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Department of Trade and Industry

Office of Science and Technology

PSA target metrics for the UK research base

December 2005

Using OST PSA target metrics for Research or Private Study:

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Summary

This is our third report on the performance of the UK research base. It confirms the UK's strong relative international performance in terms of achievement, productivity and efficiency. The UK sustains a more consistent performance across fields than most countries and is strongest overall in the natural sciences. On many indicators it has been second only to the USA, but the situation is dynamic: it has moved into first place this year on some indicators and it has been overtaken in other areas. The UK's strong international performance in terms of quality has been achieved with lower investment compared to its competitors. Thus far, this has led to a high level of productivity in the research base, for both research publications and trained people. The UK has a relatively lower general availability of people with research training although there is a shift to a more highly skilled profile for the research workforce.

Theme 1 - Inputs (including expenditure on research)

The UK's share of OST comparator group R&D expenditure is about 4.5%. The UK is spending less on research (Gross Expenditure on R&D, GERD) as a proportion of its total economic activity (GDP) than its competitors. GERD, at about 1.8% of GDP, has increased only marginally, and the UK is seventeenth of the twenty-one OST comparator group nations for which data are available (the average is about 2.25% of GDP) and seventh among G8 nations. Total publicly performed R&D (PUBERD = Government + Higher Education sectors) increased in real terms over the last decade (with a slight recent drop) but the increase is less than the average for the OST comparator group.

Theme 2 - Outputs (including people and publications)

The UK's share of OST comparator group PhD awards and publications is about 9%. The UK's share of PhD awards is broadly the same as other countries for which data are available but much less than Germany. Growth is higher in SE Asia and some smaller and research competitive European nations. The UK's share of world journal article publications is ranked second behind the USA. A recent plateau in publication output appears to be consolidation rather than actual contraction.

Theme 3 - Outcomes (research recognition, citations; training and research quality)

The UK's share of world citations is about 12% and is second highest to the USA. It remains well ahead of most OST comparator group competitors. Germany has not improved on last year, but China and some smaller nations are increasing their global share rapidly and this has effects on larger countries. The UK is also second to the USA in all of ten main research fields except mathematics, where it remains third, and in physical sciences and in engineering, where it is fourth. UK share of citations has been maintained in most fields. Smaller nations have displayed sometimes substantial but inconsistent increases. Other measures reflect the high impact of UK publications. The UK has now moved ahead of the USA on impact for pre-clinical & health and biological sciences. There are marked improvements elsewhere but next year's data will reveal whether these are statistical or sustained. The UK also benefits from a relatively low frequency of uncited material and a consistently good performance across disciplines. Correlation between training volume and impact is positive through weak for the UK whereas it is absent for most other G8 countries.

Theme 4 – Productivity - financial (outputs and outcomes related to inputs)

The UK is highly productive by the measures applied in this analysis but it is not consistently quite as strong as in the past. The UK produces relatively more PhDs per unit HERD (Higher Education R&D spend) than most OST comparator group nations. It is ranked fifth where the USA is ranked eleventh. In terms of publicly performed R&D (PUBERD), UK productivity ranks first in the G8 and well ahead of the OST comparator group average. The UK is still ahead of other G8 nations in terms of citations per unit GERD but has dropped to fifth place in the OST comparator group. Its share of citations (Theme 3) compared to share of funds (Theme 1) is twice the OST comparator group average. The UK has been overtaken by Switzerland in terms of citations per unit HERD, although it has improved on other G8 nations.

Theme 5 – Productivity - labour (outputs and outcomes related to other measures)

The UK is highly productive in terms of labour productivity. The UK is second behind and has gained further on Germany in terms of PhDs awarded per researcher; only Switzerland and Spain are more productive. The UK has a lead position in G8 countries and is third overall behind Switzerland and the Netherlands on relative productivity (papers published per researcher) and effectiveness (citations acquired per researcher). Indeed, its slight fall in papers but gain on citations suggests a shift to quality over quantity. [NB Italy data are anomalous.]

Theme 6 - People

For the UK, the general availability of highly skilled people with research training is lower than among its competitors, although the balance within the research workforce suggests that there is increasing professionalisation. Only 0.3% of the UK population as a whole and only 0.6% of the workforce would be classified as a researcher, which is less than the OST comparator group average. The UK's rank position in the low 'teens among the OST comparator group has changed little over the period. Researchers are becoming more frequent as a proportion of R&D personnel, however, which may reflect increasing research professionalisation. This is good for the UK where change is faster than average for the OST comparator group.

Theme 7 - Business expenditure

The UK has performed relatively well in terms of business investment in the HE research base as defined by OECD but its position is now weakening. Business spending as a part of HERD increased in the UK in the mid-1990s but it is now falling and the UK is no longer ahead of OST comparator group average. The UK profile for business spend as a proportion of HERD tends to track that of the USA. At the level of research fields, the fall is most noticeable in the natural sciences, its core area of research strength.

