Department for
Business, Energy
& Industrial Strategy

International comparison of the UK research base, 2022

Accompanying note

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Any enquiries regarding this publication should be sent to us at:
enquiries@beis.gov.uk

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Executive Summary

The report evaluates the performance of the UK's research base in an international setting using research output bibliometric data, giving an overview of the long-term trends (in period 1996 to 2020) and focusing on UK's performance more recently (in period 2016 to 2020).

The UK's performance is compared against that of the other G7 countries: Canada, France, Germany, Italy, Japan and the United States, as well as Brazil, China, India, Russia, and South Korea.

This report is an update on the 2019 edition and the latest in a series of publications assessing the UK's research performance[1], to enable continued monitoring of UK's research performance.

Key findings

The UK is showing an upward trend in the annual count of research publications; however, this growth is not as fast as in some other nations leading to the UK showing slightly decreasing shares of world publication counts.

The UK has maintained its field-weighted citation impact (FWCI) as the highest among the comparators, whilst its share of the world's highly-cited publications has declined very slightly.

The UK is a relatively well-rounded research nation, publishing across the full range of fields, but with some variation by subject area. It has higher than average publication shares for Medical Science, Social Sciences and Humanities and slightly lower than average publication shares for Natural Sciences, Agricultural Sciences and Engineering and Technology.

International collaboration reflects levels of international partnerships in research and innovation and international partnerships achieve higher citation impact than domestic collaborations.

The UK's research base has a very high level of international collaboration. Nearly 60% of the UK's publications in 2020 were co-authored with at least one non-UK researcher, currently the highest amongst the comparators.

[1] International comparison of the UK research base, 2019;
Performance of the UK research base: international comparison, 2016;
Performance of the UK research base: international comparison - 2013;
UK research base international comparative performance 2011

Introduction

This note summarises key findings from the latest 'International comparison of the UK research base' statistical release[2] and is an update of the 2019 release[3]. The release evaluates the UK's research performance in an international setting, by comparing different aspects of scholarly outputs across a selection of comparators.

Comparator countries for this release include, all of the G7 countries: Canada, France, Germany, Italy, Japan, the United Kingdom (UK), and the United States (US); and five other major economies: Brazil, China, India, Russia, and South Korea. The EU27[4], the Organisation for Economic Cooperation and Development (OECD), and the World values are included as benchmarks. There has been a dramatic shift in the research focus of emerging countries in the last decade and as they shape world trends together with the traditional research centric countries, they were included in the comparison. While this group of twelve countries is by no means comprehensive, together with the benchmarks, it does enable identification of key global trends. Previous releases employ the same selection of countries which, in addition, enables continued monitoring of scholarly performance.

Sources and Methodology

This report uses bibliometric data from SciVal, which is a data portal for Scopus (an abstract and citation database licensed by Elsevier[5] see Appendix 1). Scopus data has been used for BEIS performance releases since 2011 and it covers multi-lingual and global peer-reviewed literature, published in journals, book series and conference proceedings[6] among other features of research performance.

The Scopus database is live and updated monthly. Certain indicators, especially those linked to citations, may therefore retrospectively change and the values within this release may differ to values published in any past and future releases.

Assessment and comparison of research performance is carried out using a range of bibliometric indicators: share of total world publications, share of total world citations, share of total world highly-cited publications, field-weighted citation impact and indicators of collaboration, with focus on international collaboration. Detailed description of the indicators can be found in the Appendix.

[2] International comparison of the UK research base, 2022
[3] International comparison of the UK research base, 2019
[4] EU 27 entry represents all current European Union countries.
[5] About Elsevier webpage
[6] The database is drawn from approximately 5,000 publishers and 70 million core records. For further information, see: About Scopus webpage

Period studied in this report

This report provides an overview of long-term trends (in period 1996 to 2020) and a more focused view of performance and comparison of the UK and comparator countries more recently, in period 2016 to 2020. The years refer to the year of publication and 2020 is the last year of complete data available. It is not possible to ascertain the effect of the Covid-19 pandemic with the data available.

An analysis of the growth in scientific journal publishing from a longitudinal aspect carried out by Springer[7], observing the first six months of the years 2016 to 2020, found that while there was a large surge in the total number of publications as compared to previous years, COVID-19 publications seem to account for the growth almost in its entirety. The number of non-COVID-19 related publications follows the same pattern of previous years. This may be reflected in section “Activity index and subject area analysis”.

Bibliometric indicators and their limitations

This report uses the following types of indicators:

Numbers and shares of publications

Publication volumes, and by extension shares of total publications, provide an indication of the scale of output of the research bases in different countries and different subject areas. In this report, it is used to compare the sizes of research bases of comparators and specifically, to understand UK’s position in terms of its research base size.

However, there are several things to consider when using this indicator. Volume of research may not necessarily be associated with quality of research. Moreover, different countries and areas may have different propensities to publish their findings. Finally, the source data has high, but not 100% coverage of publications worldwide, and there may be some bias toward English-language publications.

Citation indicators

When a publication is cited in another publication, it is an indicator that it is having an impact – the greater the number of citations, all else equal, the greater that impact might be expected to be. Citation indicators, including those used here – share of citations, share of most highly-cited publications, and field-weighted citation impact – are therefore commonly used as a proxy for quality of publications.

However, citations will not always be an indicator of quality. For example, a publication could be cited a lot because a paucity of other sources – indicating impact perhaps but not necessarily quality – or even because it is being cited as being flawed.

[7] Publication patterns’ changes due to the COVID-19 pandemic: a longitudinal and short-term scientometric analysis

Collaboration indicators

International collaboration is indicated by the presence of international co-authors in a publication. It reflects levels of international partnerships in research and innovation.

In the data used for this report, however, international authorship is according to the location of the institution listed by the authors as their affiliation. The nationality of authors is unknown. So, some types of international collaboration will be missed – such as researchers from different countries currently working for institutions in the same country; and some included where the collaboration could be between authors of the same nationality, currently working in institutions in different countries.

Definitions of the indicators used can be found in the Appendix.

Measuring change

Standard methods of measuring change over time are used throughout this report: Percentage change and Compound annual growth rate (CAGR). Percentage change shows the overall change in value at the end of the period relative to the start date. CAGR is defined as the constant year-on-year rate of change over a specified period of time. Starting with the earliest value in 2016, the CAGR shows what constant yearly change of for example publications would have resulted in the value observed in 2020. In this report the CAGR gives an indication of the most recent 5-year time trend for each performance measure.

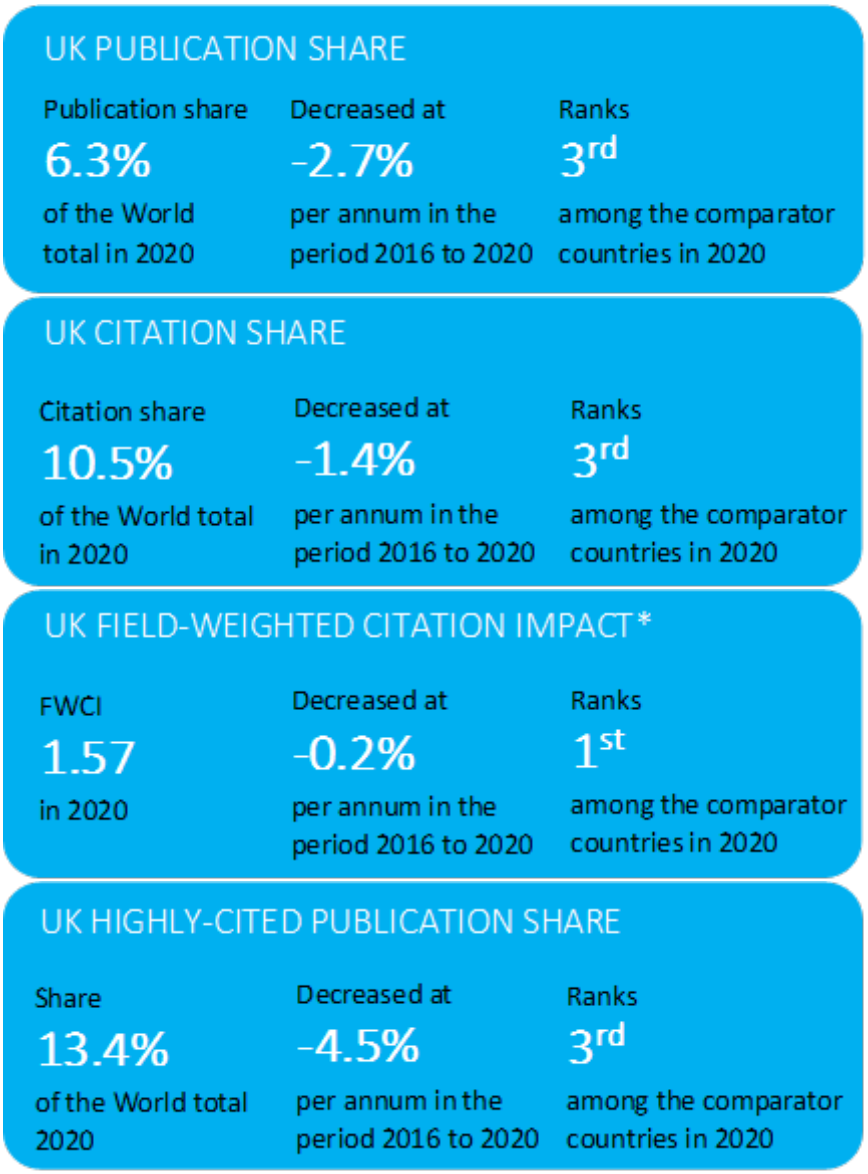
Subject area definitions

To analyse performance of the UK and comparators in different subject fields, Fields of Research and Development (FORD) classification is used. This classification is used in the Frascati Manual of the OECD[8].

