector resilience was demonstrated during the **2008 financial crisis**, when the production index for food and drink fell by 1.9 between May 2008 and May 2009, compared to 13.1 for manufacturing overall [[IfM, 2010](#)].
- Similarly, UK household and eating-out expenditure on food and drink increased between 2001 and 2020 (including during the 2008 financial crisis) [[DEFRA, 2022](#); [DEFRA, 2023](#)].

## Chart 3.12. UK food and beverages manufacturing– employees

Thousands of employees, 2009–2021

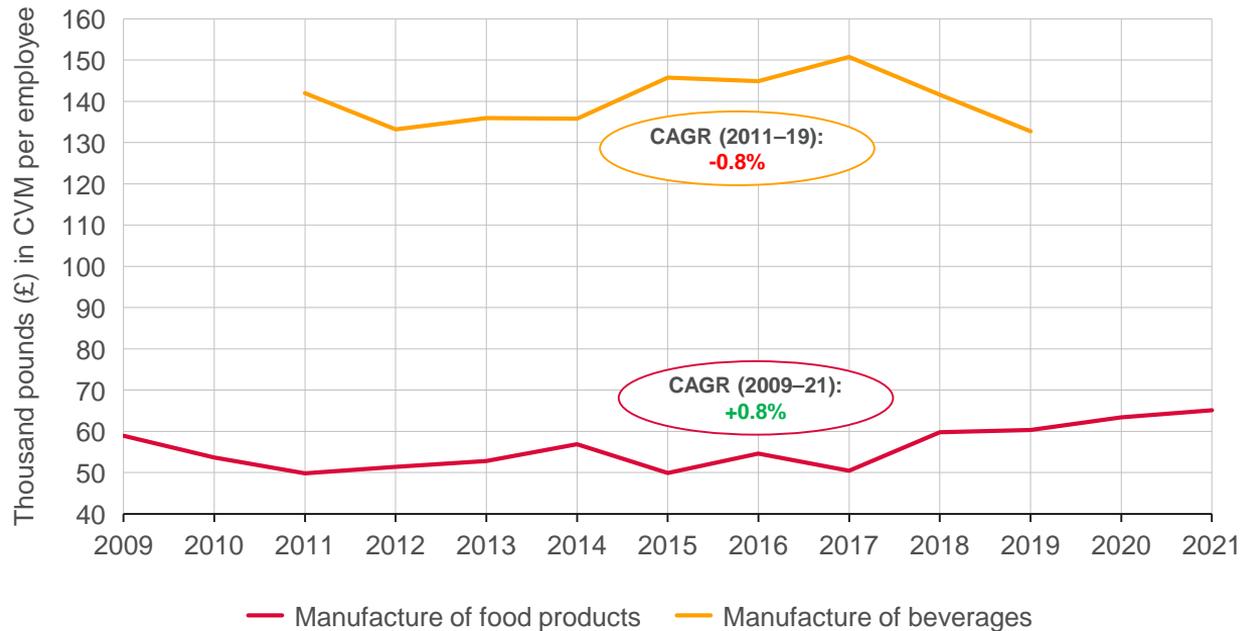


Source: ONS, *Business Register and Employment Survey (BRES)*; manufacture of food products (SIC 2007 Code 10), manufacture of beverages (SIC 2007 Code 11).

- The number of employees involved in **UK food manufacturing** increased by 10% between 2011 and 2019, surpassing 390,000 employees.
- However, a drop of 2,800 employees was recorded for **food manufacturing** between 2019 and 2021.
- There was a surge in the number of employees observed in **food manufacturing** during 2014–15, with total employees increasing by 29,500 within one year.
- The number of employees involved in **beverages manufacturing in the UK** increased by 25% between 2011 and 2019, from 36,800 to 46,100.
- Consulted stakeholders agree that unfilled vacancies remain a significant issue for **UK food and drink** manufacturers. For example, an industrial survey by the **Food and Drinks Federation** found that the number of vacancies per 100 employees increased to 9.1 in Q3 2022, from 6.3 in Q2 2022, while 76% of respondents reported vacancy rates of 0–10% [[FDF, 2022b](#)].

### Chart 3.13. UK food and beverages manufacturing – productivity

Manufacture of food and beverages, thousand £ per employee (in CVM)



- Based on the value added and number of employee trends observed in **Charts 3.11 and 3.12**, the following productivity trends (measured in thousand pounds per employee) can be observed:
  - The productivity of **the UK beverages manufacturing sector** diminished between 2011 and 2019, presenting a compound annual growth rate of -0.8% during this period, from £150,791 per employee in 2017 to £132,733 per employee in 2019.
  - The productivity of **the UK food manufacturing sector** increased slightly between 2009 and 2021, with a compound annual growth rate of 0.8%, totalling £65,100 per employee in 2021.

Source: ONS, *GDP output approach – low-level aggregates* (updated version: 22 December 2022); ONS, *Business Register and Employment Survey (BRES)*; manufacture of food products (SIC 2007 Code 10), manufacture of beverages (SIC 2007 Code 11).

## Chart 3.14. Food manufacturing – trade balance

Global ranking by trade balance in food manufacturing (excluding beverages)

2009 food		
Rank	Country	US\$ billion
1	Brazil	27.29
2	Argentina	18.86
3	Netherlands	18.10
4	Thailand	15.69
5	Indonesia	10.97
6	New Zealand	9.30
7	Malaysia	9.01
8	Denmark	6.73
9	Ireland	6.30
10	Belgium	6.29
...		
173	Saudi Arabia	-6.93
174	Rep. of Korea	-7.83
175	Russian Federation	-12.37
<b>176</b>	<b>United Kingdom</b>	<b>-21.82</b>
177	Japan	-34.37

UK exports		
2009 (US\$ billion)	2021 (US\$ billion)	CAGR (2009–21)
12.18	15.73	2.15%

2021 food		
Rank	Country	US\$ billion
1	Brazil	38.85
2	New Zealand	34.53
3	Indonesia	29.49
4	Netherlands	26.79
5	Argentina	18.68
6	Thailand	17.65
7	Spain	14.10
8	Malaysia	13.00
9	Poland	12.73
10	Canada	11.37
...		
134	Rep. of Korea	-18.17
<b>135</b>	<b>United Kingdom</b>	<b>-24.60</b>
136	USA	-27.64
137	Japan	-38.83
138	China	-41.39

UK imports		
2009 (US\$ billion)	2021 (US\$ billion)	CAGR (2009–21)
33.99	40.33	1.44%

Source: UN Comtrade (accessed in December 2022), HS 2007.

- **The UK** occupied the lower part of the global **food trade balance** ranking in both 2009 and 2021, with a total deficit in food trade balance of US\$24.6 billion in 2021 (**UK** food exports totalled US\$15.73 billion in 2021, compared to US\$40.33 billion in imports).
- Both **UK food exports and imports** increased between 2009 and 2021. The compound annual growth rate in **food exports** was 2.15% between 2009 and 2021, while **imports** recorded a 1.44% CAGR during the same period.
- **The UK** produces around 60% of its domestic food consumption by economic value, part of which is exported, including the majority of grains, meat, dairy and eggs [DEFRA, 2022b]. However, consulted stakeholders shared the view that the UK cannot produce all of the food it consumes because of geography, weather and/or resource and land availability and suitability.
- According to an industry survey by the FDF, the majority of manufacturers are focused on meeting **local UK demand**, with exports accounting for under 10% of their UK turnover for 58% of the sample [FDF, 2017].

## Chart 3.15. Beverages manufacturing – trade balance

Global ranking by trade balance in beverages manufacturing (excluding food)

2009 beverages			2021 beverages		
Rank	Country	US\$ billion	Rank	Country	US\$ billion
1	France	9.95	1	France	17.27
2	Italy	4.78	2	Italy	9.97
3	Mexico	1.65	3	Mexico	8.04
4	Spain	1.42	4	Spain	3.45
5	Chile	1.29	5	Austria	2.71
6	Austria	1.26	6	Netherlands	2.05
7	Netherlands	1.15	7	New Zealand	2.04
8	Australia	1.01	8	Thailand	1.38
9	Argentina	0.84	<b>9</b>	<b>United Kingdom</b>	<b>1.25</b>
10	Ireland	0.82	10	Chile	1.23
11	Portugal	0.64	11	Belgium	1.13
12	New Zealand	0.48	12	Argentina	1.03
13	South Africa	0.39	13	Portugal	0.93
14	Ukraine	0.25	14	Ireland	0.88
15	Uruguay	0.15	15	South Africa	0.61
...					
<b>29</b>	<b>United Kingdom</b>	<b>0.03</b>			

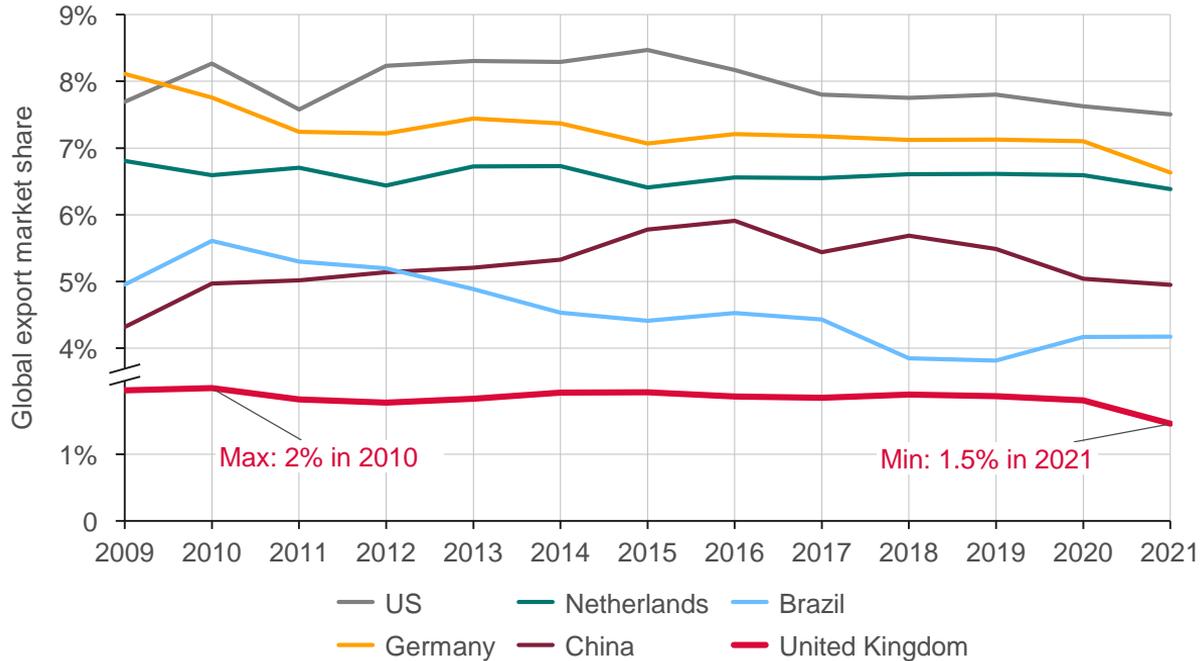
UK exports			UK imports		
2009 (US\$ billion)	2021 (US\$ billion)	CAGR (2009–21)	2009 (US\$ billion)	2021 (US\$ billion)	CAGR (2009–21)
7.99	9.81	1.72%	7.96	8.57	0.62%

Source: UN Comtrade (accessed in December 2022), HS 2007.

- **The UK** ranked ninth in the global **beverages trade balance** ranking in 2021, after recording a significant improvement in its position compared to 2009, going from a total balance of US\$0.03 billion in 2009 to US\$1.25 billion in 2021.
- Both **UK beverages exports and imports** increased between 2009 and 2021; however, the compound annual growth rate (CAGR) of beverage **exports** was over 1% larger than that of **imports** during this time period.
- In 2021 the **UK exported beverages** totalling US\$9.81 billion, while **imports** totalled US\$-8.57 billion.
- **France, Italy, Mexico, Spain and Austria** were the top five performing countries in terms of **beverages** trade balance in 2021.
- **Alcoholic beverages** represented the third-largest share of businesses in the sector in 2017, with roughly the second-highest turnover and highest profits before taxes, above **meat and meat product businesses**, which had the fifth-highest profits before tax [[FDF, 2017](#)].