Introduction

This is a report about indicators of the UK's relative international research performance in science, engineering, the social sciences and the humanities and arts. It is the third report with these indicators and in this format. The information content, analysis, commentary and overall structure have developed in successive cycles. The main change this year is the inclusion of data on research in the humanities and arts. This has extended the number of sub-fields covered by some indicators.

The Research Footprint® diagrams summarise the outcomes of analyses for six leading indicators, comparing the research profile of the UK, the G8 and a number of other leading research economies. The thematic commentary, following the Footprints, gives a broad overview of the UK's performance in terms of the selected indicators.

Background

The objective is to support a system for assessing outputs, outcomes and impacts related to the Public Service Agreement (PSA) target to 'improve the relative international performance of the UK research base'. This target is challenging. Many studies have indicated that successive advances in research become increasingly expensive (the "sophistication" factor, Advisory Board for the Research Councils (ABRC), 'Strategy for the Science Base', 1986) and the costs of improving relative performance rise in parallel.

The Atkinson Review of 'Measurement of Government Output' (2005) for the Office of National Statistics affirmed that 'the measurement of quality is central to our concerns'. Sir Tony Atkinson recommended that all assessments of output and productivity should account for this. This is what the OST sets out to do, capturing information not only on what the research base produces for the Science Budget investment but how its output is perceived internationally.

The UK is widely acknowledged to be an extremely effective research performer. It is therefore difficult to improve significantly on this relative level of achievement. Indeed, it will be difficult in some fields to maintain the UK's international status without, for example, additional investment that meets the growing competition from technologically specialist research nations in the Asia-Pacific economies. This year's report particularly highlights the impact that China is having as its research base expands.

Until 2002, the UK Office of Science and Technology (OST) employed a core set of indicators that demonstrated the position of the UK and reflected effectiveness in the use of research funding. This report describes an extended basket of indicators established in 2003. Plurality in an indicator system is a desirable feature, because over-dependency on any one indicator can be misleading. A balanced set can take account of differences in the pattern of performance between research disciplines, the interaction between inputs and outputs and possible measures of efficiency and effectiveness, and year on year fluctuations in any one indicator.

Assessing excellence is as important as measuring system average. The peak of research excellence, however defined, includes those highly innovative outcomes that are most likely to impact on economic performance. The indicators in this report allow for disaggregation, to throw light on changing patterns of selectivity and concentration within the UK science base. That work is being developed in a parallel OST study to be published in 2006.

Other countries and communities – such as the EU, the NSF in the USA, CWTS in the Netherlands and the OST in Paris - already publish reports about national science and technology indicators on a regular basis. This report has taken note of the good practice established elsewhere.

Data and Indicators

Every piece of research data should have three attributes: subject area, time and location. Each attribute works at varying levels of detail and we need to identify the best level for analysis. Data about research usually measure something in one of three primary categories: input (usually financial), activity (or proxies such as staff numbers) and outputs. Secondary indicators describe the relationship between them. Sometimes, outputs can be followed through into outcomes and impacts. The UK indicators include both primary and secondary indicators and focus on impacts where possible. They are listed in the table (below) on the "Definition and description of indicators".

Bibliometric data play a key part in these indicators. There are reasons for being cautious about some uses of such data particularly with respect to social science and to humanities' and arts' research (see Background sections after the indicator pages). There is also great value and applicability. Crucially, these data uniquely provide us with international comparisons of research quality for most countries and by subject area.

The Background sections that come after the indicator data describe the main data sources, list the range of the OST comparator group of countries, the level of subject disaggregation and the time frames used for comparisons. There is also a discussion about the significance and interpretation of bibliometric indicators and some cultural aspects of publication and citation behaviour in different countries and disciplines.

International comparisons are made across an OST comparator group of 25 countries. This includes the full G8 (UK, USA, Canada, France, Germany ,Italy, Japan, Russia). In addition there is a combination of some larger and OECD countries from different continents with research bases both similar and contrasting in structure to the UK, and a spread of smaller nations with active and rapidly growing research bases with specific strengths. These are Belgium, Denmark, Finland, Netherlands, Poland, Spain, Sweden, Switzerland, Australia, Brazil, China, India, Iran, Israel, Singapore, South Africa, South Korea, and Taiwan. A separate line of analysis for a group of 15 EU countries (EU15 = member countries in 2003) is also included where feasible and appropriate.

Many of the graphs that illustrate performance indicators use short codes for these countries, for clarity. These codes are linked to their countries in a table in the Background sections.

Subject disaggregations used in this report employ two systems of categorisation. First, there are five main OECD categories (medical sciences, natural sciences, engineering and technology, social sciences and humanities [which includes the arts]). Second, subjects based on 69 UK Units of Assessment (UoAs) are grouped by publication similarity into ten Super-UoAs (Clinical, Pre-clinical/health, Biological sciences, Environmental sciences, Mathematics, Physical sciences, Engineering, Social sciences, Business, Humanities).

International R&D databases have historically focussed on science and technology and are therefore have some deficits in social science and humanities data. This does affect some analyses, and this is discussed further in the Background sections.