[8] Frascati manual webpage

Research Outputs

Highlights



*Field-weighted citation impact compares how a number of citations for a given set of publications compares to the average number of citations received by all world publications in the same field (for a full definition of FWCI, see Appendix).

A decline in the recent growth across all indicators can be seen for the UK.

Both quantity and impact (in terms of citations) of the UK's research output place it at the top of many of the rankings. However, steady growth of other countries in both publication volume and citation performance, notably China and India within this report's selection, has led to decreasing shares of the world outputs for the more traditional research nations (including the US and Germany).

Even though the UK is showing an upward trend in the annual count of publications, this growth is not as fast as in some other nations and leads to the slightly decreasing trend in UK's world publication shares.

While UK maintained its citation impact as the highest among comparator countries, its share of the world's highly-cited publications has declined very slightly.

Key Findings

World publication shares

UK researchers published 225,595 articles in 2020, corresponding to a continuous growth of 1.3% per annum on the 214,082 publications published in 2016. This annual growth results in an overall increase of 5.4% in the 5 years from 2016 to 2020.

As shown in Figure 1, the UK has maintained its third place in world publication shares since 2004, when China became the second largest nation in number of publications. In 2020, China (773,140 publications) also overtook US (708,092 publications) and became top ranked publications producer and share-holder. China accounted for 21.7%, while US and the UK produced 19.9% and 6.3% of world publications in 2020, respectively.

Figure 2 shows the recent faster growth of India (8.1% per annum and 36.5% overall, for period 2016 to 2020) in the volume of research output. India ranks fourth with 211,834 publications (5.9% of world publications) in 2020, having swapped 4th place with Germany in 2019.

The UK's annual growth in the number of publications in period 2016 to 2020 (1.3%) is slower than the world average of 4.1%, but faster than some other research-intensive countries, such as Japan (1.1%), France (0.1%) and US (0.8%). Significant annual growth, in period 2016 to 2020, in the number of publications of China (11.4%), Russia (11.0%) and India (8.1%), means that the UK, as well as other large research nations, are seeing a decline in their world shares of publications (see Figures 1 and 2).

Figure 1 - Share of world publications for the UK and comparator countries, for the period 1996 to 2020.

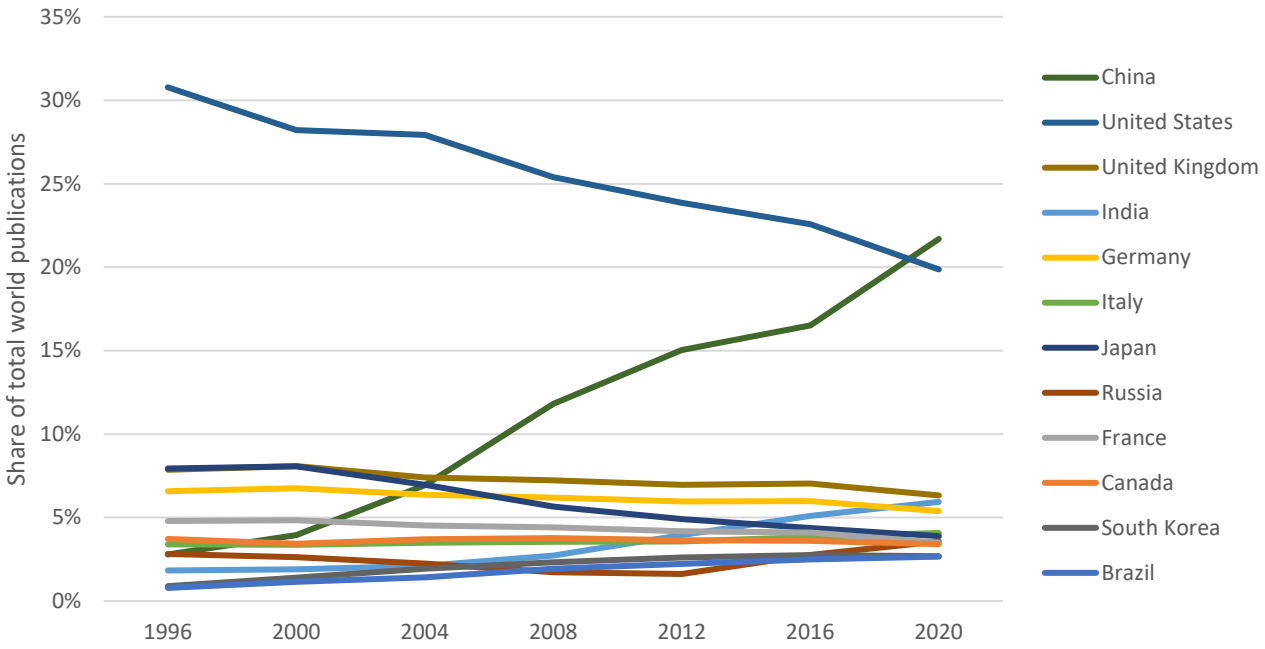


Figure 2 provides a detailed insight into the more recent trends (2016 to 2020) in the world publication shares by highlighting the lower part of Figure 1 only. To this end the y-axis has been set to values between 2% and 8% and US and China have been removed.

Figure 2 (Lower section of Figure 1) - Share of world publications for the UK and comparator countries, excluding US and China, resetting the axis between 2% and 8% and focusing on the period 2016 to 2020.

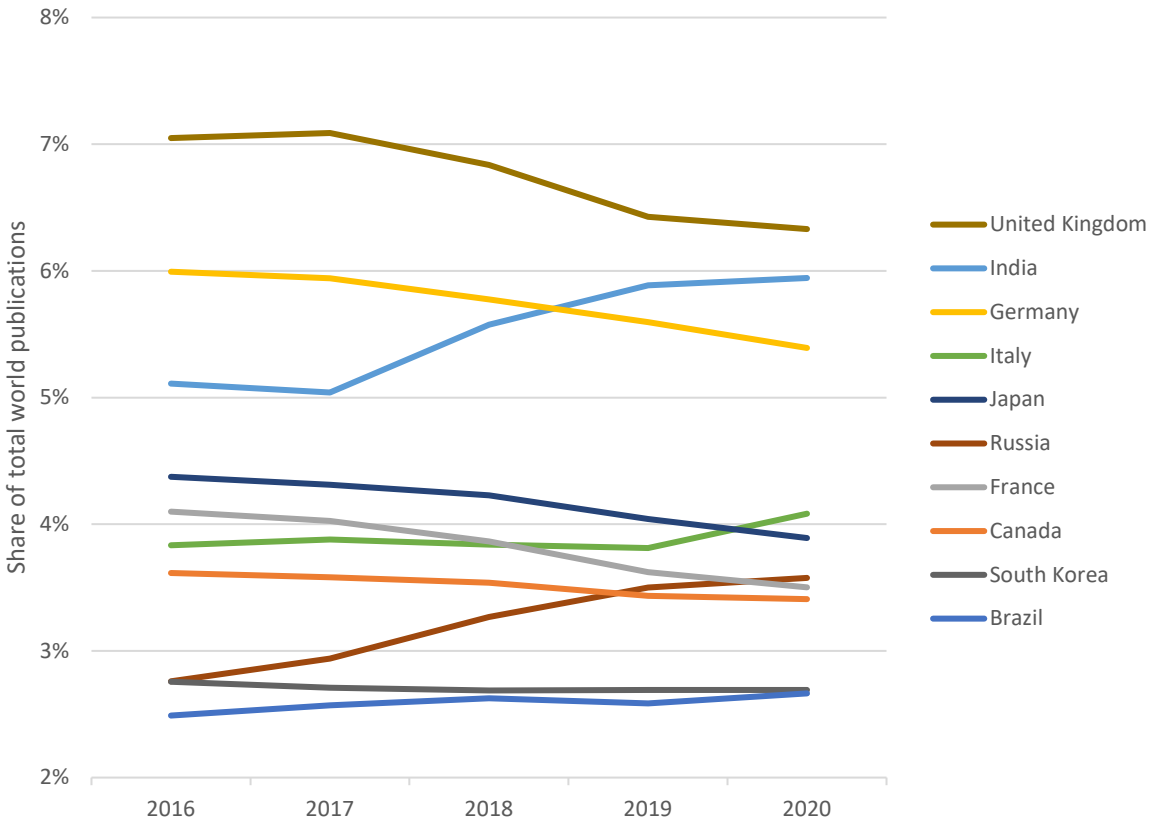


Table 1 - Shares of world publications: values and ranking of the UK in 2016 and 2020.