## Chart 3.16. Food manufacturing – global export market share

Top countries by export market share in 2021 plus the UK (worldwide share = 100%)

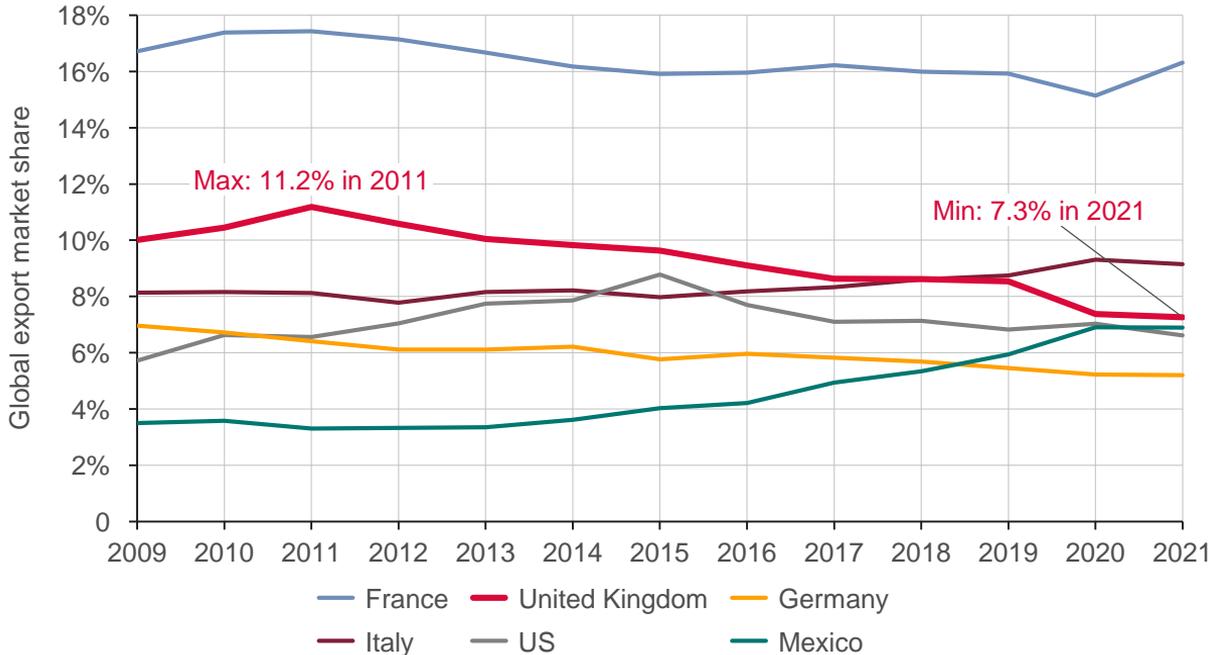


Source: UN Comtrade (accessed in December 2022), HS 2007.

- **The US** had the largest **global export market share** (7.5%) in food products in 2021, followed by **Germany** (6.6%), **the Netherlands** (6.4%), **China** (5%) and **Brazil** (4.2%).
- The **UK's global market share in food exports** decreased from 2% in 2010 to 1.5% in 2021. Between 2009 and 2020 **the UK's** market share fluctuated around 1.9%, with a noticeable reduction recorded in 2020–21.
- **China** surpassed **Brazil** as the fourth-largest global export market share in 2013, maintaining that position until 2021, with a 5% share above **Brazil's** 4.2%.

## Chart 3.17. Beverages manufacturing – global export market share

Top countries by export market share in 2021 (worldwide share = 100%)

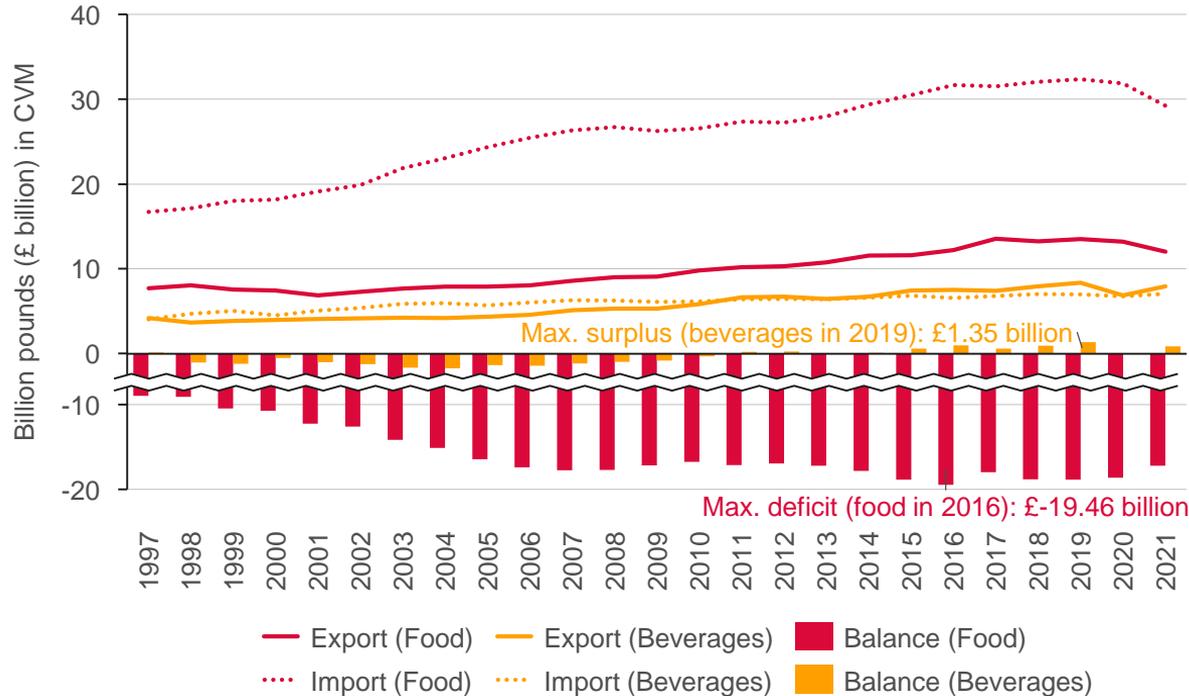


- **France** had the largest global export market share in **beverages** in 2021, with 16.3%, followed by **Italy** (9.1%), **the UK** (7.3%), **Mexico** (6.9%), **the US** (6.6%) and **Germany** (5.2%).
- **The UK's** global market share in **beverage exports** decreased from 11.2% in 2011 to 7.3% in 2021. **Italy** surpassed the **UK's** export market share in 2019 and has maintained the second-largest share in **beverage exports** since then.
- **Mexico** has recorded an upward trend since 2014, surpassing **Germany** in 2019 and the **United States** in 2021, with a global beverages export market share just below that of **the UK** for the last recorded year.

Source: UN Comtrade (accessed in December 2022), HS 2007.

## Chart 3.18. UK food and beverages manufacturing – trade balance

Food and beverages, £ billion in CVM



Source: ONS, UK trade in goods by classification of product by activity time series (updated version: 15 December 2022); food (SIC 2007 Code 10), beverages (SIC 2007 Code 11).

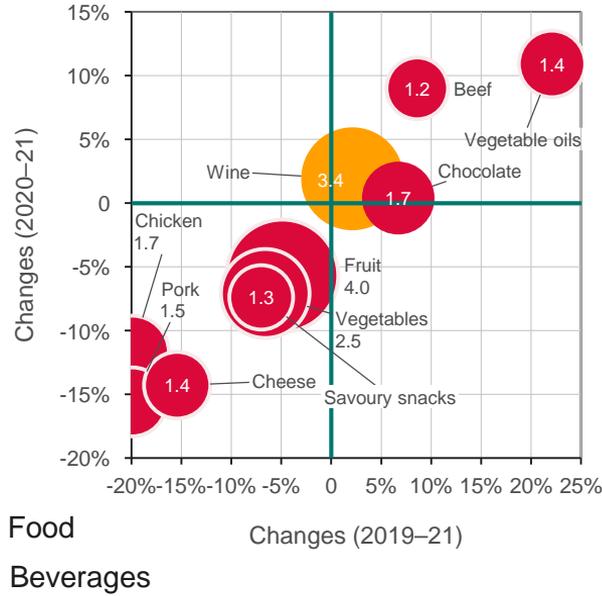
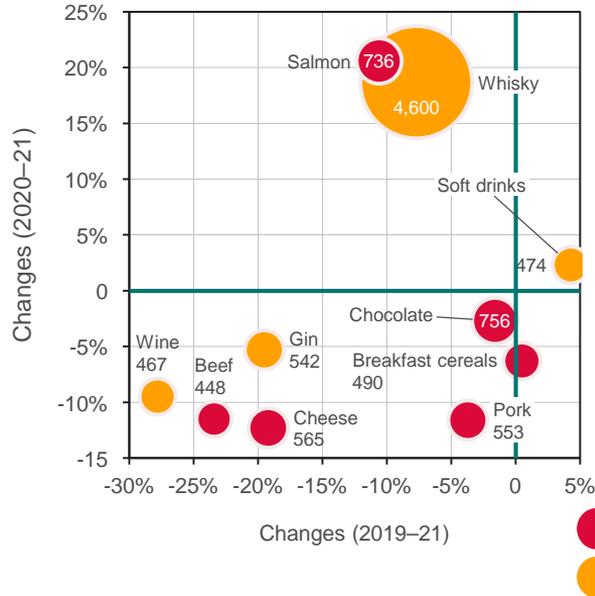
- **The UK** recorded large trade deficits in **food products** between 1997 and 2021.
- **The UK** also recorded small trade deficits in **beverages** between 1998 and 2010, followed by small surpluses since then.
- **The UK's food trade** deficit peaked in 2016 with a value of £19.46 billion, while the country's **beverages** trade surplus reached a maximum of £1.35 billion in 2019.
- Since the COVID-19 pandemic in 2020, the surplus in **beverages** trade balance has decreased by £0.49 billion, while the deficit in the **food** trade balance has reduced by £1.65 billion.

# Chart 3.19. UK food and beverages manufacturing – top export and import products

Top 10, 2021

Top 10 export products in 2021 (£ million)

Top 10 import products in 2021 (£ billion)

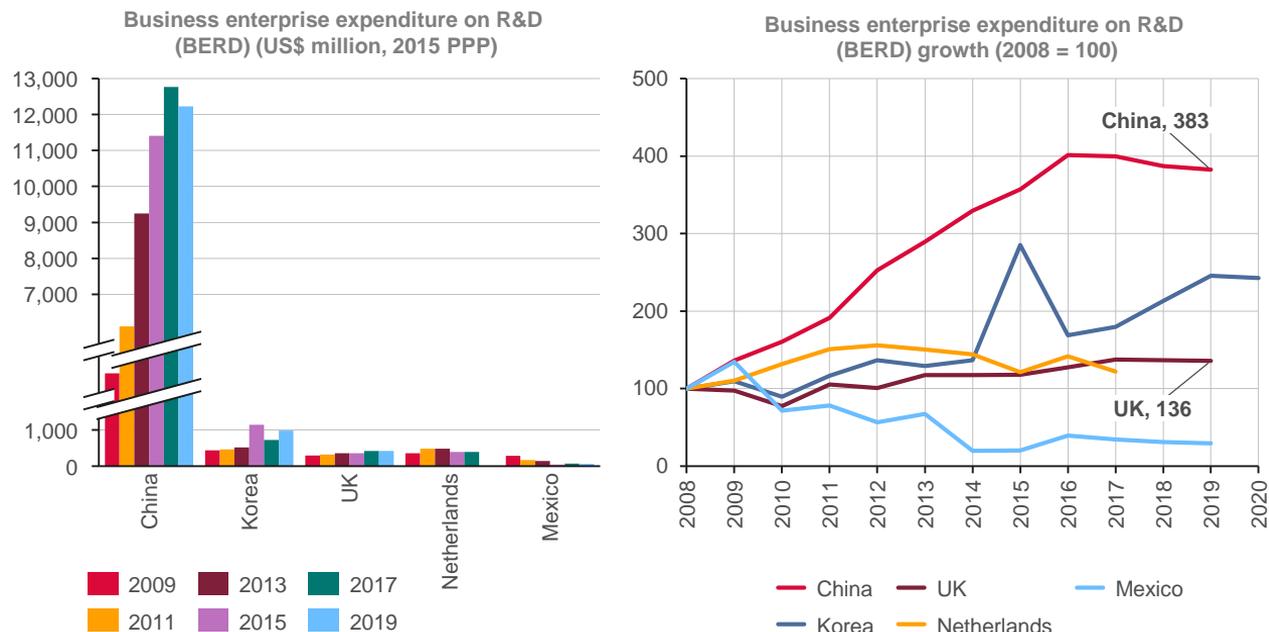


- **Whisky** represents the **top export product** from the **UK**, with an export value of £4.6 billion in 2021, followed by **chocolate exports** worth £756 million during the same year.
- **Soft drinks** are the only product that experienced positive growth in **exports** between 2019 and 2021 and 2020 and 2021, despite the COVID-19 pandemic.
- **Fruits, wine and vegetables** were the top three **import products** in 2021. Of these, only **wine imports** have increased since 2020.
- **Wine** is also the only beverage among the top 10 **import products**. Imports of various top products such as **vegetables, pork and chicken** have diminished since 2020.