The humanities and arts are included in the subject spread for the first time. Not all the research indicators used in the natural sciences are well suited to analysing research performance in these disciplines. Account can be taken of feedback from readers and users of this report so as to 'tune' these presentations for later editions.

Details of the countries and subjects are given in the relevant part of the Background section after the indicators.

Definition and description of indicators

Indicator number	Description of performance indicator	Condition signalling improvement	Level of disaggregation	Primary data sources
THEME 1	INPUTS including expenditure on research			
1.01	GERD relative to GDP (R&D intensity)	Increased proportion of R&D specific spend	System	OECD MSTI 2005-1
1.02	Publicly performed R&D (PUBERD) as proportion of GDP	Increased proportion of R&D specific spend	System	OECD MSTI 2005-1
THEME 2	OUTPUTS including people and publications			
2.01	Number and share of OECD PhD awards	Increased count and increased share by comparison with competitors	System	OECD Education Database
2.02	PhDs awarded per head of population	Increased ratio	System	OECD MSTI 2005-1 OECD Education Database
2.03	Number and share of world publications	Increased count and increased share by comparison with competitors	System	ISI National Science Indicators 2004
THEME 3	OUTCOMES including research recognition and citations; training and research quality			
3.01	Number and share of world citations	Increased count and increased share by comparison with competitors	System	ISI National Science Indicators 2004
3.02	Number and share of world citations in ten main research areas	Increased national count and share	SUoA	ISI National Science Indicators 2004
3.03	Rank of share of world citations by nine main research fields - frequency in top 3	More frequent presence in top three among fields	System	ISI National Science Indicators 2004

| Indicator number	Description of performance indicator	Condition signalling improvement	Level of disaggregation	Primary data sources
3.04	Share of citations relative to share of publications	Increase in citation share compared to source share within field	SUoA, using NSI5 for constant time frame	ISI National Science Indicators 2004
3.05	Number and proportion of uncited publications	Decrease in ratio of uncited to total sources	SUoA, using NSI5 for constant time frame	ISI National Science Indicators 2004
3.06	Number and share of cited publications	Increase in ratio of cited to total sources	System	ISI National Science Indicators 2004
3.07	National share of papers in top 1% by citation count	Increase in share	System	ISI Essential Science Indicators
3.08	Citation impact (citations per publication) relative to world baselines	Increased impact compared to world	System	ISI National Science Indicators 2004
3.09	Citation impact relative to world baselines in ten main research fields	Increased impact in main research fields	SUoA	ISI National Science Indicators 2004
3.10	Variation and consistency of research strength	Reduced ratio between variance and average. Maximised ratio of average/variance.	SUoA	ISI National Science Indicators 2004
3.11	Relationship between distribution of research training across subjects and research quality	Improved match in distribution; improved research training power (product of volume and quality)	Data related across research fields (OECD level)	ISI National Science Indicators 2004 OECD Education Database
THEME 4	PRODUCTIVITY – FINANCIAL including outputs and outcomes related to inputs			
4.01	PhDs awarded relative to HERD	Increased ratio	System	OECD Education Database OECD MSTI 2005-1
4.02	PhDs awarded relative to HERD in five main research areas	Increased ratio	OECD fields	OECD Education Database UK SET statistics and HESA data OECD RDS 2004-2

Indicator number	Description of performance indicator	Condition signalling improvement	Level of disaggregation	Primary data sources
4.03	PhDs awarded relative to PUBERD	Increased ratio	System	OECD Education Database OECD MSTI 2005-1
4.04	Citations relative to GDP	Improved ratio of citations per GDP compared to recent past	System	ISI National Science Indicators 2004 OECD MSTI 2005-1
4.05	Number and share of citations relative to GERD	Increased citations per unit expenditure	System	ISI National Science Indicators 2004 OECD MSTI 2005-1
4.06	Citations relative to PUBERD (GOVERD + HERD)	Increased citations per unit expenditure	System	ISI National Science Indicators 2004 OECD MSTI 2005-1
4.07	Citations relative to HERD	Increase in citations per unit spend	System	ISI National Science Indicators 2004 OECD MSTI 2005-1
4.08	Citations relative to HERD in five main research areas	Increase in citations per unit spend at the OECD macro-category level	OECD fields	ISI National Science Indicators 2004 UK SET statistics and HESA data OECD RDS 2004-2
THEME 5	PRODUCTIVITY – LABOUR including outputs and outcomes related to non-financial measures			
5.01	PhDs awarded per researcher	Increased ratio	System	OECD Education Database OECD MSTI 2005-1
5.02	Publications per researcher	Increased relative output	System, NSI5 averaging	ISI National Science Indicators 2004 OECD MSTI 2005-1
5.03	Citations per researcher	Increase in citation ratio	System, rolling 5 year averages	ISI National Science Indicators 2004 OECD MSTI 2005-1
THEME 6	PEOPLE			
6.01	Researchers per thousand population	Increased ratio	System	OECD MSTI 2005-1