Entity	2016	2020	Percentage Change	CAGR[9]	UK rank 2016	UK rank 2020
UK	7.0%	6.3%	-10.2%	-2.7%	-	-
EU27	25.5%	24.0%	- 5.8%	-1.5%	1[10]	1[10]
OECD	63.3%	57.5%	- 9.3%	-2.4%	2	2
World	100%	100%	-	-	3	3

Table 1 shows that, despite its slowly falling share of world publications, the UK has maintained its high rankings above the EU countries, at second in the OECD and third in the world.

[9] CAGR stands for Compound Annual Growth Rate. See Methodology Section for definition.
[10] UK's ranking when compared to each of the 27 countries that make the EU, EU27 does not include the UK in this report.

Activity Index and Subject Area analysis

The relative importance of a subject/discipline in a country's research performance is given by the relative share of that subject/discipline in that country's total. The Activity Index[11], for a given subject area, is defined as the ratio of the country's subject share of all country publications to the World's subject share of all world publications. To illustrate this with an example, in 2020 the UK published 39% of its total research output in Medical Sciences, while globally Medical Sciences represented 33% of all publications in the same year. Therefore, the Activity Index for the UK in Medical Sciences in 2020 was 39%/33% = 1.2.

The Activity Index is a means of showing the relative importance of different subjects within a country with respect to the world: a value of 1 indicates that the country's share of the subject or discipline is the same as the world's, value higher than 1 implies the country's share is higher than the world and lower than 1 suggests a lower share than the world.

As shown in Figure 3, the UK has around half of its subject areas showing an Activity Index greater than 1 and the remaining half below but close to 1. For the UK, Engineering and Technologies, Agricultural Sciences and Natural Sciences fall below the world's shares. In terms of the changes in those three subject areas' Activity Index:

1. Natural Sciences relative share in 2020 (0.83) has not changed significantly since 2012 (0.85).
2. Agricultural Sciences in 2020 (0.75) is slightly lower compared to 2012 (0.86)[12].
3. The Activity Index in Engineering and Technology has grown since 2012 (0.60) although they are the lowest share for the UK in 2020 (0.66)[13].
4. Despite a falling Activity Index on Humanities and Social Sciences between 2012 and 2020, the UK remains between 40% and 50% above the world average in both subjects (at 1.49 and 1.43 respectively). Finally, the UK's focus on Medical sciences has increased in the last eight years to around 20% above the worlds activity baseline.

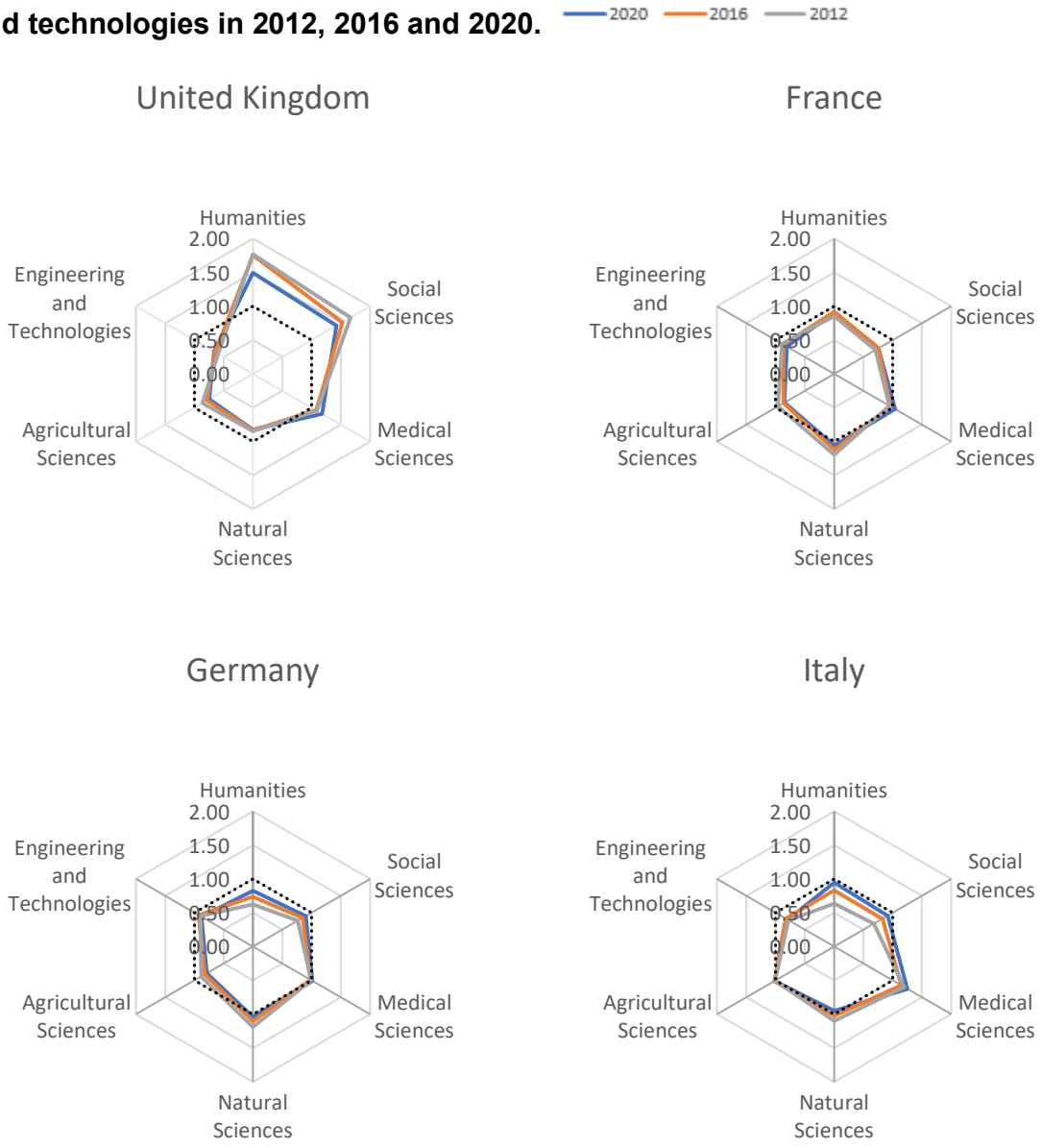
Other research-intensive countries are showing a well-rounded profile of Activity Index, with US showing a similar profile to the UK's. On the other hand, emerging, fast-growing countries are showing a less balanced Activity Index, with significantly greater focus on some subject areas than the others. China's noticeable focus on Engineering and Technologies and Natural Sciences and its growing focus on Social and Agricultural Sciences make its profile more like those of South Korea and India. Brazil has maintained its particularly high focus on Agricultural Sciences, while Russia has expanded its focus towards Humanities.

[11]Hu, X., & Rousseau, R. (2009) "A comparative study of the difference in research performance in biomedical fields among selected Western and Asian countries" *Scientometrics*, 81 (2) pp. 475-491.

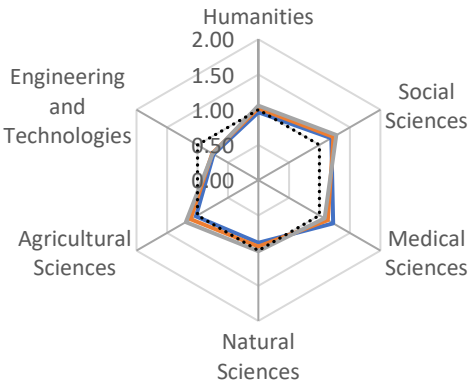
[12] However, this proves to be a trend among comparator countries, apart from China.

[13] Worth noting Engineering and Technology activity shares have grown among comparator countries, except for India

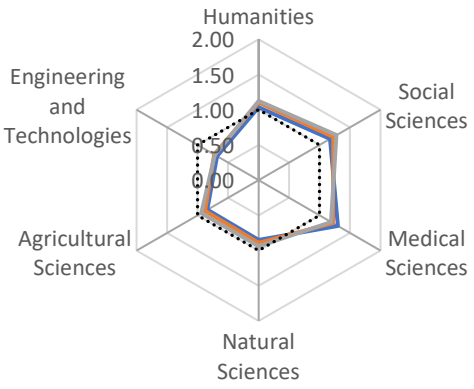
Figure 3 - Activity Index for the UK and comparators, across six research areas: Humanities, Social sciences, Medical sciences, Natural sciences, Agricultural sciences and Engineering and technologies in 2012, 2016 and 2020.