Source: Food and Drink Federation (FDF), 2021 Trade Snapshot.

## Chart 3.20. Food and beverages – business spending on R&D

Business enterprise expenditure on R&D (BERD) in food products and beverages, top OECD countries<sup>[1]</sup>



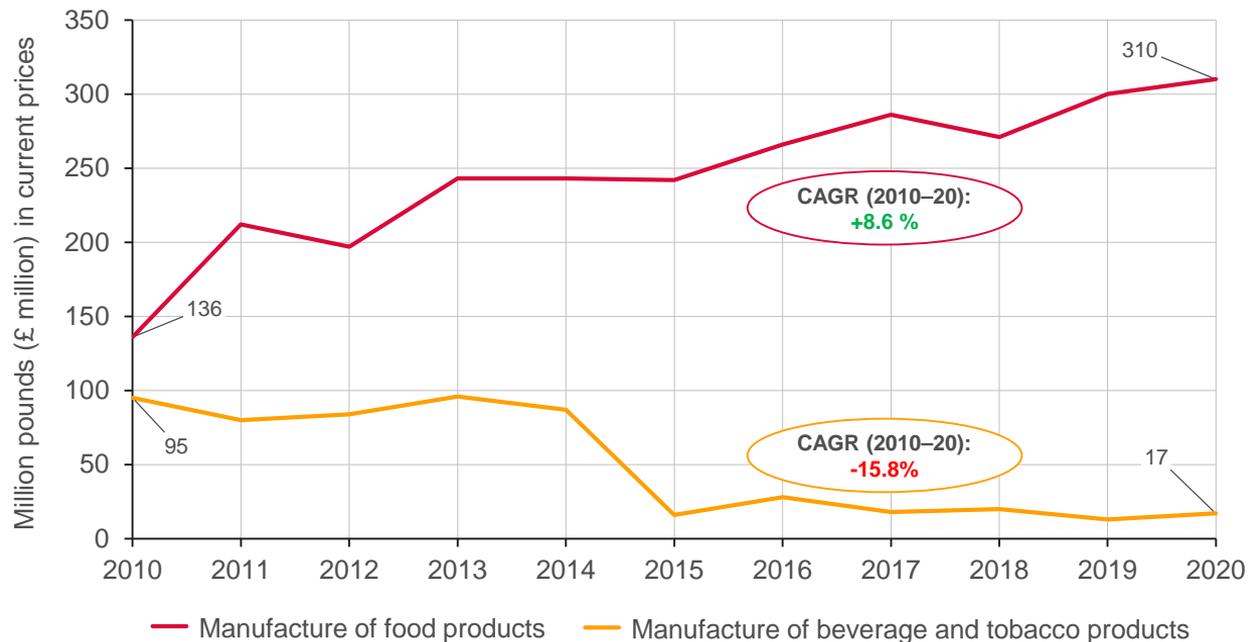
Note: <sup>[1]</sup> US BERD data unavailable.

Source: OECD Research and Development Statistics, ISIC Rev.4, Code D10T11: food products and beverages.

- In absolute terms, **the UK** had the third-largest **business R&D expenditure** among the **OECD** data sample in 2019, while **China** maintains a dominant position, with a significantly larger **business R&D expenditure** than comparator countries (**US data unavailable**).
- **UK food and beverages** businesses invest in R&D at a similar absolute level as those in **the Netherlands**. However, **the Netherlands** had the fourth-best trade balance in **food** and sixth in **beverages** in 2021, highlighting an export vocation.
- R&D expenditure by **UK food and beverages** businesses recorded positive yearly growth from 2011 to 2019.
- Overall R&D expenditure by **UK food and beverages** businesses was 36% higher in 2019 than in 2008, compared to increases of 283% in **China**, 146% in **Korea**, and 22% in **the Netherlands**. **Mexico** recorded negative yearly growth in business R&D expenditure between 2010 and 2019.

## Chart 3.21. UK food and beverages – business spending on R&D (BERD)

BERD by product group classification<sup>[1]</sup> (£ million in current prices)



**Source:** ONS, *business enterprise research and development, UK (designated as national statistics)* (updated version: 22 November 2022); manufacture of food products (SIC 2007 Code 10), manufacture of beverage and tobacco products (SIC 2007 Code 11 and 12).

**Note:** New BERD data for 2018–21 under the updated ONS methodology only provides estimates for the manufacturing sector as a whole (Code 10 to 33).

- Based on **ONS** data, **UK** business expenditure on R&D (BERD) in **food manufacturing** has increased since 2010, with a compound annual growth rate of 8.6% between 2010 and 2020 and a total BERD of £310 million in 2020.
- Regarding **beverages manufacturing**, the ONS publishes annual BERD updates for **beverage and tobacco products combined**.
- BERD in this category (**beverage and tobacco manufacturing**) decreased after 2014, with a compound annual growth rate of -15.8% between 2010 and 2020 and a total BERD of £17 million in 2020.
- Product innovation is a core strength of a sector that demands constant improvement to update and introduce new products, which require significant innovation beyond simple repackaging or rebranding [[IfM, 2010](#)].
- Just over 11,600 **new food and drink products** were introduced in the **UK** in 2021, which reflects the highly competitive nature of the industry [[Intel, 2023](#)].

**Note:** <sup>[1]</sup> Developed by the ONS, the term "product group" refers to business R&D expenditure allocated to the product group that best describes the subject type of R&D activities carried out by firms, rather than based on the economic activities SIC classification.

# Drivers behind the trends in the food and beverages manufacturing sector

Insights from the literature review and consultations with sector experts

# What is driving value added, productivity and trade trends in food and beverages manufacturing? (1)

## Key trend identified

- The value added of the UK food and beverages sector has increased during the last decade, while its productivity remained roughly stable
- The UK has one of the largest food trade deficits among comparator countries, while it remains a leading exporter of beverages

## Potential drivers identified from the literature review and consultations with sector experts (see Appendix 3.1 for details)

### Demand for the food and beverages sector is inherently resilient to recession and external events

- The consulted stakeholders largely agreed that because **food and beverages** are essential customer goods, domestic demand for **UK food and beverages** tends to be more stable than products from other sectors:
- Competition in the **grocery retail sector** helps to push prices down and shapes consumer preferences based on the highest-value propositions on offer [[Make UK, 2020](#)].
- Sector resilience was demonstrated during the 2008 financial crisis. Between May 2008 and May 2009 the production index for food and drink fell by 1.9, compared to 13.1 for manufacturing overall. Exports grew by 5.4% in the first 9 months of 2009, compared with the same period in 2008, compared with the -14.3% performance for all UK commodity exports during the same period [[IfM, 2010](#)].
- UK household and eating-out expenditure on food and drink increased between 2001 and 2020 (including during the 2008 financial crisis). Although expenditure reduced in 2021 because of COVID-19, this is attributed to a fall in food and beverages eaten out of the household as a result of restaurants and other licensed premises being shut for large parts of the 2020–21 pandemic period [[DEFRA, 2022](#); [DEFRA, 2023](#)].
- Stakeholders also highlighted that **UK food and beverage sector** resilience is supported by adaptable and flexible supply chains, which have traditionally been capable of resisting external shocks (e.g. economic, climate, trade, transportation, labour) [[DEFRA, 2021](#)].
- In addition, close collaboration between the government and the private sector to monitor, anticipate and respond to risks adds to the resilience of **UK food and beverages** supply chains [[DEFRA, 2021](#)].

### The sector's domestic orientation contributes to resilience and food security, while it diminishes the appetite for export markets

- **The UK** produces around 60% of its domestic food consumption by economic value, part of which is exported, including the majority of grains, meat, dairy and eggs, rising to 75% for food that can be grown in the country [[DEFRA, 2022b](#)]. This strong and consistent domestic production, combined with a diversity of international supply sources that avoids over-reliance on any one source, translates into a resilient UK food supply, albeit one that is not fully self-sufficient.
- The interviewees suggested that **food and drink manufacturers** see exports as a secondary priority given the large and consistent domestic market.
- For example, according to an industry survey by FDF, the majority of manufacturers are focused on meeting **local UK demand**, with exports accounting for under 10% of their UK turnover for 58% of the sample [[FDF, 2017](#)]. Potential export barriers identified by stakeholders included product shelf life and the fragile nature of their products [[FDF, 2017](#)].

# What is driving value added, productivity and trade trends in food and beverages manufacturing? (2)

## Key trend identified

- The value added of the UK food and beverages sector has increased during the last decade, while its productivity remained roughly stable
- The UK has one of the largest food trade deficits among comparator countries, while it remains a leading exporter of beverages

## (continued)

- The share of domestically produced food consumed in the UK increased from 51.1% in 2009 to 53.9% in 2020 [DEFRA, 2021].
- Domestic production has been stable, with consumer demand balanced by imports and exports [DEFRA, 2021].
- For the remaining share coming from abroad, the UK has diverse and longstanding trade links that meet consumer demand for a range of products at all times of the year. However, trade is dominated by countries in the European Union supply chain (28% of UK domestic consumption came from the EU in 2020, while the remaining 18% came from the rest of the world), which has exposed the UK to potential disruptions in the immediate aftermath of the exit from the EU [DEFRA, 2021].

## Food and drink exports reflect niche strengths in high-value segments for the UK, which can be expanded to new markets

- As suggested by the FDF and the consulted stakeholders, the UK's export strengths in food and drink are often driven by innovation built on long-term past investment in food and beverages production processes, brands and local product identities [FDF, 2022].
- Although the EU is still the largest market in the food and drink sector, there is an untapped export potential in non-EU markets, where exports grew 8% in 2021 compared to 2020. Overall, exports to the non-EU market accounted for 44.3% of total UK exports in 2021. New trade agreements such as the UK-Singapore Digital Economy Agreement and UK-South Korea Trade Agreement could further boost exports in the future [FDF, 2021].

## Imports are a necessary and inevitable part of the UK food and beverages sector

- The consulted stakeholders shared the view that the UK cannot produce all of the food it consumes because of geography, weather and/or resource and land availability and suitability. This means that, inevitably, some ingredients and products will have to be imported.
- The production to supply ratio has remained stable over the last 2 decades, and for crops that can be commercially grown in the UK this has been around 75% [DEFRA, 2021].
- Products that cannot be produced in the UK, such as rice, have to be imported. These are not only important products for consumer consumption but they also constitute key inputs for UK manufacturing industries such as the milling industry [DEFRA, 2002b].
- Furthermore, imported products and raw materials that are not produced in the UK, such as tropical ingredients, help to extend the availability of produce outside their growing season in the UK [FDF, 2022].

Potential drivers identified from the literature review and consultations with sector experts (see Appendix 3.1 for details)

# What is driving value added, productivity and trade trends in food and beverages manufacturing? (3)

## Key trend identified

- The value added of the UK food and beverages sector has increased during the last decade, while its productivity remained roughly stable
- The UK has one of the largest food trade deficits among comparator countries, while it remains a leading exporter of beverages

## Potential drivers identified from the literature review and consultations with sector experts (see Appendix 3.1 for details)

### Ready-meal market growth correlates positively to post-2008 financial crisis sectoral recovery

- The consulted stakeholders highlighted that the last decade saw a move by food retailers towards the introduction of ready meals at scale that most likely supported the overall growth of the **food and drinks manufacturing sector** in the aftermath of the 2008 financial crisis.
- The **UK ready-meal market** experienced significant growth between 2008 and 2022, with sales of ready meals totalling £3,733 million in 2022, compared to £2,450 million in 2008 [[Euromonitor Database, 2023](#)]. The top three retailers by share of ready-meal sales in 2022 included Tesco (17.8%), Marks & Spencer (12.2%) and Sainsbury's (10.7%) [[Euromonitor Database, 2023](#)].