Indicator number	Description of performance indicator	Condition signalling improvement	Level of disaggregation	Primary data sources
6.02	Researchers per thousand workforce	Increased ratio	System	OECD MSTI 2005-1
6.03	R&D personnel per thousand population	Increased ratio	System	OECD MSTI 2005-1
6.04	R&D personnel per thousand workforce	Increased ratio	System	OECD MSTI 2005-1
6.05	Researchers per R&D personnel	Change in ratio	System	OECD MSTI 2005-1
THEME 7	BUSINESS EXPENDITURE			
7.01	Business R&D investment in publicly performed R&D (BE-PUBERD as a proportion of PUBERD)	Increased ratio	System	OECD MSTI 2005-1
7.02	BE-GOVERD as a proportion of total GOVERD	Increased ratio	System	OECD MSTI 2005-1
7.03	BE-PNPERD as a proportion of total PNPERD	Increased ratio	System	OECD RDS 2004-2
7.04	BE-HERD as a proportion of total HERD	Increased ratio	System	OECD MSTI 2005-1
7.05	BE-HERD as a proportion of total HERD in five main research areas	Increased ratio	OECD fields	OECD RDS 2004-2 UK SET statistics and HESA data

Research Footprints[®]

There are over 30 research indicators grouped under seven themes. This complex body of data provides an informative and comprehensive view of many aspects of the comparative international performance of the research base, but it is not readily absorbed. We have used a Research Footprint® to illustrate key data.

Each country has a distinctive Research Footprint[®] of its international research competitiveness. Our figure uses six key indicators and provides a direct graphical comparison of the performance of select comparator countries with the OST comparator group average. The shaded area is the 'footprint' of a stated country, which can be compared directly with the dotted line that marks the average footprint for the group. Each axis measures a specific indicator, with the lowest level of performance (low rank or zero activity) at the origin near the centre and the maximum value at the outer end of the axis. The area of the footprint has no statistical significance.
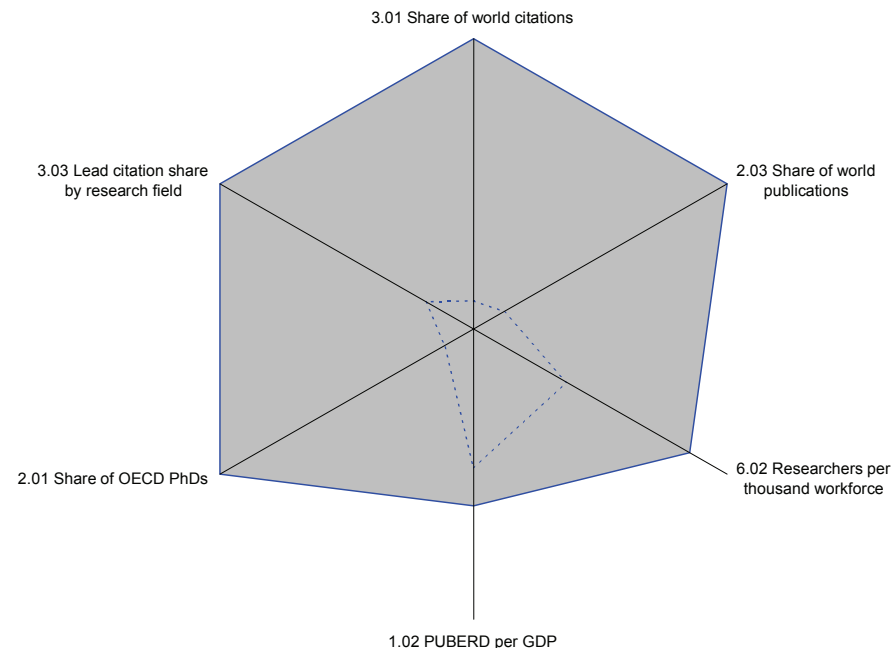
1.02   PUBERD per GDP
Theme: Inputs
Full title: Publicly performed R&D (PUBERD) as proportion of GDP
Description: Volume of publicly funded R&D relative to general economy

2.01   Share of OECD PhDs
Theme: People (research degree output)
Full title: Number and share of OECD PhD awards
Description: Highly skilled people: research degree output

2.03   Share of world publications
Theme: Outputs
Full title: Number and share of world publications
Description: Relative output volume

3.01   Share of world citations
Theme: Outcomes
Full title: Number and share of world citations
Description: Esteem measured by share of world citations

3.03   Lead citation share by research field
Theme: Outcomes
Full title: Frequency in top three for rank of world citation share by nine main research fields
Description: Breadth of research strength measured by spread of dominance

6.02   Researchers per thousand workforce
Theme: People
Full title: Workforce research capacity
Description: Skilled R&D capacity within national workforce

Research Footprint® of comparative UK research performance

The Research Footprint® for the UK is compared in the next two pages, first with other G8 nations and with the pattern for the EU15 as a whole and second with a set of other leading research nations in the OST comparator group.