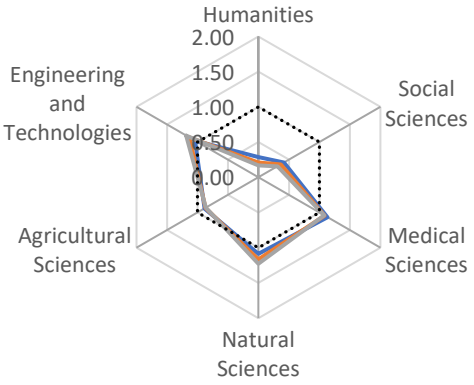
Canada



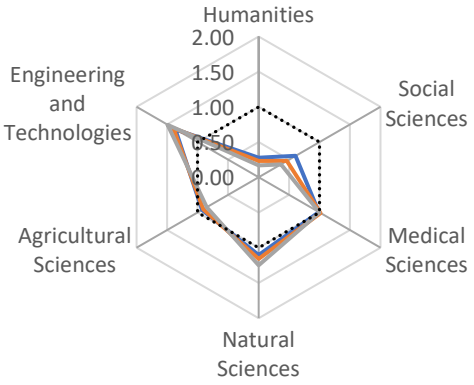
United States



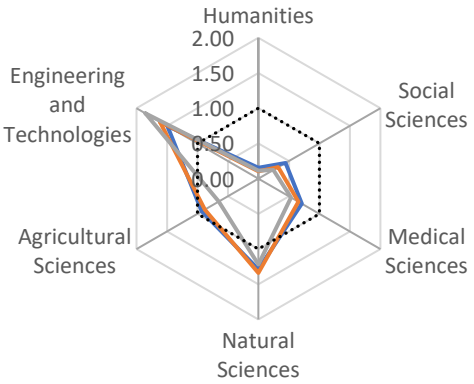
Japan



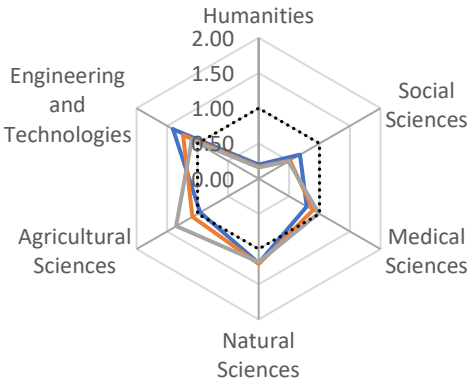
South Korea

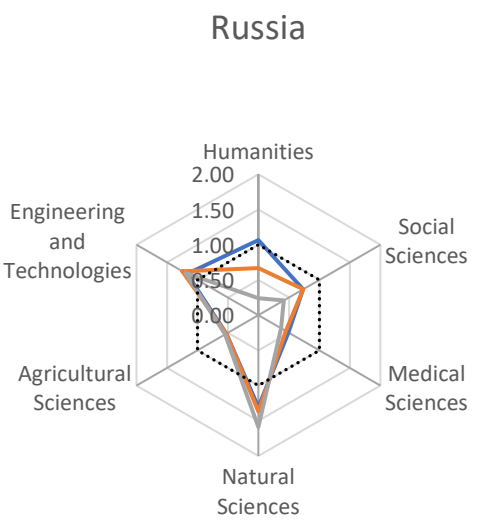


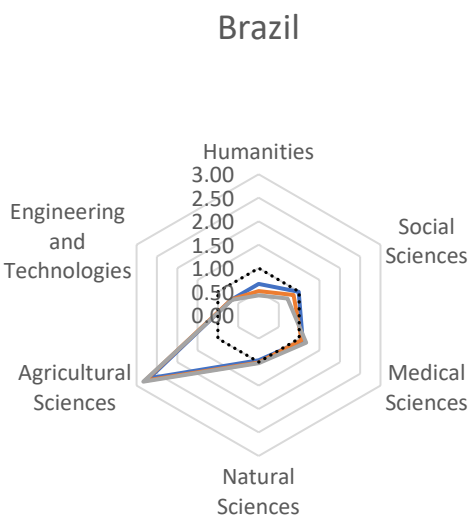
China



India







Citation shares

Citation count, the number of citations received by a publication from research outputs published after it, is an indicator of the documented impact that the research has. The UK has maintained its third place in the world share of citations, despite a period of shrinking citation counts. Figure 4 shows the continued decline in world citation shares for the US and continued rise for China. This evolution has led to China at 29.7% overtaking the US at 27.4% as the top's world citation share-holder in 2020. Unlike the case of publications, Germany continues to rank fourth in citation shares, but Figure 5 with the detail shows that India is catching up with top performers in this indicator. This reflects the fact that citation shares often follow publication shares with some lag if the publication trend is sustained, as it takes around three years for citations of research to start converging to their final count after it has been published.

Figure 4 - Share of world citations for the UK and comparator countries, for period 1996 to 2020. This period refers to when the research output was published and not when the citations were received.

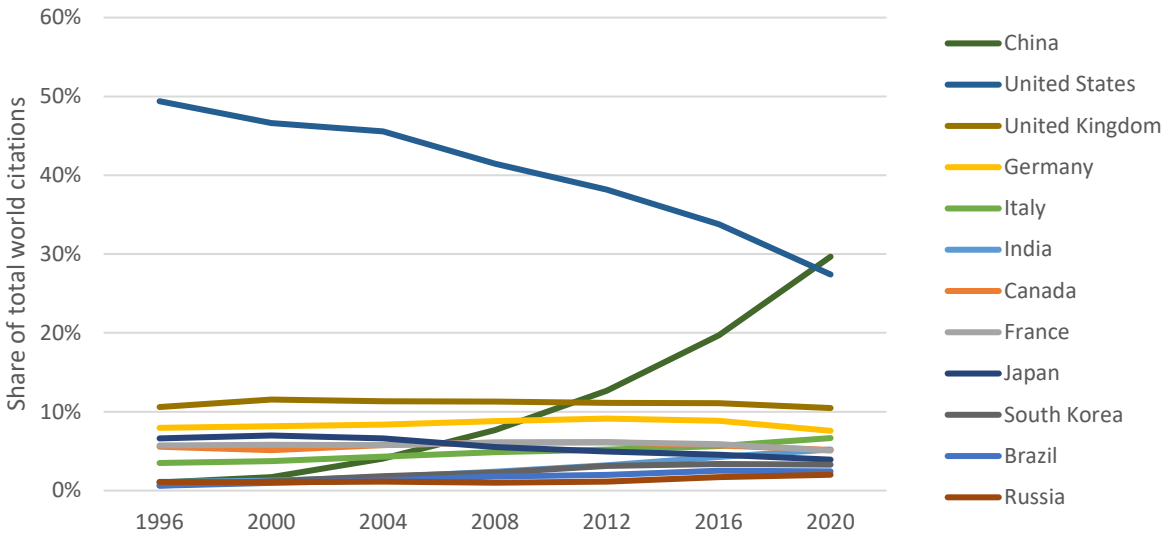


Figure 5 provides a detailed insight into the more recent trends (in period 2016 to 2020) in the world citations shares of the UK and comparator countries. The axis is truncated at 12% and US and China have been excluded to allow the other countries to be more easily viewed.

Figure 5 (Lower section of Figure 4) - Share of world citations for the UK and comparator countries, truncating the axis at 12%, excluding US and China, and focusing on period 2016 to 2020. This year refers to when the research output was published and not when the citations were received.

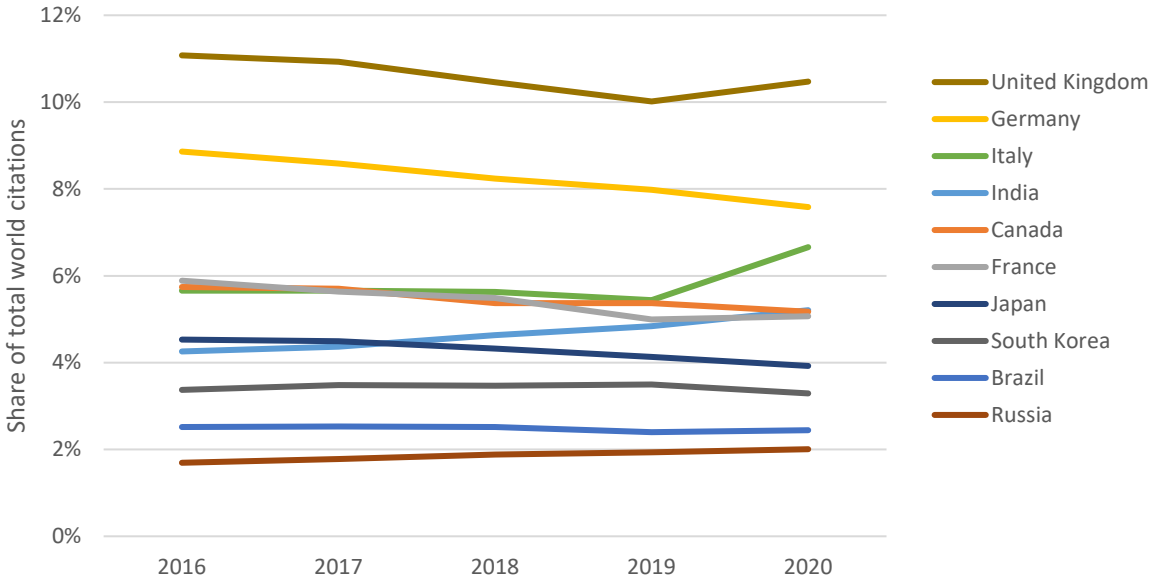


Table 2 - Citation shares: values and ranking of the UK in 2016 and 2020.