### Alcoholic beverages and other food products have been key drivers of sectoral turnover and profitability

- **Alcoholic beverages** represented the third-largest share of businesses, with roughly the second-highest turnover and highest profits before taxes, above **meat and meat product** businesses, which had the fifth-highest profits before tax [[FDF, 2017](#)].
- The sub-sector known as **other food products\*** not only had the largest share of businesses in the sector over the 2013–15 period but also generated the highest turnover and second-highest profits before taxes, only after the profitability of **alcoholic beverage** manufacturers [[FDF, 2017](#)].

\*The other food product sub-sector includes the manufacture of sugar, cocoa, chocolate and sugar confectionery, the processing of tea and coffee, the manufacture of condiments and seasonings, the manufacture of prepared meals and dishes, the manufacture of homogenised food preparations and dietetic food.

### A number of concerns are driving policy and industrial strategy to ensure future sector growth

#### Inflation and rising energy costs:

- As suggested by the consulted stakeholders, the cost of **food and beverages** manufacturing is intrinsically linked to energy and input costs. Rises in energy and input prices through 2021–22 have been transferred to the food prices paid by consumers [[DEFRA, 2023b](#)]. The energy crisis that started in 2022 represents a challenge for **food and beverages** manufacturing businesses, particularly major energy users such as bakers and millers.
- ONS data shows that higher energy prices had already impacted the production and/or supply of around 60% of **food manufacturers** back in March 2022, compared to only 38% of all UK businesses [[FDF, 2022b](#)].

#### Sterling depreciation:

- The depreciation of sterling against the dollar since the start of 2022 has driven up the cost of imported ingredients and raw materials. A 2022 industry survey by the **Food and Drink Federation** found that around 57% of surveyed businesses reported being greatly impacted by the depreciation of sterling [[FDF, 2022b](#)].

# What is driving value added, productivity and trade trends in food and beverages manufacturing? (4)

## Key trend identified

- The value added of the UK food and beverages sector has increased during the last decade, while its productivity remained roughly stable
- The UK has one of the largest food trade deficits among comparator countries, while it remains a leading exporter of beverages

(continued)

### Labour shortages:

- The consulted stakeholders agree that unfilled vacancies remain a significant issue for **UK food and drink** manufacturers. For example, an industrial survey by the **Food and Drinks Federation** found that the number of vacancies per 100 employees increased to 9.1 in Q3 2022, from 6.3 in Q2 2022, while 76% of respondents reported vacancy rates of 0–10% [[FDF, 2022b](#)].
- Vacancies cover a wide range of roles and skills, including: high-skilled workers such as engineers, R&D scientists, area supervisors and sales administrators; technical specialists such as food and packaging technologists; and production operatives such as warehouse operators, machine operators, drivers, packers and seasonal workers [[FDF, 2022b](#)].
- The consulted stakeholders highlighted automation as key to addressing labour shortages, although this can also lead to a need for upskilling the existing workforce. As suggested by the interviewees and the FDF, more sector-wide efforts are required to better connect the education system and industry to provide skills for the future [[FDF, 2017](#)].

### Long-term threats

- The consulted stakeholders highlighted a few potential risks to the stability and long-term sustainability of food ingredients and inputs, including: climate change, biodiversity loss, soil and water-quality degradation, and over-exploitation of natural capital resources, including fish stocks and water resources. This view was also shared by DEFRA's *Food Security Report 2021* [[DEFRA, 2021](#)].
- The stakeholders viewed climate change as a major factor in medium- to long-term risks to the production of domestic **UK food and beverages**.
- For example, wheat yields dropped by 40% in 2020 because of heavy rainfall and droughts during the growing season. The concern is that these events could become more frequent and unpredictable in the future, reducing the resilience of the **UK food system** [[DEFRA, 2021](#)].

Potential drivers identified from the literature review and consultations with sector experts (see Appendix 3.1 for details)

# What is driving business R&D expenditure trends in food and beverages manufacturing? (1)

## Key trend identified

- UK business expenditure on food and beverages R&D has increased steadily during the last decade, comparable to other leading OECD nations

Potential drivers identified from the literature review and consultations with sector experts (see Appendix 3.1 for details)

### Product innovation is a key focus for the UK food and drink industry

- Just over 11,600 new **food and drink** products were introduced in the UK in 2021, which reflects the highly competitive nature of the industry [[Mintel, 2023](#)].
- Product innovation is a core strength of a sector that demands constant improvement to update and introduce new products, which require significant innovation beyond simple repackaging or rebranding. This competitive need is driving a sectoral push for investment in design and technology research and development (R&D) [[IfM, 2010](#)].

### UK business and government R&D investments are driven by the need to create a more resilient and nutritious food supply

- The **Knowledge Transfer Network (KTN)** has identified five areas driving **food and drink** R&D efforts: i) healthier and more nutritious food; the use of agricultural and food-processing side-stream materials to produce nutritious food ingredients; the development of products based on sustainable sources of new materials and protein; flexible and scalable manufacturing solutions; and digital manufacturing [[KTN, 2018](#)].
- The consulted stakeholders also highlighted low-emission production systems, food safety, packaging, recycling and lightweighting, and CO<sub>2</sub> traceability as key R&D areas for the future.
- In particular, the consulted stakeholders see biotechnology for new **food and drink** products as a key innovation trend in recent years and one where the UK can become a global leader. Biotechnology for **agriculture** and **food and drink** manufacturing includes areas such as biopesticides, biofertilisers, the production of cultured meat, genetic engineering for agrifood, bioagrochemicals, biotech-produced flavours and fragrances, and viticulture and plant-based proteins for yogurt, milk, egg and cheese products as an alternative to dairy and egg-based goods, among others [[IfM, 2023](#)].

### Emerging regulations and high-level policy targets have partly shaped the direction of innovation efforts

- **The sugar tax:** Introduced in April 2018, the tax was aimed at incentivising drink manufacturers to reduce the sugar content of soft drinks as a way to protect the public from excessive sugar consumption. The effect on **beverage manufacturers'** recipes was significant: even before its imposition, over 50% of manufacturers took action to cut sugar in their products [[Make UK, 2020](#)].
- **Plastic packaging tax and related initiatives:** Implemented in April 2022, the **plastic packaging tax** is aimed at reducing the use of plastics and increasing its recycling and collection [[HMRC, 2022](#)]. A previous initiative, the **UK Plastics Pact**, was launched in April 2018 by WRAP and supported by DEFRA, to set targets to reduce single-use packaging and increase the use of recyclable plastic packaging [[WRAP, 2023](#)]. In addition, the new **extended producer responsibility (EPR)** for packaging came into effect on 1 January 2023 to reduce unnecessary packaging and increase packaging recyclability [[HMG, 2023](#)].

## What is driving business R&D expenditure trends in food and beverages manufacturing? (2)

### Key trend identified

- UK business expenditure on food and beverages R&D has increased steadily during the last decade, comparable to other leading OECD nations

### (continued)

- Sustainability and net-zero targets:** The UK's net-zero emissions targets, which passed into law in 2019, require major changes in the food system, with many UK-based food and drinks companies establishing net-zero targets (e.g. Danone, Innocent, McCain, Nestlé, Tate & Lyle). This involves addressing key emissions sources in food ingredients, packaging, manufacturing, and distribution and storage, among other areas. Key areas of net-zero innovation for manufacturers include energy efficiency, electricity decarbonisation, process heat decarbonisation and the creation of sustainable refrigerants, as well as opportunities to extend shelf life, cut waste, increase efficiency of refrigeration and replace single-use plastics [FDF, 2021b]. Failure to comply with net zero standards could lead to competitiveness losses against foreign producers, as suggested by consulted stakeholders.
- Food-waste targets:** Roughly 16% (1.5 million tonnes) of total UK food waste was caused by food manufacturers in 2018 [WRAP, 2020]. The UK government has committed to meeting the UN Sustainable Development Goal to halve per capita food waste and reduce food loss by 2030; in line with this, the Waste and Resources Action Programme and the Institute for Grocery Distribution launched the Food Waste Reduction Roadmap in 2018, establishing a series of milestones for retailers, food producers, manufacturers and hospitality and food-service companies to meet in order to tackle food waste in the UK. By 2020, 162 food producers and manufacturers representing 50% of the entire sector (by turnover) had joined this initiative [WRAP, 2020].

Potential drivers identified from the literature review and consultations with sector experts (see Appendix 3.1 for details)

### Automation and digitalisation are seen as opportunities to increasing sectoral productivity. However, economic and demand uncertainty may diminish business confidence and investment in these solutions

- According to the consulted stakeholders, the implementation of automation solutions and other digital technologies has been a consistent innovation trend in the sector in recent years. Data from the British Automation and Robot Association (BARA) indicates that sales of individual robots to domestic food and beverages manufacturers had an annual growth of 35% in 2020 and 21% in 2021 [Food Manufacture, 2022].
- However, investment confidence in the food and drink manufacturing industry has fallen in the last couple of years, with the FDF's net confidence tracker reaching a record low of -79% in Q3 2021. Furthermore, short-term contracts with retailers might not provide the necessary long-term security to commit to high capital investments in automation, as suggested by consulted stakeholders.
- This highlights an environment of business uncertainty fuelled by events such as the ongoing war in Ukraine and rising energy prices and inflation rates. According to FDF's *State of the Industry Report 2022 Q3*, low confidence has prevented some food and drink businesses from investing in the adoption of automation to solve labour shortages, while over half of businesses in the FDF survey sample have prioritised investment in energy efficiency and fuel-switching over automation as a way to reduce costs [FDF, 2022b].

# References

## Sectoral analyses

### Aerospace manufacturing sector analysis

- ADS (2022). ADS Commercial Aircraft & Engine Data October 2022 results.
- Airbus (2019). [Stepping into the virtual world to enhance aircraft maintenance.](#)
- Airbus (2022). [The Impact of Airbus on the UK Economy.](#)
- ATI (2021). [Annual Review 2020/21.](#)
- ATI (2022b). [Destination Zero.](#)
- BBC (2020). [Coronavirus: plane-maker Airbus to cut 15,000 jobs.](#)
- BEIS (2020). [Aerospace Sector Deal.](#)
- BIS (2016). [UK Aerospace Maintenance, Repair, Overhaul and Logistics Industry Analysis.](#)
- Boeing (2017). [Boeing in the UK.](#)
- BusinessLive (2021). [Brolls-Royce to have cut 8,500 jobs by end of 2021 as restructure delivers savings.](#)
- House of Commons (2005). [The UK Aerospace Industry.](#)
- House of Commons (2017). [Aerospace Sector Report.](#)
- JADC (2022). [Worldwide Market Forecast.](#)
- MakeUK (2019). [Sector Bulletin: Aerospace.](#)
- Mordor Intelligence (2023). [Europe Aircraft MRO Market - Growth, Trends, Covid-19 Impact, And Forecasts \(2023 - 2028\).](#)
- Partstat (2018). [The Consolidation of the Aerospace Supply Chain.](#)

### Food and beverages manufacturing sector analysis

- DEFRA (2021). [Food Security Report 2021.](#)
- DEFRA (2022). [Family Food 2020/21.](#)
- DEFRA (2022b). [Government Food Strategy.](#)
- DEFRA (2023). [Family Food Datasets.](#)
- DEFRA (2023b). [Food Statistics in your Pocket.](#)
- Euromonitor Database (2023). [Ready Meals in the United Kingdom.](#)
- FDF (2017). [FDF Economic Contribution and Growth Opportunities.](#)
- FDF (2021). [Trade Snapshot 2021.](#)
- FDF (2021b). [Roadmap to Net Zero: Overview for the UK Food and Drink Sector.](#)
- FDF (2022). [A UK Trade and Investment Strategy for Food and Drink.](#)
- FDF (2022b). [State of Industry Report.](#)
- Food Manufacture (2022). [Robotics in UK food manufacturing: what are the latest trends?](#)
- HMG (2023). [Packaging Waste: Prepare for Extended Producer Responsibility.](#)
- HMRC (2022). [Plastic Packaging Tax: Steps to Take.](#)
- IfM (2010). [Value of Food & Drink Manufacturing to the UK.](#)
- IfM (2023). Life sciences beyond human health: modern industrial biotechnology in the UK.
- KTN (2018). [Food & Drink Sector R&D Needs and Priorities: Alignment with the Industrial Strategy.](#)
- Make UK (2020). [Sector Bulletin: Food and Drink 2020 Update.](#)
- Mintel (2023). [Food and Drink Industry.](#)
- WRAP (2020). [Food Waste Reduction Roadmap Progress Report 2020.](#)
- WRAP (2023). [The UK Plastics Pact.](#)