The display uses absolute values, not ranked position. Because of data and analysis changes, the comparator average Research Footprint® – essentially the reference point for others - covers a slightly different area to that of 2004 and relative performance of specific countries may therefore appear to expand or retreat. The data coverage – for countries, years and fields – has improved again since last year. This has identified a number of exceptional performers for particular indicators, some of which appear to behave inconsistently and may be amended in later reports. There are also some anomalous values (e.g. those involving GDP for Russia).

The status of the USA is quite clear. It will continue to be a strong performer across the board and contributes the maximum volume performance on most indicators because of its sheer size, although its efficiency is certainly less impressive and its effectiveness is being challenged. One example of an exception is in terms of public expenditure on R&D as a proportion of GDP (indicator 1.02). On that indicator there are smaller nations, such as Sweden, Denmark and the Netherlands, that all spend relatively more. Other indicators show that they all have relatively highly skilled populations and rising performance in niche research areas.

The EU has no calculated value on indicator 3.03 [which would be a summation of specific countries rather than an integrated figure] where it would score as highly as the USA. It has more PhDs than the USA (indicator 1.01) and higher average PUBERD per GDP (indicator 1.02) but relatively fewer researchers in its total workforce (indicator 6.02), although the data are patchy in this area.

The UK has a substantial and growing share of world publications (indicator 2.03) and citations (indicator 3.01). Because it ranks second on average to the USA, it also has a very good position on average ranking by major research area (indicator 3.03). The UK's share of OECD PhD awards (indicator 2.01) matches its share of outputs but is less than its achievement on other indicators. It has a relatively low (below average) concentration of researchers within its workforce (indicator 6.02) by comparison with some of the smaller countries with rising profiles.

Overall, the UK can be seen to have a good all round performance by comparison with most of the G8 and all of the smaller countries, but the well balanced performance of Germany – good business investment, strong PhD output, above average proportion of research workers - is also notable. Each report has confirmed that it is the major research competitor for the UK in Europe. Japan's strength is in its research work-force (indicator 6.02), as it is for Sweden. While Switzerland has a strong average bibliometric performance in many fields, in the Research Footprint® presentation its relatively small research base and capacity becomes clear.

China has been given a Research Footprint® this year, replacing Belgium. China has exceptional growth in its research base and is rapidly expanding its volume of activity with rapid growth in GERD, growth in outputs in most fields of science and technology and a very large R&D workforce with a relatively high proportion of researchers. The Research Footprint® shows the extent to which this latent strength has yet to be translated into quality outcomes. On these criteria, China remains a 'sleeping giant' but the weight of its footfall can be expected to change this picture significantly in the next few years.
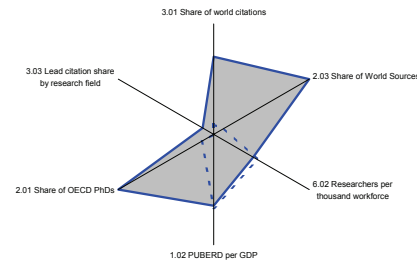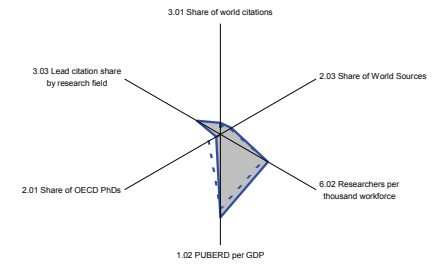
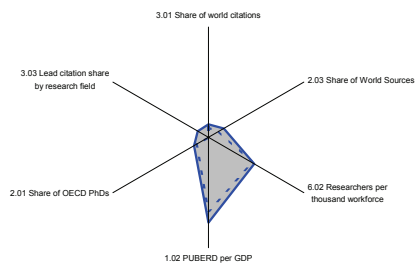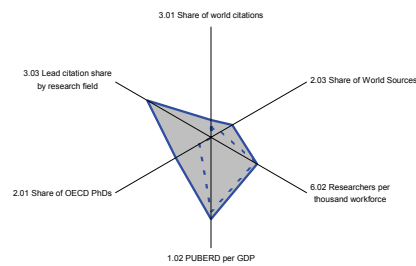# Research Footprints® for UK, G8 countries (except Russia) and the EU15
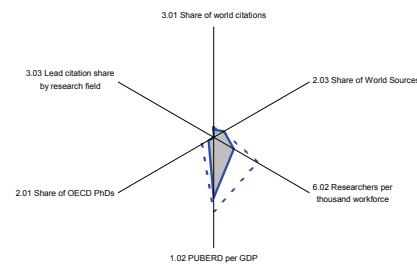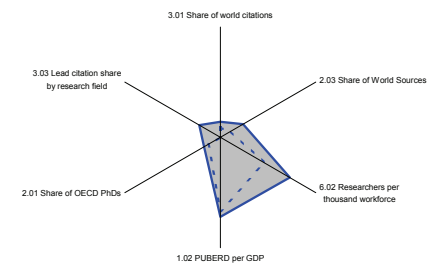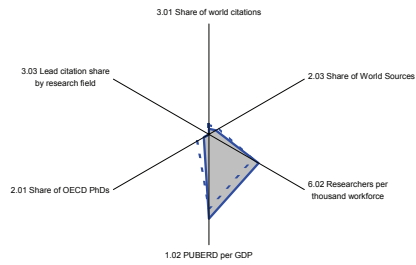