Entity	2016	2020	Percentage change	CAGR[9]	UK rank 2016	UK rank 2020
UK	11.1%	10.5%	- 5.5%	-1.4%	-	-
EU27	30.6%	28.4%	- 7.2%	-1.8%	1[10]	1[10]
OECD	75.1%	65.9%	-12.3%	-3.2%	2	2
World	100.0%	100.0%	-	-	3	3

Table 2 shows that, despite its slightly falling share of global citations, the UK has maintained its ranking above the EU countries, second in the OECD and third in the world.

Field-Weighted Citation Impact

Field-weighted citation impact (FWCI) is a measure of the scholarly impact of a set of publications. It compares how a number of citations for a given set of publications compares to the average number of citations received by all world publications in the same field (for a full definition of FWCI, see Appendix 1). A value of 1.0 represents the world average FWCI.

As shown in Figure 6, the UK occupies the top position in FWCI among the comparator countries, indicating that UK publications are cited more than comparable publications from

other nations, which is an indicator of the impact of the research. Despite increasing competition in volume from emerging nations, the UK has maintained this top position in FWCI since 2007, when the UK overtook US whose FWCI values have been declining steadily (-2.0% year-on-year and -7.6% overall, in the past five years). Italy is showing a sustained growth in FWCI since 1996 and has taken a second place in 2020.

As noted in Figure 6, the UK's FWCI has remained above 1.50 since 2007 and had a value of 1.57 in 2020. This is 57% above the world average, and around 35% above OECD (1.14) and EU27 (1.17) average, both of which are also seeing a mild decline in the FWCI values over the last five years (year on year decline of -1.1% and -0.4% respectively).

China has experienced a sustained period of growth since 1996, and in 2020 it has reached the same as the OECD value of 1.14. China went from below to above world average in 2017. India with FWCI value of 0.95 remains below the world average in 2020 but is seeing a strong ascending trend.

Figure 6 - Field-weighted citation impact for the UK and comparator countries, for period 1996 to 2020.

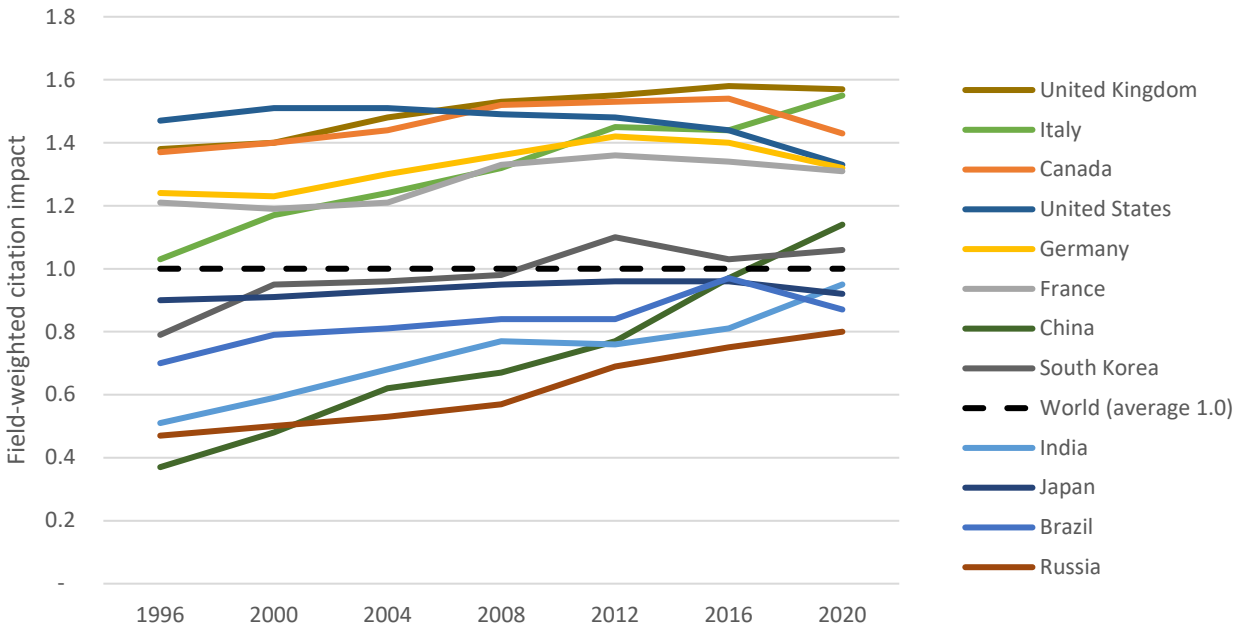


Figure 7 provides a detailed insight into the more recent trends (in period 2016 to 2020) in the FWCI of the UK and comparator countries but only for those with a FWCI higher than the world average (1.0). To show this the axis is set to values between 0.9 and 1.6, countries below 1 have been excluded and OECD and EU27 have been included.

Figure 7 - Detail of Figure 6. Field-weighted citation impact for the UK and comparator countries with FWCI above world average (1.0) and benchmarking groups OECD and EU27, focusing on the period 2016 to 2020. The FWCI axis has been adjusted accordingly (ranging from 0.9 to 1.6)

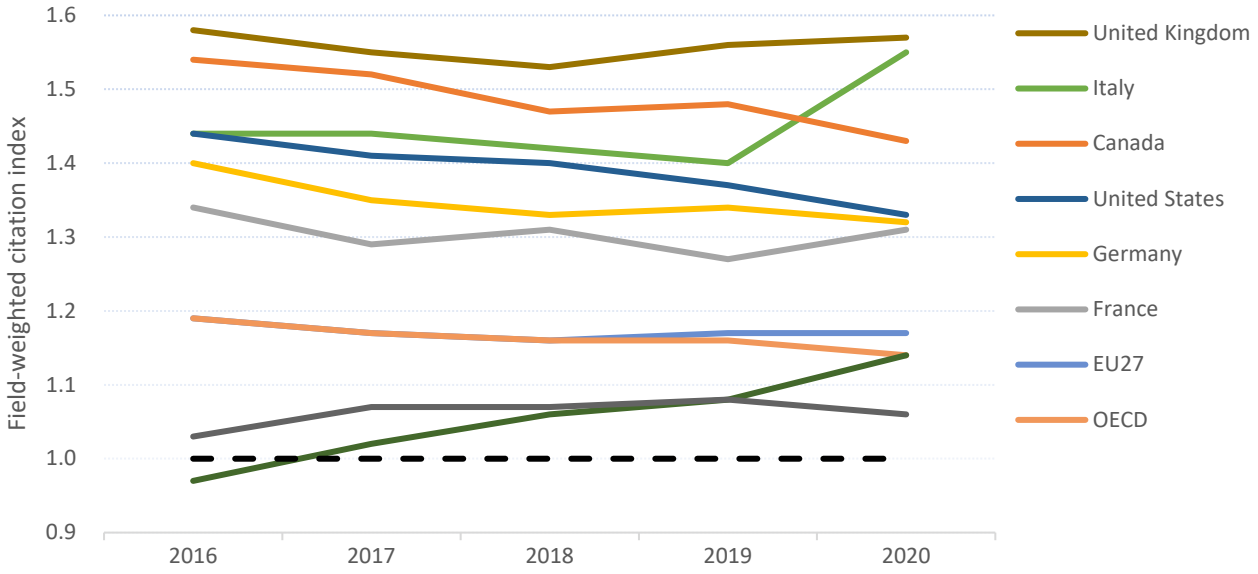


Table 3 - Field-Weighted Citation Impact: values and ranking of the UK in 2016 and 2020.

Entity	2016	2020	Percentage change	CAGR[9]	UK rank 2016	UK rank 2020
UK	1.58	1.57	- 0.6%	-0.2%	-	
EU27	1.19	1.17	- 1.7%	-0.4%	1[10]	1[10]
OECD	1.19	1.14	- 4.2%	-1.1%	1	1
World	1.00	1.00	-	-	1	1

Table 3 shows that the UK has maintained its field-weighted citation impact first place ranking above EU countries, first in the OECD and first in the world.