# Appendix 3.1

## Stakeholder consultation – aerospace and food and beverages manufacturing sectors

In an attempt to understand the reality behind the data, Theme 3 was informed by a reduced number of interviews with key UK stakeholders from industry and government – including R&I funding programme management agencies, industry associations and key private-sector organisations. The consultation included representatives from the following organisations:

### Aerospace manufacturing sector analysis

- ADS
- Airbus
- ATI
- CloudNC
- Deloitte
- Department for Business and Trade (formerly BEIS)
- GKN
- LSI Aerospace
- Make UK
- Rolls-Royce

### Food and beverages manufacturing sector analysis

- Britvic Soft Drinks
- Clegg Food Projects
- DEFRA
- Food and Drinks Federation (FDF)
- Innovate UK
- Knowledge Transfer Network (KTN)
- PepsiCo
- Raynor Foods
- Red Tractor
- Samworth Brothers
- University of Lincoln
- University of Manchester

# Theme 4: Science and engineering workforce

UK INNOVATION REPORT

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# Theme 4: Science and engineering workforce

Theme	Policy questions and key messages
Key policy questions addressed	<ul style="list-style-type: none"><li>▪ Is the UK producing enough scientists and engineers?</li><li>▪ Is the UK government investing enough in technical and vocational education?</li><li>▪ How does this compare with other countries?</li></ul>

## Key findings

**The UK has relatively high shares of graduates in STEM disciplines, but the share of graduates in the STEM sub-discipline of engineering, manufacturing and construction remains relatively low**

- In 2020 STEM (science, technology, engineering and mathematics) graduates in the UK accounted for 41% of total graduates, above countries such as France (35%), Canada (39%), and similar to the US.
- The share of graduates in engineering, manufacturing and construction in the UK, at 9%, is low compared with countries such as Germany (26%) and Korea (21%).

**The UK higher education system has been continuously attracting international students who show a preference for non-science fields of study**

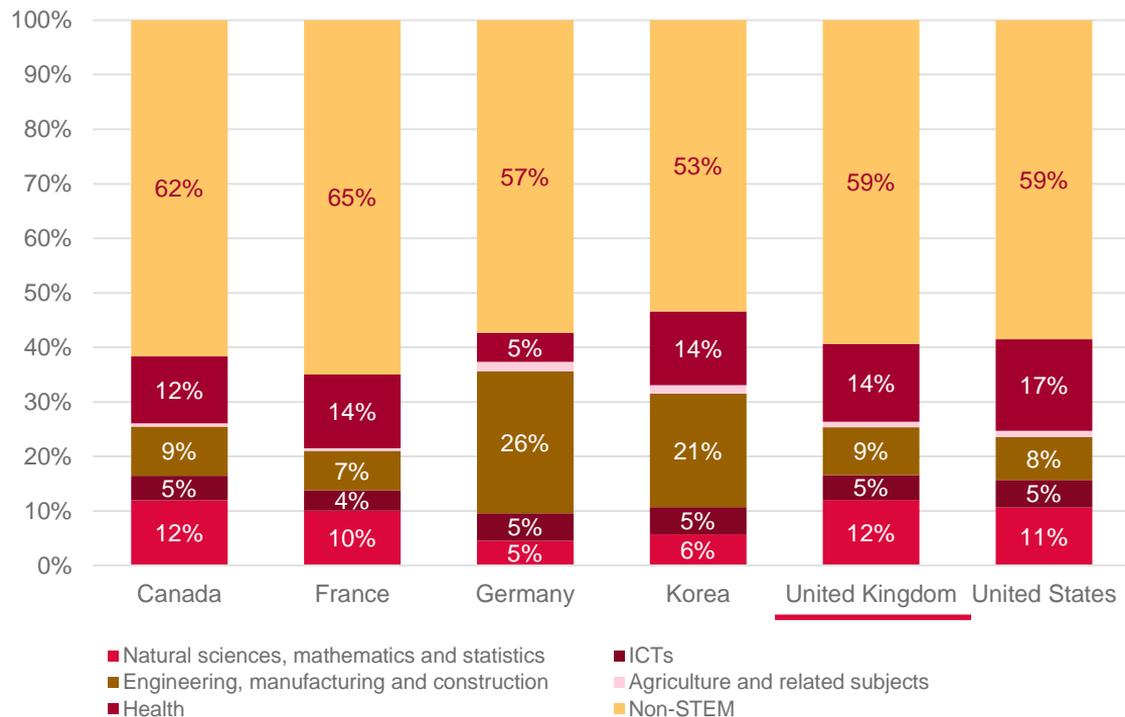
- In 2020 the share of international students enrolled in tertiary education courses in the UK was 20.1%, against an OECD average of 10.1%.
- Between 2017/18 and 2021/22, the number of international students enrolled in the UK increased by 45%.
- For the academic year 2018/19, 61% of international students were enrolled in non-science subject courses.

**The UK has a relatively low share of researchers working in the business sector, and women researchers are under-represented**

- In 2020 the business sector in the UK employed 42% of researchers, below Korea (82%), Japan (75%) and the US (72%) but also below countries such as France (63%) and Germany (60%).
- In 2019 women accounted for 39% of total researchers, placing the UK in the top 10 of OECD countries.
- In the UK female graduates are under-represented in some STEM disciplines, particularly in engineering, manufacturing and construction.

## Chart 4.1. Graduates by subject area

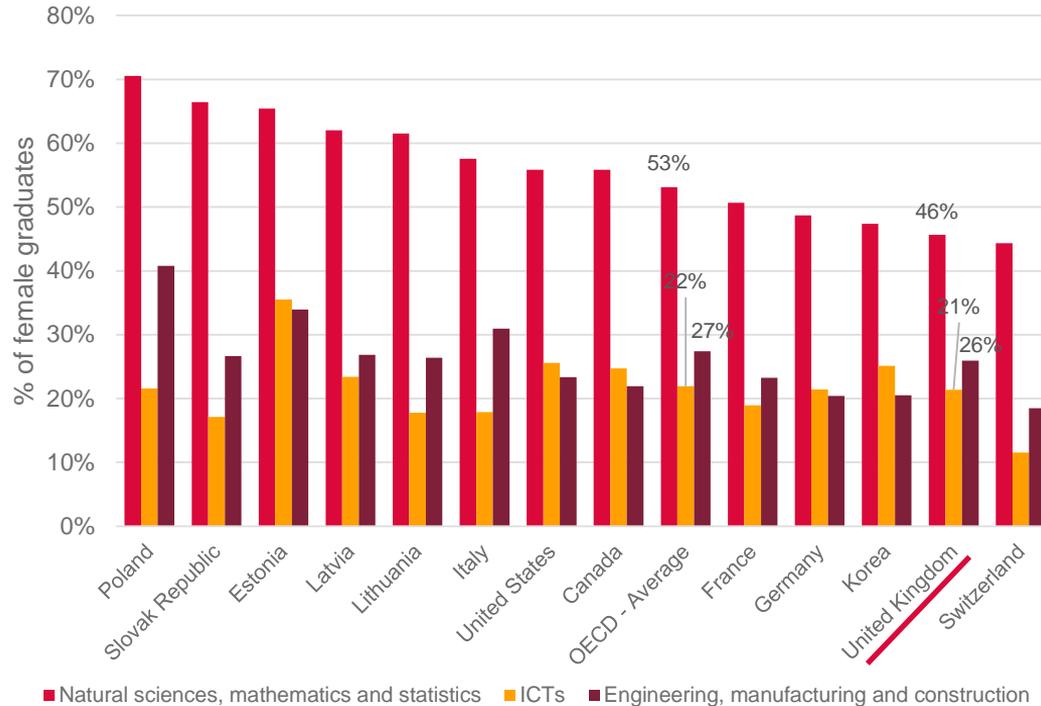
Bachelor degrees or equivalent, selected countries, 2020



- **The UK** has historically had relatively high levels of tertiary education attainment. In 2021 the level of tertiary education attainment in **the UK** was 50.1%, well above the **OECD** average (39.7%).<sup>[1]</sup>
- In 2020 **STEM (science, technology, engineering, and mathematics)** graduates in **the UK** accounted for 41% of total graduates. The value was above comparator countries such as **France** (35%), **Canada** (39%), and similar to **the US** (41%).
- The share of graduates in **engineering, manufacturing and construction** remains relatively low in **the UK**, at 9%, especially compared to countries such as **Germany** (26%) and **Korea** (21%).

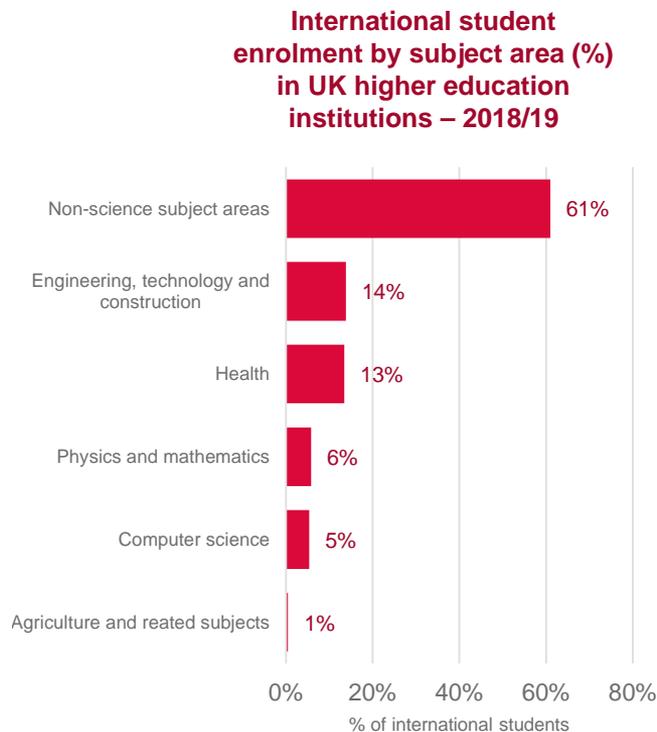
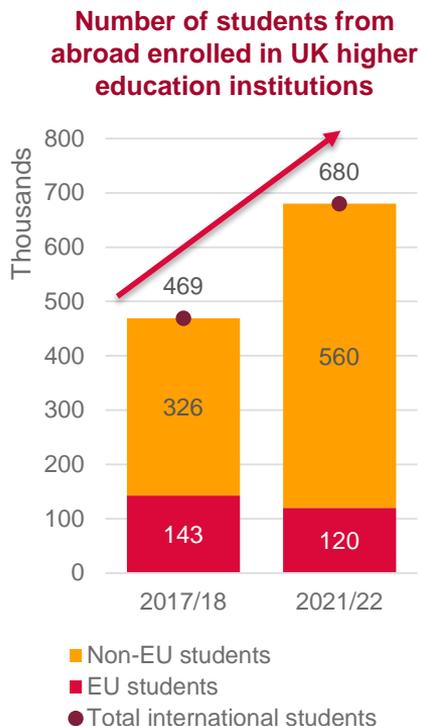
## Chart 4.2. Women in STEM tertiary education

Female graduates, share of total graduates, selected countries, 2020



- While women have tertiary education attainment levels that are higher than men, they are usually under-represented in some **STEM** disciplines, in both **the UK** and most **OECD countries**.<sup>[1]</sup>
- In 2020, in **the UK**, women represented 26% of graduates in **engineering, manufacturing and construction** degrees, against the 27% **OECD** average. In **ICT** disciplines, women represented 21% of graduates, against the **OECD** average of 22%.
- **Natural sciences, mathematics and statistics** are the fields of study that have higher shares of female graduates among **STEM** disciplines. In 2020 the share of female graduates among **natural sciences, mathematics and statistics** graduates in **the UK** was 46%, below the **OECD** average (53%).