UK
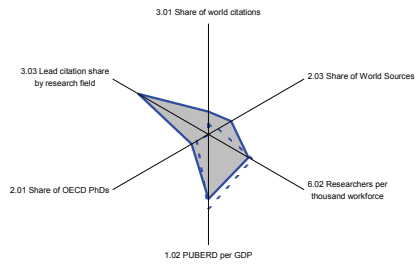
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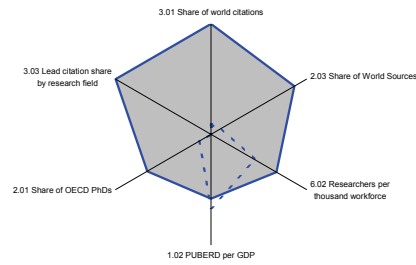
EUROPEAN UNION

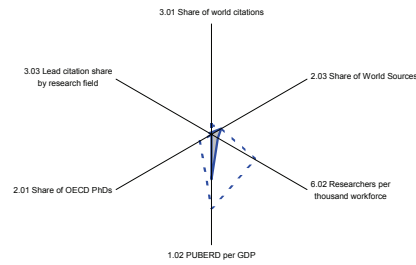CANADA

FRANCE

GERMANY

ITALY

JAPAN

Research Footprints® for other leading comparator nations

AUSTRALIA

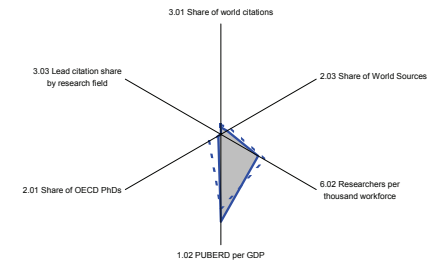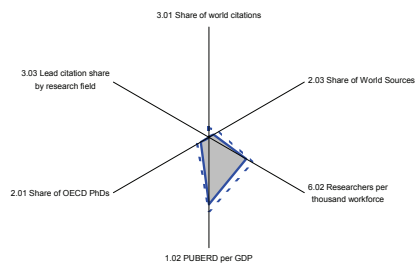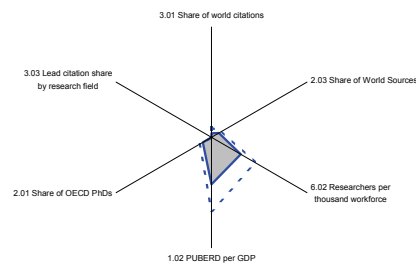## CHINA

DENMARK
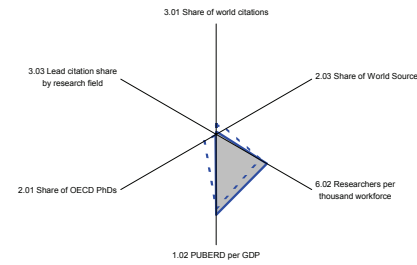
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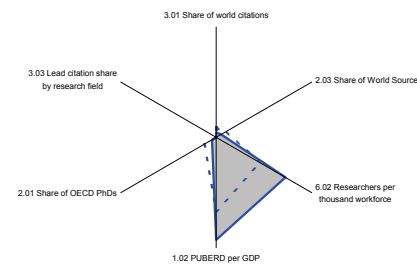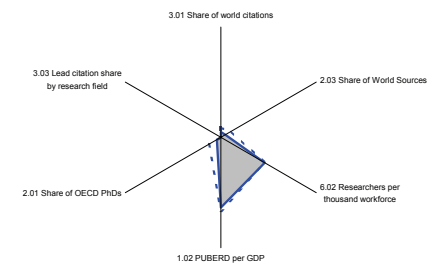

SOUTH KOREA

SPAIN

SWEDEN

SWITZERLAND

Thematic commentary

Theme 1 - Inputs (including expenditure on research)

The UK is spending less on research as a proportion of its total economic activity than its competitors and less than the EU15 average. It share of comparator group R&D spend is about 4.5%, which is barely half its share of group outputs (Theme 2 and Indicator 4.05). Its ranked position on R&D spend is also declining on current data.

GERD as a proportion of GDP indicates research intensity in the economy. UK GERD was about 8% higher in 2003 compared with the average for the recent past (Indicator 1.01) but it remains at only about 1.8% of GDP and has fallen in regard to the OST comparator group average. Business expenditure in UK R&D has fallen across the public sector (Theme 7). The UK is 6th among G8 nations and ranks only 17th among the twenty-one OST comparator group nations for which data are available (average around 2.3% GDP and progressively increasing). The most rapid increase in GERD is for China, which now exceeds all but the USA and Japan.