Highly-cited publication share

Analysis of the world shares of highly-cited publications (top 1% highly cited articles) allows a more focussed comparison of the impact of the highest-performing parts of the research bases[14].

The UK saw a slow but steady growth in the share of highly-cited publications for two decades until 2016 when the UK produced 16.1% of world's highly-cited publications. Since 2016, there

[14] A small number of publications receives the majority of citations, a larger proportion of all publications gets some citations and a significant proportion does not get any citations, hence looking at highly-cited publications gives more insight into the impact of the research.

has been a decline (-4.5% year on year and -16.8% overall) in the UK's share, reaching 13.4% in 2020 (see Table 4).

The US have been experiencing a downwards trend in the share of world's highly-cited publications since 1996, with an even steeper slope in period 2016 to 2020 (-7.3% year on year and -26.2% overall), falling from 43.7% in 2016 to 32.3% in 2020. China, on the other hand, has seen sustained growth since 1996. Moreover, China's share growth accelerated in recent years: China went from a 14.4% of the world's highly cited publications in 2016, (overtaking the UK in 2017) to a share of 24.0% in 2020, second largest share after the US. (Figure 8).

Figure 8 - Share of world's highly cited publications (top 1% cited publications) for the UK and comparator countries in the period 1996 to 2020.

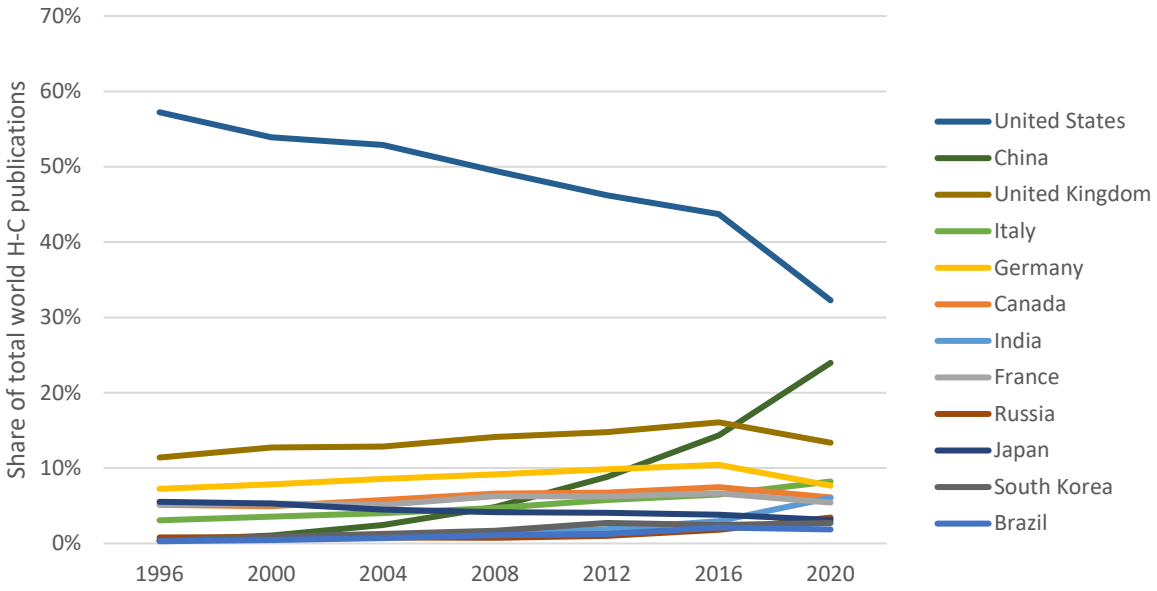


Figure 9 provides a detailed insight into the more recent trends (in period 2016 to 2020) in the world shares of highly-cited publications of the UK and comparator countries. The y-axis has been truncated at 18% and US and China removed to allow for the other countries to be more easily read.

While Germany and Canada have seen a decline in the shares of the world's highly-cited publications over the period 2016 to 2020, with year-on-year decline of -7.3% and -4.9% respectively, India and Russia have been recording a notable growth (19.8% and 17.2% year-on-year respectively). This amounts to an overall increase of 105.7% for India and 88.5% for Russia in the last five years (Figure 9).

Figure 9 (Detail of Figure 8) - Share of world's highly cited publications for the UK and comparator countries, excluding US and China and truncating the axis at 18% over the period 2016 to 2020 only.

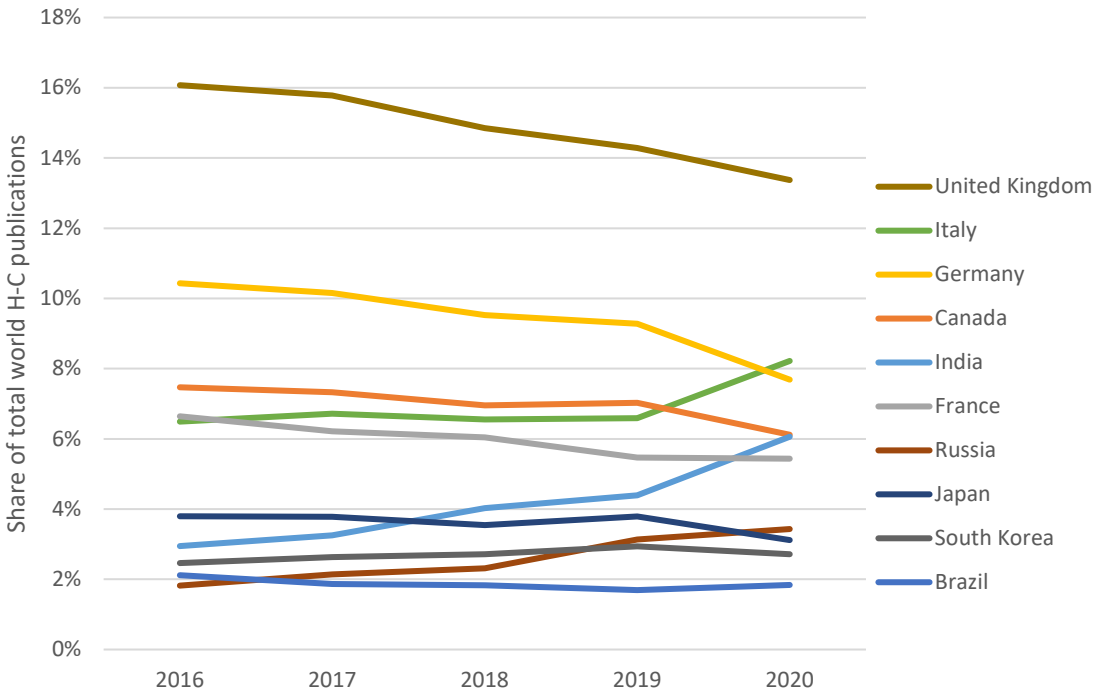


Table 4 – Highly-cited publications (top 1%): values and ranks for the UK in 2016 and 2020.

Entity	2016	2020	Percentage change	CAGR[9]	UK rank 2016	UK rank 2020
UK	16.1%	13.4%	- 16.8%	-4.5%	-	
EU27	31.7%	28.8%	- 9.1%	-2.4%	1[10]	1[10]
OECD	82.7%	68.5%	- 17.1%	-4.6%	2	2
World	100%	100%	-	-	2	3

Table 4 shows that the UK has maintained its place above the EU countries in its share of the world's most highly-cited publications, that it still ranks second in the OECD, but has fallen to third in the world having been overtaken by China.

Research output trends in volume and impact

In the period 2016 to 2020, the UK shares of total world publications and world's highly-cited publications were both declining. However, contrasting UK's world publications share (6.3% in 2020) with its share of world's highly-cited publications (13.4% in 2020), it is evident that the UK produces a relatively higher share of the most impactful publications than of total publications, indicating leadership in research impact.

Figure 10 shows the same comparison of publication against H-C shares but for each year in the period 2016 to 2020, exposing the recent trend in volume against high quality of research output. The lines represent transition over this period, with vertical reading representing a

change in share of total world H-C publications and the horizontal line representing a change in share of total world publications. The US and China have recorded high shares in both publication share (19.9% and 21.7% in 2020, respectively) and highly-cited publications shares (32.3% and 24.0% in 2020, respectively). However, the US is seeing a decline while China is seeing a significant growth in both indicators.

Figure 11 shows detail that is missing due to scale in Figure 10. While Canada, Germany and France are showing a noticeable decline in their respective shares, Japan remains fairly static. On the other hand, Russia and India have been growing their shares of highly-cited publications faster than the world publications shares particularly in more recent years, which indicates a relative increase in their research impact.

Figure 10 - Share of world's highly cited publications versus share of world's publications for the UK and comparator countries in the period 2016 to 2020. The lines represent transition from 2016 to 2020, with vertical reading representing a change in share of total world H-C publications and the horizontal line representing a change in share of total world publications. The arrow represents the direction of change.