## Chart 4.3. International students in the UK



- In 2020 the share of international students enrolled in tertiary education courses in **the UK** was 20.1%, against an **OECD** average of 10.1%.<sup>[1]</sup>
- Only **Luxemburg** (48.8%) and **Australia** (26%) had a higher proportion of international tertiary students enrolled in 2020.
- The **UK higher education system** has been continuously attracting international students. Between the academic years of 2017/18 and 2021/22, the number of international students enrolled in **the UK** increased by 45%, despite the decrease in new students coming from **the EU**.
- For the academic year 2018/19, 61% of international students showed a preference for **non-science** subject areas.
- In the academic year 2018/19, the share of international students enrolled in **engineering, technology and construction** was 14%.

Source: HESA (2022). Figure 9 – HE student enrolment by domicile.

Source: HESA (2022). Table 22 – HE student enrolment by subject of study and domicile.

Note: <sup>[1]</sup>OECD (2023). International student mobility (indicator).

## Chart 4.4. Graduates entering the workforce in the UK

Graduates entering work in the UK by field of study and economic sector, 2019/2020

	Field of study						
	Agriculture and related studies	Physics	Mathematics	Engineering and technology	Computing	Architecture	Natural sciences
Information and communication	1%	11%	16%	8%	41%	1%	5%
Other sectors	20%	9%	8%	12%	9%	11%	17%
Wholesale and retail trade; repair of motor vehicles and motorcycles	12%	7%	6%	7%	9%	4%	10%
Professional, scientific and technical activities	15%	21%	17%	21%	8%	45%	24%
Education	8%	17%	18%	7%	8%	3%	12%
Financial and insurance activities	1%	5%	19%	3%	8%	1%	4%
Manufacturing	14%	14%	4%	24%	6%	2%	3%
Public administration and defence; compulsory social security	4%	6%	5%	4%	4%	7%	10%
Human health and social work activities	5%	7%	3%	2%	3%	2%	5%
Administrative and support service activities	2%	2%	3%	3%	3%	2%	4%
Construction	1%	1%	1%	9%	1%	22%	5%
Agriculture, forestry and fishing	17%	0%	0%	0%	0%	0%	1%

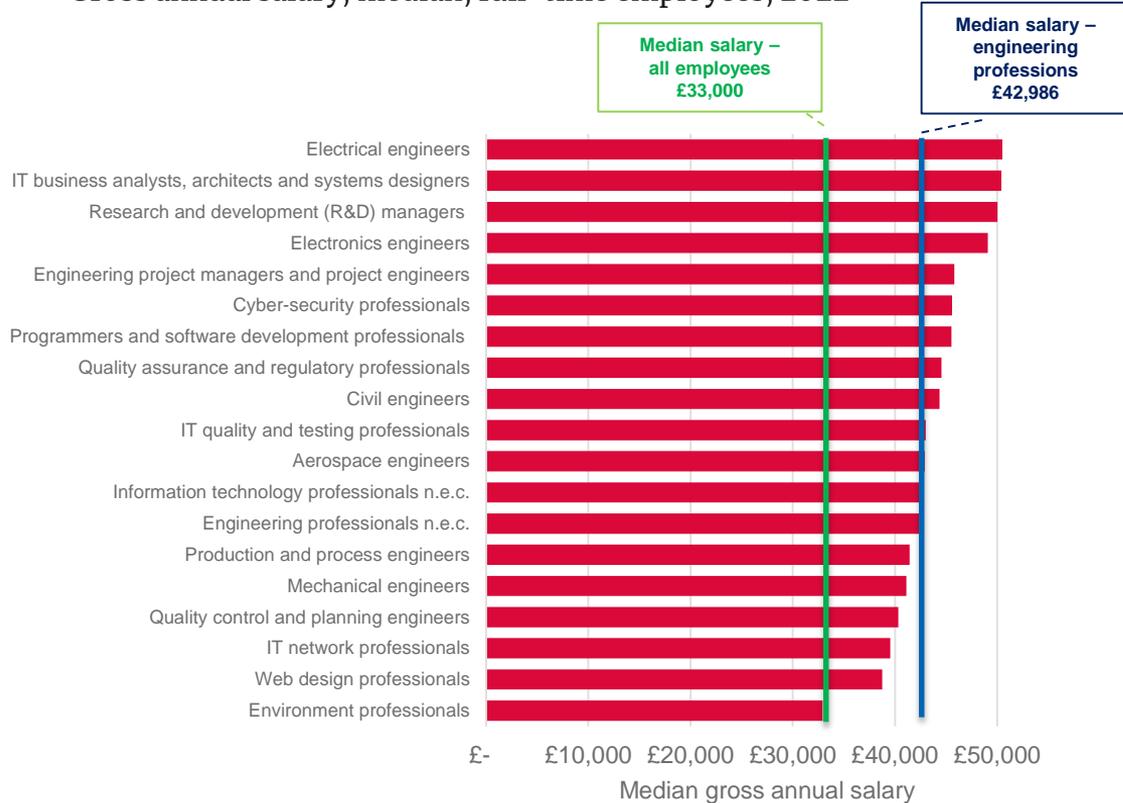
**Note:** Other sectors include: mining and quarrying; electricity, gas, steam and air conditioning supply; water supply; sewerage, waste management and remediation activities; transportation and storage; accommodation and food-service activities; real-estate activities; administrative and support-service activities; and arts, entertainment and recreation; other service activities; activities of households as employers; undifferentiated goods- and services-producing activities of households for own use; and the activities of extraterritorial organisations and bodies.

**Source:** HESA (2022). Figure 11 – standard industrial classification of graduates entering work in the UK by subject area of degree – higher education providers (HEPs) – academic year 2019/20.

- The chart on the left shows which economic sectors **STEM** graduates entering work in **the UK** are employed in, by subject area of degree for the academic year 2019/20, for example:
  - **Engineering and technology graduates:** 24% work in manufacturing; 21% in professional and scientific activities; and just 3% in finance and insurance.
  - **Physics graduates:** 21% work in professional and scientific activities; 17% in education; 14% in manufacturing; and 11% in information and communication.
  - **Mathematics graduates:** 19% work in finance and insurance; 18% in education; 17% in professional and scientific activities; and 16% in information and communication.
  - **Computing graduates:** high concentration in the information and communication sector (41%).

## Chart 4.5. Engineering profession salaries

Gross annual salary, median, full-time employees, 2022



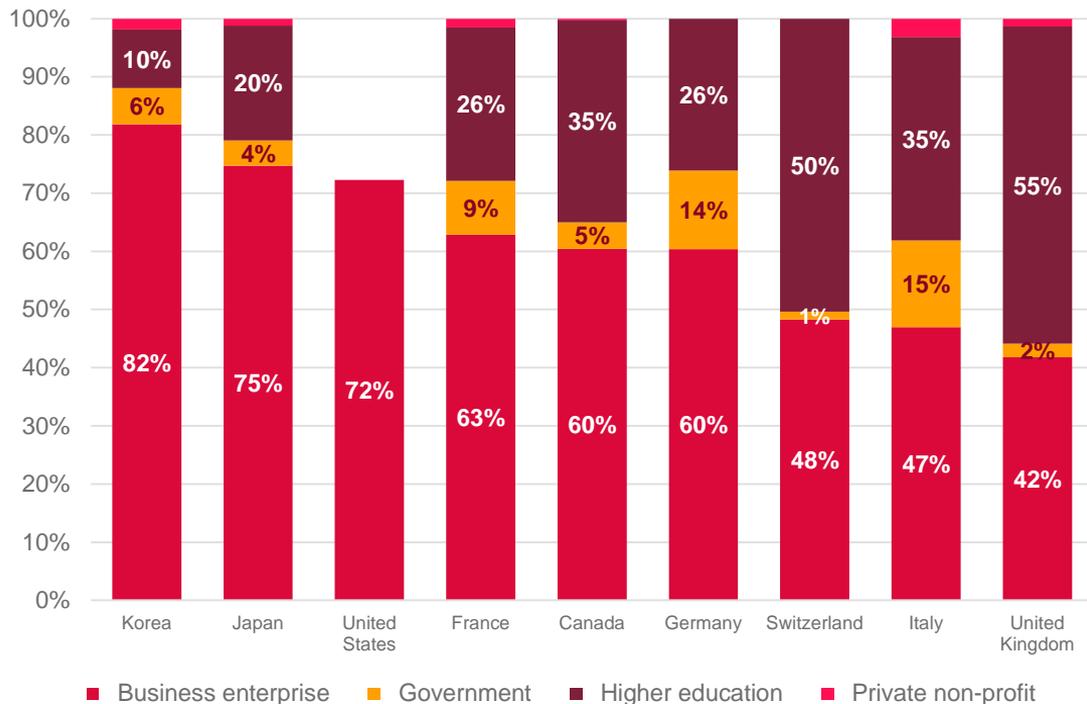
- In 2022 the median salaries for **engineering** occupations in **the UK** were higher than the average in the job market.
- In 2022 the median for **engineering** professionals' gross annual salaries was £42,986, against £33,000 of all **UK** workers.

**Note:** Standard Occupational Classification (SOC) codes for the engineering professions are based on Engineering UK (2018). The State of Engineering 2018; SOC2010 Codes were updated to SOC2020 Codes based on ONS (2022). SOC 2020 Volume 2: the coding index and coding rules and conventions.

**Source:** ONS (2022). Annual Survey of Hours and Earnings (ASHE) – Table 14.7a.

## Chart 4.6. Researchers by sector of employment

% of total researchers, FTE, selected countries, 2020 or latest available



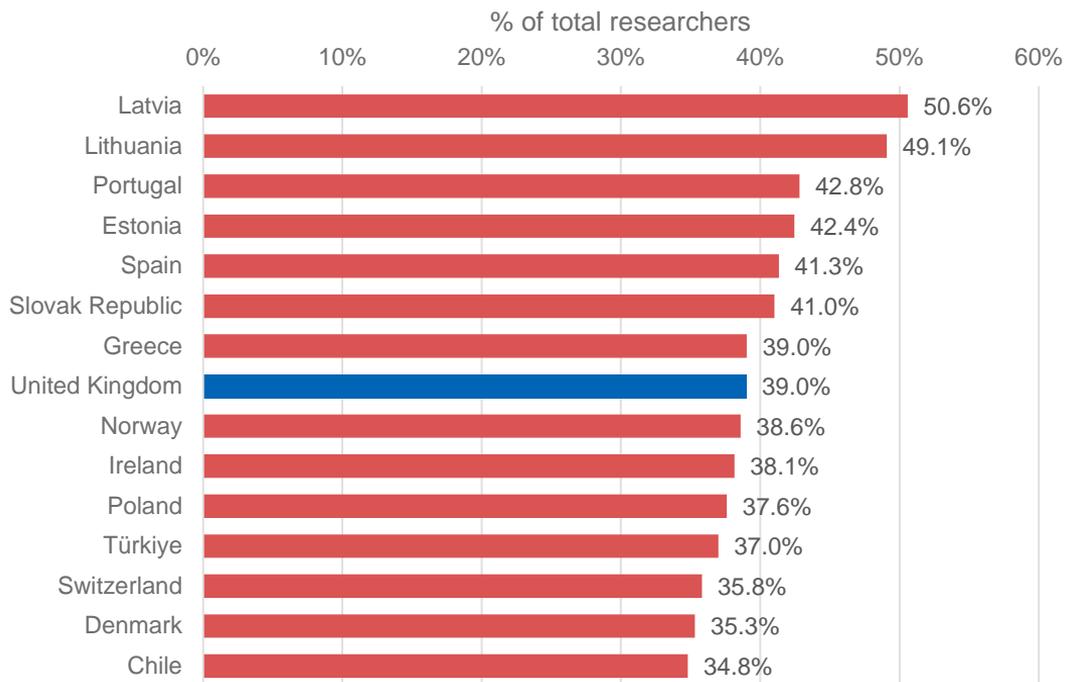
- Compared to key competitor countries, **the UK** has a relatively low share of researchers working in the business sector.
- In 2020 the **business sector** in **the UK** employed 42% of researchers, below the share employed by **Korea** (82%), **Japan** (75%) and **the US** (72%) but also below countries such as **France** (63%) and **Germany** (60%).
- Roughly 2% of **UK** researchers worked in the **government sector** in 2020, below comparator countries such as **Italy** (15%), **Germany** (14%) and **France** (9%).
- The UK** stands out for the share of researchers working in **higher education** (55%), the highest among comparator countries, followed by **Switzerland** (50%), **Canada** (35%) and **Italy** (35%).