GOVERD and HERD refer to expenditure on R&D performed in the GOVernment and Higher Education sectors. The sum of these (PUBERD) forms the bulk of the publicly funded research base. This has generally increased in real terms for the UK over the last decade, but dropped in 2001-02 and the increase now is less than the average for the OST comparator group. The UK is 7th among G8 nations (Indicator 1.02). UK HERD has increased in real terms (see table in Indicator 4.07) but at a slower rate than the OST comparator group.

Theme 2 - Outputs (including people and publications)

The UK's share of global research people and publication outputs are both around 9% The UK is ranked 3rd globally in terms of people output and 2nd in terms of papers, despite a recent fall in volume. This contrasts with its rank on inputs (Theme 1).

The UK's share of PhD awards (now over 9%) is similar to that of similar countries for which data are available but much less than Germany (Indicator 2.01). In relation to population size, UK output has been in line with a general trend whereas Germany is a high outlier. Looking to the future, growth is higher in South East Asia, and some smaller and research competitive European nations also outrank the UK on this measure (Indicator 2.02).

The UK's share of world journal article publications (slightly less than 9%) was overtaken by Japan in 2003 but has now moved back to 2nd behind the USA (Indicator 2.03). A plateau in publication output over the last few years followed a period of annual increases in many countries. The drop in UK share is likely to be due to consolidation rather than contraction as it has not affected quality (Theme 3).

Theme 3 - Outcomes (research recognition, citations; training and research quality)

The UK is very efficient in terms of research outputs (as the contrast between Theme 1 and 2 shows) and, generally, has fewer lower quality papers than most of its competitors. The UK relative international research performance is second behind the USA in terms of overall research recognition but it now performs better than the USA in some specific areas though less well in others. It has a good balance of strength in its performance, however, and has fewer areas of relative weakness than some competitor nations. The rapid growth of outputs from the China research base is likely to make the international picture more dynamic over the next few years.

The UK's total citation count is 2nd highest to the USA and has risen to just over 12% of world citations (Indicator 3.01). It remains ahead of all other OST

comparator group competitors. Germany was closing but has not improved its relative position in recent years. China is rapidly increasing its global share, as are some smaller nations and this has effects on larger countries.

The UK is clearly ahead of competitors (albeit 2nd to the USA) on citation count in all of ten research fields including the new humanities field, but not in mathematics, where it is 3rd, and in physical sciences and in engineering, where it is 4th (Indicator 3.02). Its share of global citations has increased in most fields but not in environmental sciences. It is becoming clear that there are some inconsistent annual oscillations and that longer term trends are more important. Citation growth among smaller nations does 'attack' the global share of larger countries but the trend among individual small countries is erratic.

A measure of consistency in research strength is found in the frequency with which a country appears in the top tier of nations, ranked by citation count for each of nine main fields (Indicator 3.03, see also Indicator 3.10). The USA is in the top tier in all fields. The UK performs strongly on this indicator and is in the top three in seven of nine fields. Germany is the only other nation that performs well across many fields. It had improved to place in the top three in six fields but has slipped to only five fields. No nation outside the G8 is placed in the top three on this measure in any field.

Citation count usually increases with numbers of papers published (source count). So, although numbers of citations (Indicators 3.01, 3.02) give one measure of esteem, it is also important to look at share of global citations compared to share of sources so as to account for this scaling. Indicator 3.04 shows that the UK has a positive difference between share of citations less share of outputs in eight of ten research areas, particularly biological, physical and environmental sciences. Other countries have multiple positive balances but these are smaller in scale than for the UK or concentrated in niche areas.

Not all papers are subsequently cited, so their impact on research remains obscure. About 35% of UK papers remain uncited in any 5-year period but this proportion and the UK's share of the world's uncited papers has declined – so its performance has improved - compared to the recent past (Indicator 3.05). The decline is seen across all fields; it has the fewest uncited among G8 countries in Biological, Environmental and Social Sciences and Humanities.

The UK's ratio of cited papers to total outputs is greater than for the OST comparator group average and improving in all fields (Indicator 3.06).

The UK has the 2nd greatest - and a growing - share (13.2%) of the world's most highly cited papers (Indicator 3.07). Its average research impact (measured by the number of citations per paper for these data) is ranked 8th but the volume of this high impact material is greater than for countries ahead of the UK such as Switzerland, the Netherlands and Scandinavia. UK share has again increased whereas that for the countries ahead of the UK on impact, including the USA, has fallen.

Research impact is usually indexed by the average ratio of citations to sources. Indicator 3.08 shows that, for the research base as a whole, the UK's average impact increased progressively in the last ten years and has stepped up between the recent past (the five years to 2003) and 2004. This has moved the UK even closer to the USA and further ahead of most other G8 countries but Germany has also improved and is a close competitor. The UK now stands 5th in the world where it was 7th.

How does the pattern of research impact vary between disciplines? It is reviewed at the level of the ten main research fields in Indicator 3.09. The data show marked improvements for the UK in some areas where it is now ranked ahead of the USA in pre-clinical & health sciences and in biological sciences. Although ranked further back among the OST comparator group as a whole, its impact has improved progressively in many fields over the last decade. The UK has almost closed the gap on the USA in mathematics, and has a marked improvement in physical sciences and a sustained upturn in engineering.