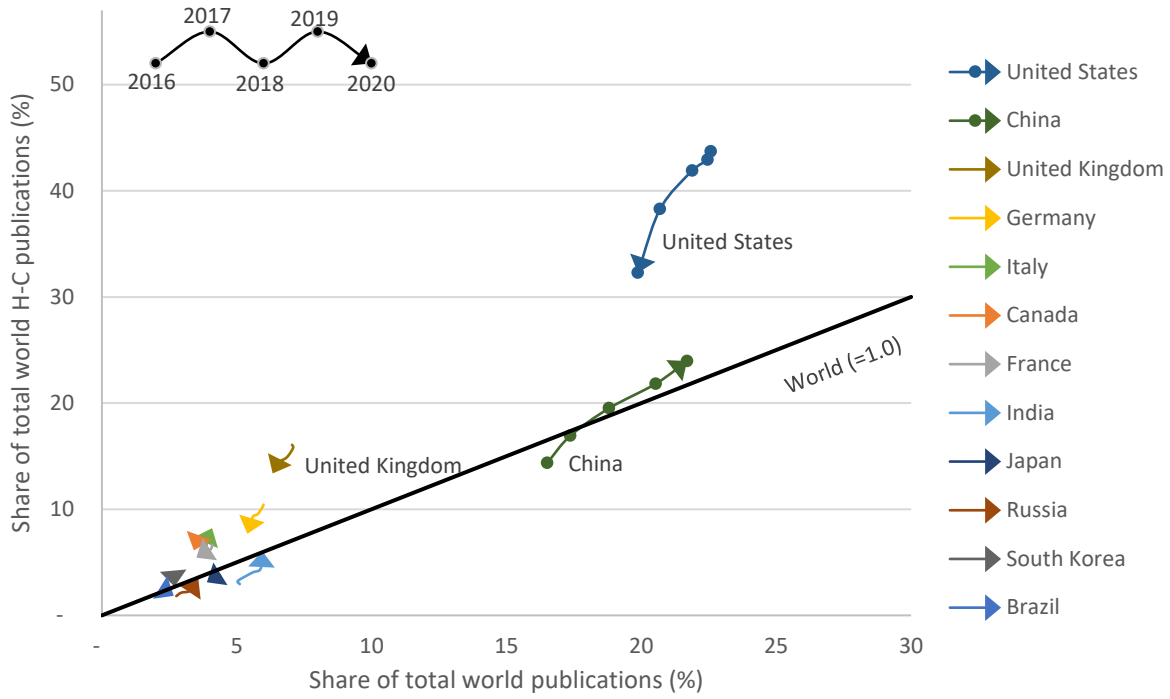
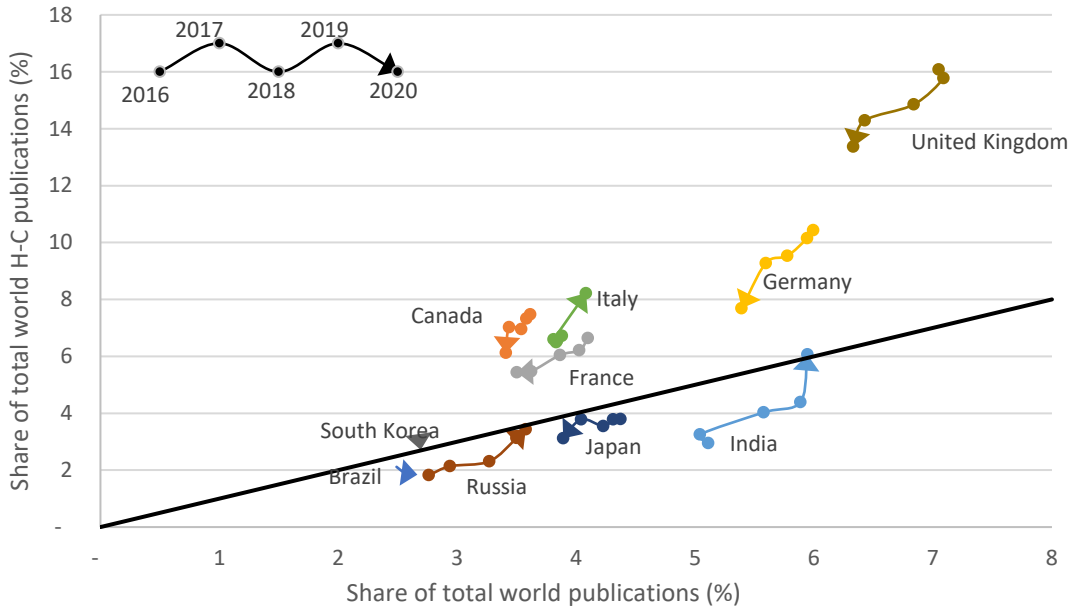
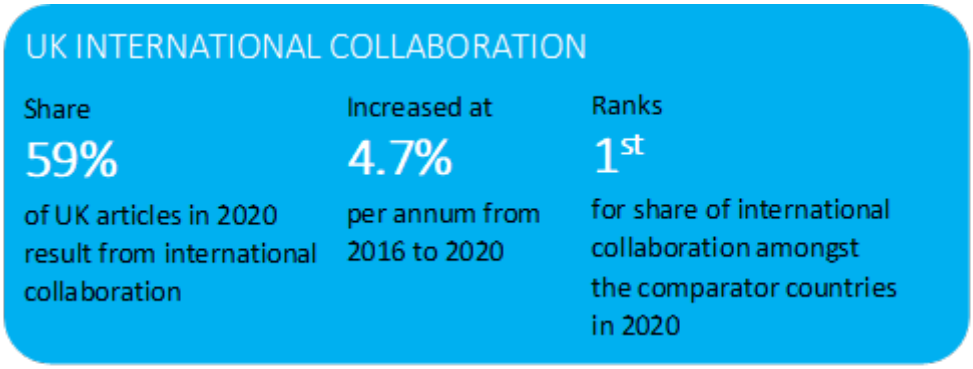


Figure 11 (Detail of Figure 10) - Share of world's highly cited publications versus share of world's publications for the UK and comparator countries excluding the US and China and truncating the scale at 18% for clarity, for period 2016 to 2020.



Collaboration

Highlights



International collaboration reflects levels of international partnership in research and innovation and international partnerships achieve, on average, 50% higher impact in terms of citations than domestic collaborations.

After experiencing sustained growth in international co-authorship in the last five years, nearly 60% of the UK's publications in 2020 are co-authored with at least one non-UK researcher, currently the highest amongst comparator countries.

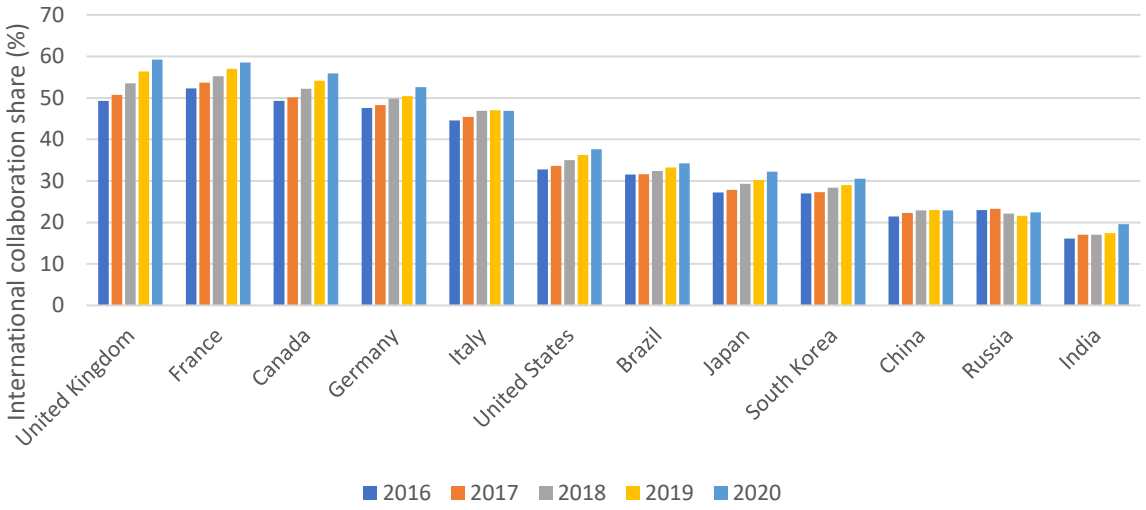
Key findings

There are four types of collaboration: single authorship, only institutional collaboration, only national collaboration and international collaboration. Single authorship is a publication authored by a single author. Only institutional publication is a publication which was co-authored by at least two researchers, but all authors affiliated to the same institution. Only national publication is a publication which was co-authored by at least two researchers affiliated to two different institutions but all authors within the country. An international publication is a publication which was co-authored by at least two researchers affiliated to institutions in different countries. A single publication may display each of international, national and institutional collaboration in its affiliation information, but a single collaboration type is assigned to ensure that the sum of entity's publications across the four types adds up to 100%. See appendix for a more detailed explanation.