**Note:** For Switzerland, the UK and the US, data refers to 2019; for the US, data is only available for business enterprises.

**Source:** OECD (2022). R&D personnel by sector and function database.

## Chart 4.7. Women researchers

% of total researchers, headcount, top 15 countries, 2019



- In 2019 **the UK** had a relatively high share of women researchers, featuring in eighth place among **OECD** countries where data is available.

**Note:** Data for the US not available.

**Source:** OECD (2022). Main Science and Technology Indicators.

# Theme 5: Environmental Innovation

## UK INNOVATION REPORT

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For many, the greatest challenge of the 21st century is climate change and environmental sustainability. Markets for new technologies that can help businesses and countries to achieve sustainability targets are expanding; therefore, they are a key area in which innovative activity has the potential to contribute to national economic growth and competitive advantage.

Our *2023 Innovation Report* has environmental innovation as a topic in focus, to highlight how the UK is performing in what has the potential to be a high-growth economic sector. While environmental goods, services and technologies are not clearly classified within typical economic indicators, this section brings together available data from the ONS, OECD and the EU to provide a snapshot of whether environmental innovation is translating into economic growth in the UK.

# Theme 5: Environmental innovation

## Key policy questions addressed

- How does the UK compare in environmental and energy technology research and development (R&D) investment?
- How is R&D expenditure translating into patenting performance?
- Is the UK capturing the economic potential of the transition towards environmental sustainability?

## Key findings

**The government R&D budget allocated to environment and energy innovation in the UK (as a share of total R&D budget) is similar to other leading nations, and has a positive correlation with the country's ranking in environment-related patent applications**

- The UK had the sixth highest government budget allocation for R&D in environment and energy innovation among OECD countries in 2020. This represented 6% of the UK's total budget allocation for R&D, higher than that of the United States (3%), but lower than Japan (8%), Germany (8%), Korea (8%), and France (9%).
- The UK ranked seventh in the world by the number of environment-related patent applications according to OECD data, behind Japan, the US, Germany, Korea, China, and France, and ahead of Taiwan, Canada and Italy.

**Half of the environmental goods and services sub-sectors in the UK have grown over the last decade (2010-2019) in terms of GVA, while the rest have declined**

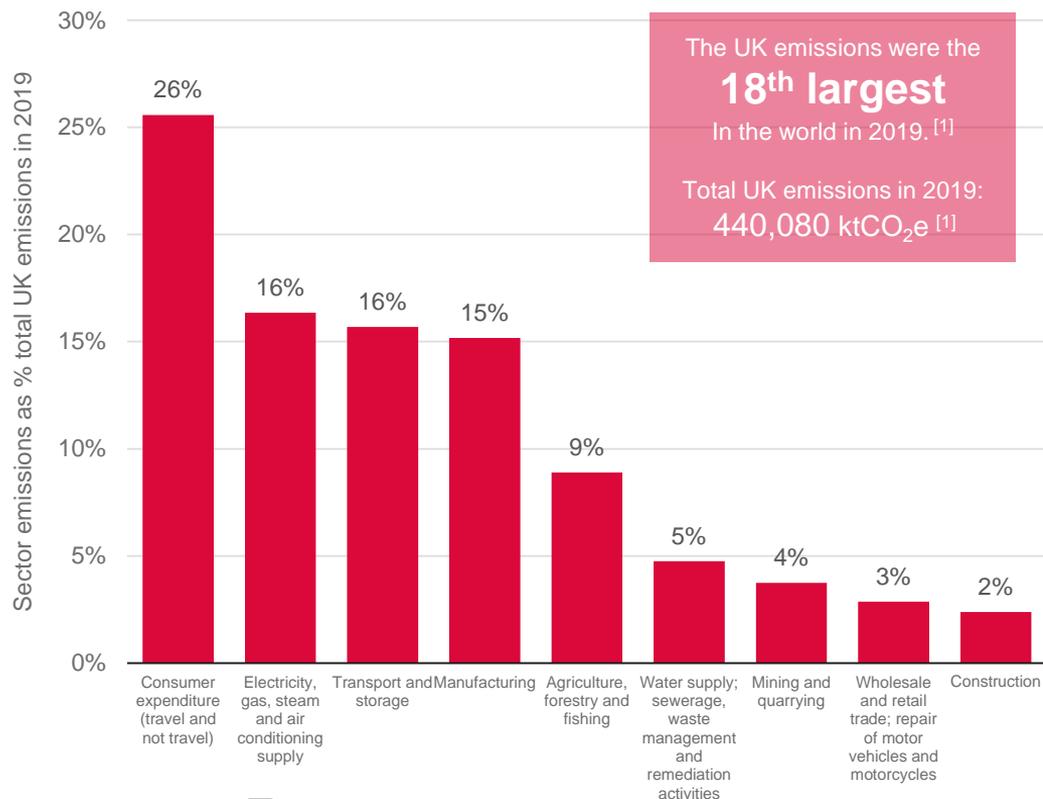
- Output in the UK environmental goods and services sector (EGSS) was estimated to be £89.0 billion in 2019 (up 4.4% from 2018), while gross value added was estimated to be £45.2 billion in 2019 (up 5.4% from 2018), and employment registered 394,900 full-time equivalent employees in 2019 (down 4.7% from 2018).
- The production of renewable energy was the activity in 2019 with the largest share of total EGSS output (22.5%) and GVA (26.4%).
- The activity of waste had the largest share of total EGSS employment (29.3%) and the second-largest share of total EGSS output (17.8%) in 2019.

**The UK environmental goods and services sector performs strongly at European level, ranked 2nd by GVA only behind Germany**

- Output in the UK environmental goods and services sector was the 3rd highest in Europe in 2019, after Germany and France.
- Gross value added in the UK EGSS was the 2nd largest in Europe in 2019, after Germany.
- Exports from the UK EGSS were the 3rd largest in Europe in 2019, after Germany and Austria.
- Employment in the UK EGSS was the 5th highest in Europe in 2019, after Germany, France, Spain and Italy.

## Chart 5.1. UK carbon emissions by sector

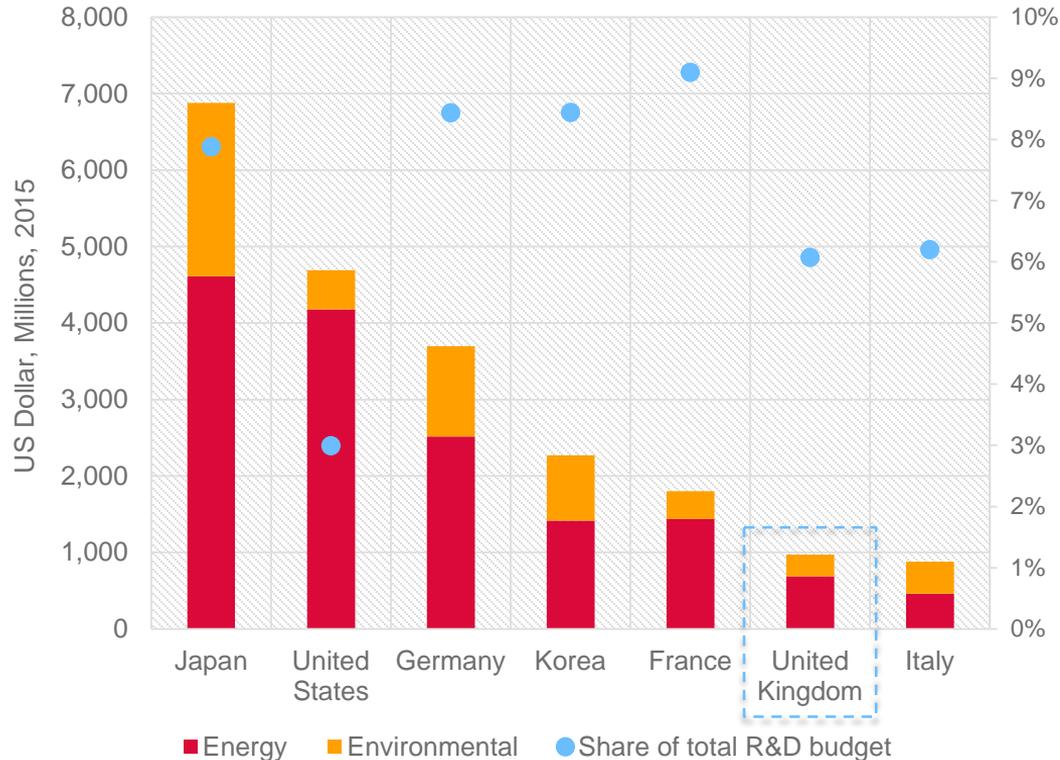
UK emissions of greenhouse gases by industry, share of total emissions in 2019



- The **UK** is one of the top 20 emitters globally and has above-average emissions per capita, even before accounting for emissions embedded in imported goods. The **UK's** emissions were the 18th largest in the world in 2019.<sup>[1]</sup>
- In 2019, four industry sections accounted for 73% of carbon emissions in the **UK**: **consumer expenditure** (26%); **electricity, gas, steam and air conditioning supply** (16%); **transport and storage** (16%); and **manufacturing** (15%).
- Carbon emissions abatement represents a significant challenge but also a significant opportunity for innovation, together with other legally binding environmental targets set by the government's **Environment Act**:<sup>[2]</sup>
  - Halt the decline in species populations by 2030;
  - Restore precious water bodies to their natural state;
  - Deliver net zero ambitions and boost nature recovery by increasing tree and woodland cover to 16.5% of total land area in England by 2050;
  - Halve the waste per person that is sent to residual treatment by 2042;
  - Cut exposure to the most harmful air pollutant to human health – PM2.5;
  - Restore 70% of designated features in Marine Protected Areas to a favourable condition by 2042.

## Chart 5.2 Government budget allocations for R&D (environment & energy innovation)

2020, top countries (2015 US Dollars)

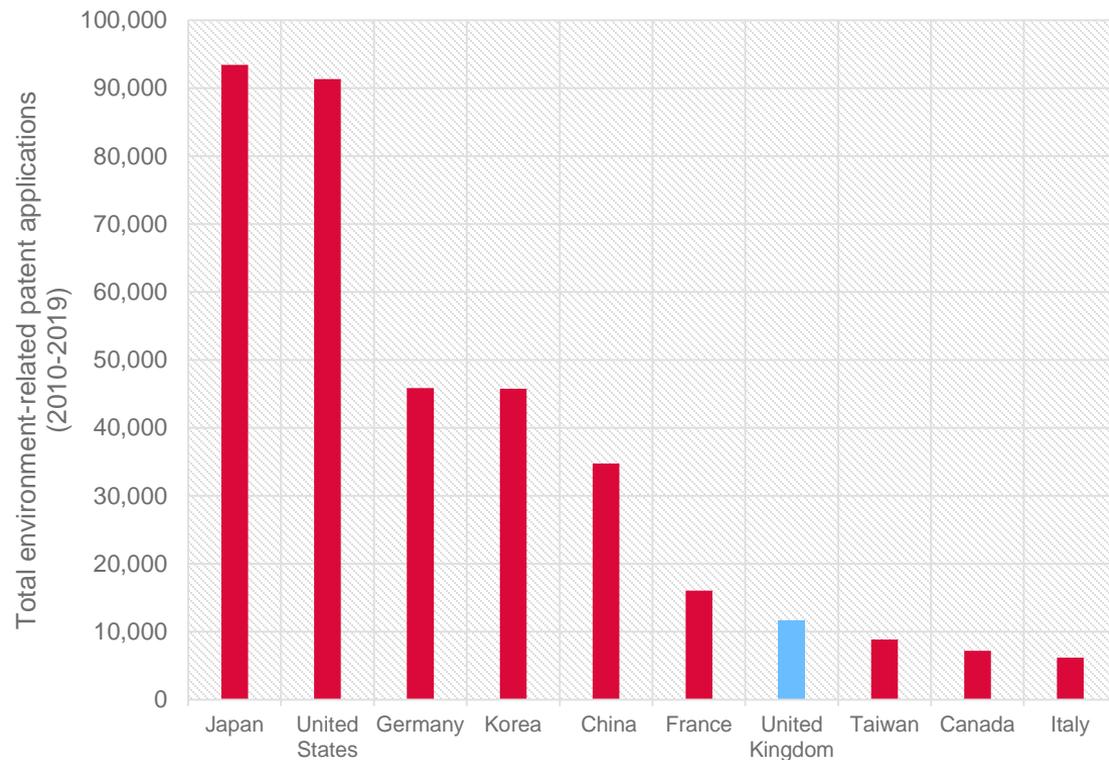


- In absolute numbers, the **UK** had the sixth highest government budget allocation for R&D in environment and energy innovation among **OECD** countries in 2020.<sup>[1]</sup>
- This represented roughly 6% of the **UK's** total budget allocation for R&D. This share is higher than that of the **United States** (3%), but lower than other leading countries such as **Japan** (8%), **Germany** (8%), **Korea** (8%), and **France** (9%).
- Government budget allocations for R&D in environmental innovation are significantly lower than allocations for energy R&D in all leading nations, except for Italy where both categories show similar budget allocations in absolute numbers.

Note: <sup>[1]</sup> The OECD presents data on Government budget allocations for R&D (GBARD) by socio-economic objective (SEO), using the NABS 2007 classification. Geographic coverage includes OECD members plus Romania, Russian Federation and Chinese Taipei.

## Chart 5.3 Innovation in environment-related technologies

Top countries by total number of patent applications, 2010–2019 (patent families by inventor country)

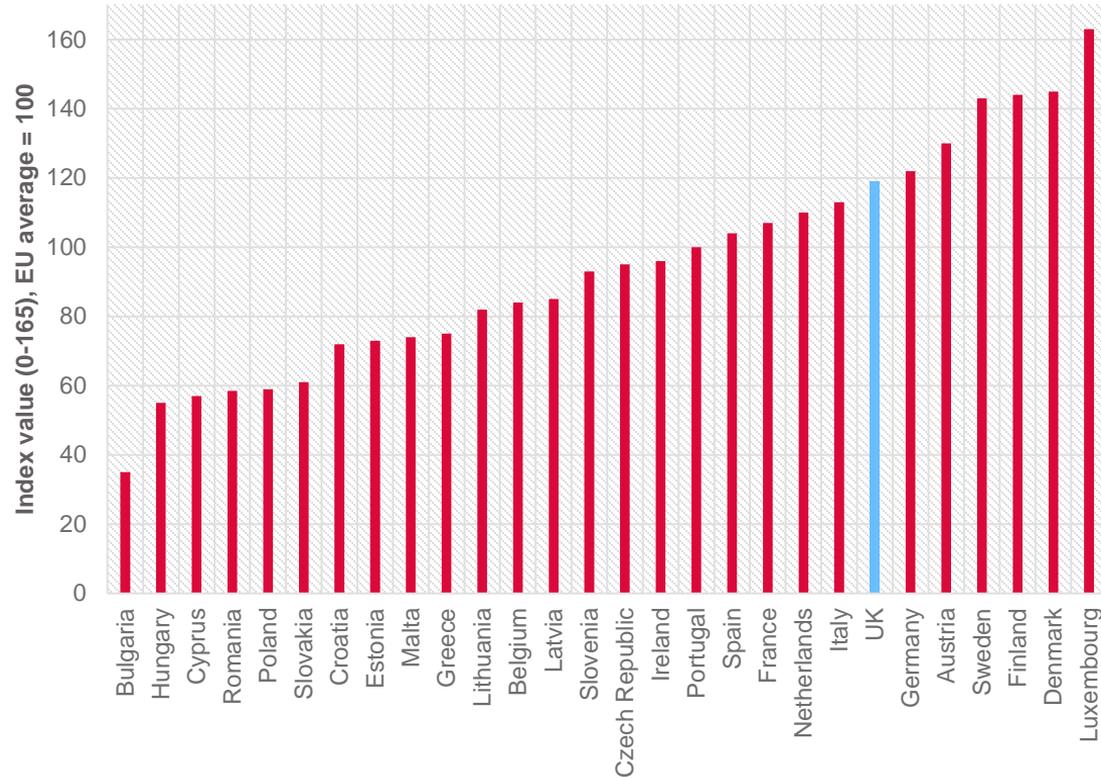


- The **UK** ranks seventh in the world by the number of environment-related patent applications, behind **Japan, the US, Germany, Korea, China, and France**, but ahead of **Taiwan, Canada and Italy**.<sup>[1]</sup>
- Technologies covered under the **OECD's "environment-related technologies"** group include:
  - Environmental management;
  - Climate change mitigation technologies related to energy generation, transmission and distribution;
  - Capture, storage, sequestration or disposal of greenhouse gases;
  - Climate change mitigation for transport;
  - Climate change mitigation for buildings;
  - Wastewater treatment and waste management;
  - Climate change mitigation in the production or processing of goods;
  - Climate change mitigation in information and communication technologies.

**Note:** <sup>[1]</sup> The patent family concept (defined as all patent applications protecting the same 'priority') is applied to all statistics presented here (i.e. counts of patent families by inventor country). Consistent with other patent statistics provided in OECD.Stat, only published applications for "patents of invention" are considered (i.e. excluding utility models, petty patents, etc.). The relevant patent documents are identified using search strategies for environment-related technologies.

## Chart 5.4 Eco-innovation performance

EU 28 Eco-Innovation Index for the year 2019



- The Eco-Innovation Index gathers data on eco-innovation performance across the **EU** and beyond, thus helping to monitor and evaluate progress made since 2010.<sup>[1]</sup>
- The Index included data for the **UK** up to 2019. In this year, the highest (aggregated) Eco-Innovation Index belonged to **Luxembourg** (index value: 165, EU-average=100), followed by **Denmark, Finland, Sweden, Austria, Germany** and the **UK**.
- The **UK's** position on the Eco-Innovation Index increased from **11th** to **7th** between **2017** and in **2019**.
- Among the indicators for the Eco-Innovation Index, the **UK** showed a strong performance in resource efficiency (i.e. material-, water- and energy productivity, and GHG intensity), where it ranked **3rd** in **2019**.
- The **UK** was above the **EU** average in environmental and energy R&D, R&D personnel, early stage green investments, innovating enterprises obtaining environmental benefits, and ISO 14001 companies.
- The country ranked slightly below the **EU** average for relevant patents and academic publications per million inhabitants, media coverage of eco-innovation topics per electronic media source, exports, revenues and employment from the eco-industries and circular economy.

# Chart 5.5 UK environmental goods & services sector (EGSS)

Output, GVA and exports in current £ million, employment in full-time equivalents

Activities	Output (£ million)		GVA (£ million)		Exports (£ million)		Employment (full-time equivalents)	
	2010-2019 average	CAGR	2010-2019 average	CAGR	2010-2019 average	CAGR	2010-2019 average	CAGR
Wastewater	9,291.4	1.7%	7,759.7	1.3%	-	-	20,060	2.3%
Water quantity management	9,491.8	3.0%	6,702.7	2.3%	4.8	6.4%	31,210	5.6%
Waste	13,170.3	5.0%	5,241.2	4.4%	3,624.7	0.6%	107,640	2.0%
Production of renewable energy	8,012.6	29.0%	4,483.1	31.9%	161.3	22.2%	9,570	19.3%
Environmental related construction	7,023.5	-2.6%	2,799.1	-3.1%	-	-	52,550	-2.1%
Recycling	7,945.0	-2.1%	1,880.9	-4.5%	2,852.1	0.3%	23,600	-1.2%
Low emission vehicles, CCS, and inspection and control	4,921.6	6.7%	1,841.7	6.9%	2,781.9	7.3%	17,030	4.2%
Environmental charities	2,279.4	0.0%	873.7	-0.2%	-	-	21,540	8.8%
Energy saving and sustainable energy systems	1,722.6	-1.0%	766.6	1.1%	158.5	4.1%	15,870	-0.4%
Managerial activities of government bodies	1,523.1	-2.7%	587.2	-3.0%	-	-	21,540	-4.7%
Environmental consultancy and engineering	988.6	-4.5%	579.1	-5.3%	79.9	7.8%	10,400	-6.7%
In-house environmental activities	732.5	-8.0%	572.7	-9.8%	-	-	5,240	-9.4%
Management of forest ecosystems	1,224.9	5.3%	487.0	7.1%	8.2	-2.4%	8,760	2.4%
Production of industrial environmental equipment	1,276.1	1.4%	474.8	1.7%	296.4	0.8%	9,640	-0.5%
Insulation activities	933.1	0.5%	339.2	-1.0%	237.6	7.9%	6,680	-0.7%
Organic agriculture	668.2	-2.5%	336.1	-1.9%	69.4	-1.3%	9,740	-4.0%
Environmental related education	342.1	4.9%	142.5	14.4%	-	-	2,260	3.1%

- The **environmental goods and services sector (EGSS)** estimates from the **ONS** follow the **UN System of Environmental- Economic Accounting (SEEA)**. It measures 17 activities across the economy that produce goods and services for environmental protection and resource management purposes.<sup>[1]</sup>
- As defined by the **ONS** and international guidelines, the environmental goods and service sector includes "**areas of the economy engaged in producing goods and services for environmental protection purposes, as well as those engaged in conserving and maintaining natural resources**". These areas of the economy must also produce the goods and services for primarily environmental reasons.
- **Output** in the **UK** environmental goods and services sector (EGSS) was estimated to be £89.0 billion in **2019**, up 4.4% from **2018**.<sup>[2]</sup>
- **Gross value added (GVA)** in the **UK** EGSS was estimated to be £45.2 billion in **2019**, up 5.4% from **2018**.<sup>[2]</sup>
- **Employment** in the **UK** EGSS was estimated to be 394,900 full-time equivalent (FTE) employees in **2019**, down 4.7% from **2018**.<sup>[2]</sup>
- The **production of renewable energy** was the activity in **2019** with the largest share of total EGSS **output** (22.5%) and **GVA** (26.4%).<sup>[2]</sup>
- The activity **waste** had the largest share of total EGSS **employment** (29.3%) and the second-largest share of total EGSS **output** (17.8%) in **2019**.<sup>[2]</sup>

**Note:** <sup>[1]</sup> EGSS estimates use a range of data sources, including the ONS' low carbon and renewable energy (LCREE) estimates, supply and use tables (SUT), the annual business survey (ABS), and the business register and employment survey (BRES).

<sup>[2]</sup> ONS (2022). [Environmental goods and services \(EGSS\) estimates.](#)

## Chart 5.6 UK environmental goods & services sector (EGSS) – International comparison

Top European countries per category (2019). Output, GVA and exports in current € million; employment in full-time equivalents <sup>[1]</sup>

Country	Output (€million)		GVA (€million)		Exports (€million)		Employment (full-time equivalents)	
	2019	Ranking	2019	Ranking	2019	Ranking	2019	Ranking
Germany	197,379.4	1	68,023.1	1	39,992.7	1	657,035	1
France	115,464.7	2	44,920.3	3	9,568.8	5	610,099	2
United Kingdom <sup>[2]</sup>	98,386.5	3	47,773.3	2	12,736.9	3	404,199	5
Italy	81,482.6	4	34,063.0	4	5,476.8	9	435,677	4
Spain	62,684.4	5	28,002.8	5	6,515.6	8	436,661	3
Austria	41,570.9	8	16,734.9	8	13,356.7	2	183,507	7
Denmark	34,793.1	11	10,438.7	12	11,504.5	4	79,123	15

- The **UK** performs strongly in terms of EGSS output, GVA, exports and employment when compared to other leading European nations.
- **Output** in the **UK** environmental goods and services sector (EGSS) was the **3<sup>rd</sup>** highest in Europe in **2019**, after **Germany** and **France**.
- **Gross value added (GVA)** in the **UK** EGSS was the **2<sup>nd</sup>** largest in Europe in **2019**, after **Germany**.
- **Exports** from the **UK** EGSS were the **3<sup>rd</sup>** largest in Europe in **2019**, after **Germany** and **Austria**.
- **Employment** in the **UK** EGSS was the **5<sup>th</sup>** highest in Europe in **2019**, after **Germany**, **France**, **Spain** and **Italy**.

Source: [Eurostat \(2023\)](#). Accessed 30 January 2023.

## Cambridge Industrial Innovation Policy

Cambridge Industrial Innovation Policy (CIIP) is a global, not-for-profit policy group based at the Institute for Manufacturing (IfM), 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 practices. This report was delivered through IfM Engage, the knowledge transfer arm of the Institute for Manufacturing (IfM), University of Cambridge

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