The UK researchers are highly collaborative internationally. In 2020, 59.2% of all publications were produced in collaboration with at least one non-UK author. As shown in Figure 12, the only country with such high levels of international collaboration is France (58.5%).

India, China, and Russia have half the UK share of internationally co-authored publications. Most countries including the UK show experienced sustained growth in the share of international co-authorship since 2016 (Figure 12), apart from China and Russia, which are the only comparators not exhibiting increase.

Figure 12 - Annual shares of internationally co-authored publications for the UK and comparators, for period 2016 to 2020.



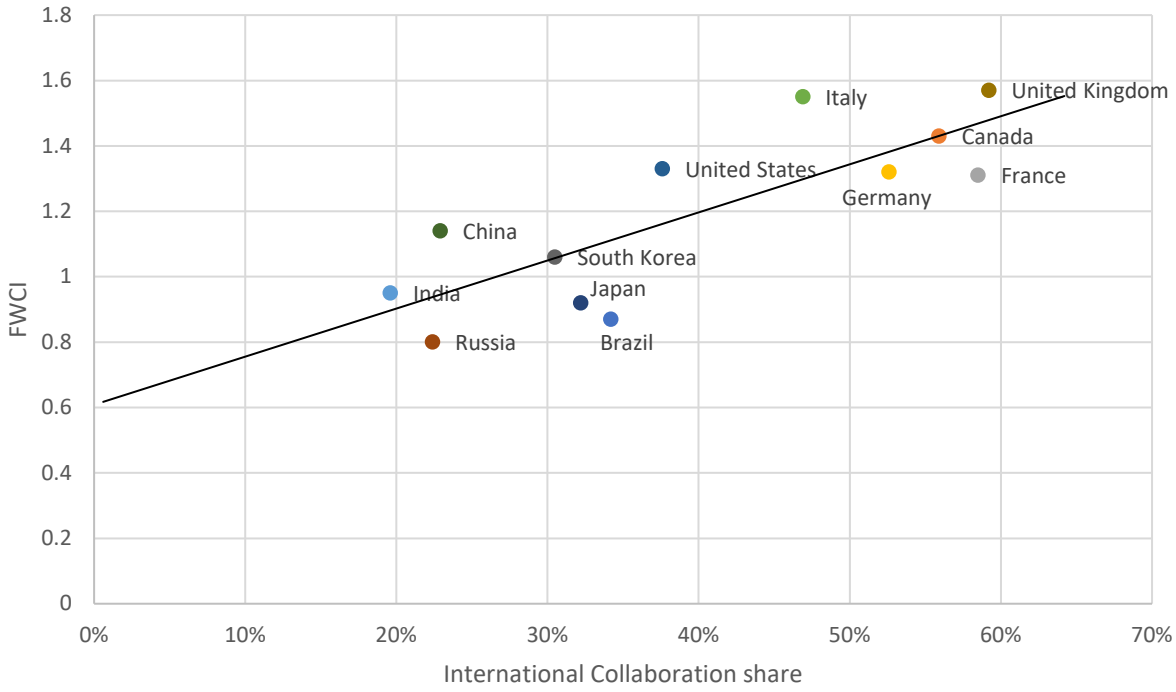
Internationally co-authored articles are, generally, associated with a higher field-weighted citation impact than those co-authored institutionally or nationally (see Table 5). The field-weighted citation impact of the UK's internationally co-authored publications was 26% higher than the world average (1.51), 41% higher than that of the UK's nationally co-authored articles (1.36), and 57% higher than that of institutionally co-authored articles (1.22). Table 5 further shows that the UK had the highest field-weighted citation impact among the comparator countries for single author and institutional collaborations, whilst it was second to the US for national collaborations and second to Canada for international collaborations.

Table 5 - Field-weighted citation impact (FWCI) of single-authored, institutionally, nationally and internationally co-authored publications, for research output published in period 2016 to 2020.

Country	Single author	Institutional	National	International
United Kingdom	0.88	1.22	1.36	1.91
Brazil	0.39	0.61	0.65	1.52
Canada	0.83	1.04	1.11	1.92
China	0.5	0.76	0.97	1.76
France	0.47	0.69	0.95	1.7
Germany	0.6	0.96	1.09	1.77
India	0.49	0.71	0.78	1.57
Italy	0.62	1.14	1.2	1.88
Japan	0.48	0.64	0.75	1.59
Russia	0.46	0.58	0.59	1.42
South Korea	0.49	0.8	0.84	1.73
United States	0.79	1.19	1.39	1.78
EU27	0.62	0.93	1.01	1.55
OECD	0.73	1.01	1.13	1.53
World	0.61	0.87	1	1.51

The relationship between shares of international collaboration and their impact demonstrates the value of these collaboration for national performance. Countries with higher shares of international collaboration also show higher FWCI (Figure 13).

Figure 13 - International co-authorship share vs field-weighted citation impact for the UK and comparators, 2020.



Appendix 1

Indicators and Methodology

For assessment and comparison of performance of the UK and comparator countries, the following indicators were used.

Share of total world publications – a ratio of country's research output volume over the world's total publication output volume.

Share of total world citations - Citation count is the number of citations received by a publication from subsequently published publications. Share of total world citations is a ratio of a number of citations country's publications have received over the number of citations World's publications have received in the same period.

Field-Weighted Citation Impact (FWCI) – FWCI is a measure of the impact of a group of publications. It compares how a number of citations of an entity's[15] publications compare to the average number of citations received by all other World publications published in the same year, discipline, and format (book, article, review, conference paper), for which data is available in the database.

Share of total world highly-cited publications - a ratio of country's number of highly-cited publications over the world's number of highly-cited publications.

International collaboration share – a ratio of a country's publications that were co-authored with at least one foreign author over the country's total number of publications.

International, national, institutional collaboration share and single authorship - Each publication is assigned to 1 of 4 mutually exclusive collaboration types, based on its affiliation information: international, national, institutional, or single authorship. A single publication may display each of international, national and institutional collaboration in its affiliation information, but a single collaboration type is assigned to ensure that the sum of an entity's publications across the 4 categories adds up to 100% of the publications with the necessary affiliation information.

FWCI of International, National, Institutional Collaboration and Single authorship – This is the FWCI as defined above which considers only publications co-authored internationally, nationally, institutionally and with a single authorship, respectively.

Percentage change – as defined in introduction. Its formula is

$$\frac{V_{final} - V_{initial}}{V_{initial}}$$

[15] Here, entity represents an institution, country or a group of countries. In this publication it is used to gauge impact for individual countries and groups of countries (EU27, OECD and World).

where V_{final} is the final, $V_{initial}$ is the initial value.

CAGR – as defined in the Introduction. Its formula is

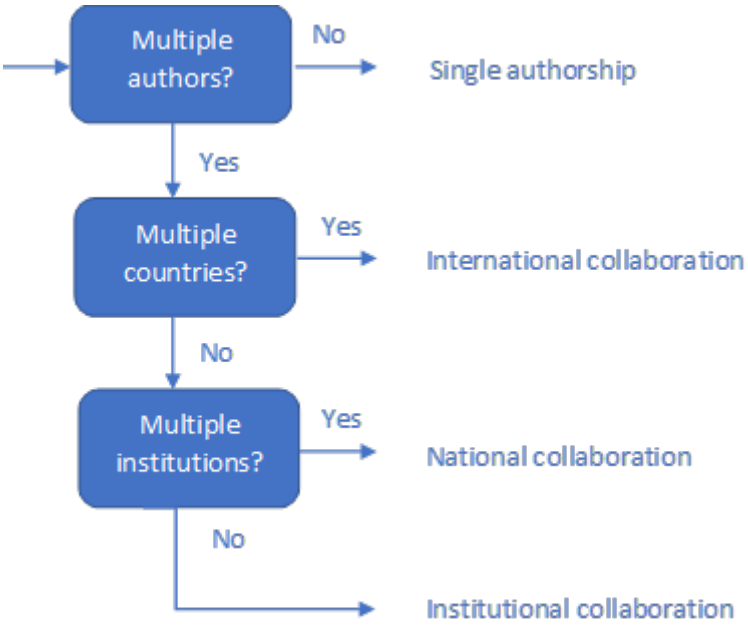
$$CAGR = \left(\frac{V_{final}}{V_{initial}}\right)^{\frac{1}{t}} - 1,$$

where V_{final} is the final value, $V_{initial}$ is the initial value and t is the period in years.

Ranks – Rank of the UK in a group of countries is calculated as a position of the UK within a set of countries (OECD, World) in terms of values of the observed indicator. There is an exception of EU27, which has been expanded by the UK to allow ranking.

Activity Impact model – Activity Impact model is defined in detail in the main text.

Types of collaboration – decision diagram[16]:



[16] Research metrics guidebook

This publication is available from: www.gov.uk/government/publications/international-comparison-of-the-uk-research-base-2022

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