Is research strength broad based and diverse or does it peak only in specific disciplines? Average research impact and variation in quality between fields both contribute to the overall performance of the research base (see also Indicator 3.03). A more consistent performance provides more even capacity and hence enables flexibility in response to opportunities. Indicator 3.10 links information on field specific impact and considers both average across fields and variation between fields for leading research countries. The UK has both a strong average and a relatively even performance. The UK position has been consistent between 2000 and 2004 whereas the USA has dropped back and

the Netherlands has improved its average only at the cost of more concentrated excellence.

Does people quality match publication quality? It is not possible directly to measure the quality of highly skilled people trained in the research base, but we can test the broad correlation between relative training volume and relative research impact. There is a correlation between training and impact for the UK (Indicator 3.11) whereas this is absent for most G8 countries. UK PhD awards are concentrated in the natural sciences, which is where Indicator 3.09 suggests that the UK has relative research strength. Thus the UK's advantageous productivity pattern (Theme 1, Theme 2) is matched by a very positive quality pattern.

Theme 4 – Productivity - financial (outputs and outcomes related to inputs)

The UK is highly productive across the research base by the measures applied in this analysis, as has been indicated above. However, its position is challenged in some fields and is not as uniformly strong as it has been in the past.

Highly trained people are an important product of the research base. Indicator 4.01 shows relative productivity as PhDs awarded in relation to general spend in the HE sector (HERD) and by main research areas (Indicator 4.02). This is discussed above in terms of output (Indicator 2.01).

Total UK PhD awards are similar to most other G8 nations, though less than Germany and much less than the USA. Compared to the level of spend on R&D performed in the HE sector (HERD, Indicator 4.01) the UK produces relatively more PhDs per unit spend than most OST comparator group nations and is ranked 5th, above the EU average. The USA is ranked 11th. Other measures do indicate that UK quality is high, so the assets of the research base appear to be used effectively although it is, of course, not necessarily the case that higher people output per unit research spend is a quality measure.

At the level of five main research fields, the UK ranks 3rd to Germany and the USA in volume in the natural sciences but has moved ahead of Germany in terms of PhDs per HERD, and is well ahead of OST group average. Productivity has fallen back markedly in engineering. The correlation between level of HERD and PhD awards is less clear in medical sciences, where the UK is lower ranked and has productivity well below OST group average; Germany remains well ahead. The UK is below the OST comparator group average in the social sciences, although there are issues about data quality in this area, but well ahead in the humanities (Indicator 4.02).

We can also index PhD output in terms of total PUBlic expenditure on R&D (PUBERD, Indicator 4.03) and the UK then ranks 1st in the G8 ahead of Germany and well ahead of the OST comparator group average against which it is improving its position.

Research performance in relation to the general economy (GDP) is of less direct significance. Although productivity is falling, the UK is 1st among G8 countries on citations per GDP (Indicator 4.04) but lies 7th overall behind Switzerland and Scandinavian nations. Its performance is about 30% better than the OST comparator group average whereas other G8 apart from Canada are below that average.

The UK has dropped from 3rd to 5th in the OST comparator group in terms of citations per unit GERD but has maintained its performance over the recent past and is well ahead of other G8 nations. As would be predicted from examination of Theme 1 and Theme 2, it share of citations per share of spend is better than twice the OST comparator group average (Indicator 4.05).

UK PUBERD has fallen compared to the OST comparator group average over the last ten years. Indicator 4.06 shows that citations per unit spend have improved over the period, while the USA and Canada have fallen on this measure and the UK's lead within the G8 has therefore increased. The UK is now 3rd to Switzerland and Denmark in the OST comparator group.

In terms of citations per unit spend as HERD (Indicator 4.07), the UK had led the OST comparator group in the past and fell back slightly last year but is 2nd to Switzerland. Its performance has remained well ahead of OST comparator

group average and improved on other G8 nations while the USA has dropped. At the level of OECD fields (Indicator 4.08) the UK is now 2nd to the Netherlands in natural sciences. Denmark has moved further ahead in engineering, but the USA has dropped behind the UK. In the social sciences the UK has improved its performance relative to the OST comparator group average but the USA, though declining, remains far ahead on this measure. In the humanities the UK has a clear lead, although the significance of this is open to interpretation.

Theme 5 – Productivity - labour (outputs and outcomes related to other measures)

The UK is highly productive in terms of labour productivity.

Skilled people are a key contribution to future resources for the knowledge economy. The UK is 2nd in the G8 but has gained further on Germany in terms of PhDs awarded per researcher (Indicator 5.01). Only Switzerland and Spain are more productive. The UK has maintained its level of output during a period when the USA slipped back.

On relative productivity (papers published per researcher, Indicator 5.02) and effectiveness (citations acquired per researcher, Indicator 5.03) the UK has a strong lead position in G8 countries (excepting anomalous data for Italy) and has been 3rd overall behind Switzerland and the Netherlands. In the last year, UK paper productivity has fallen slightly compared with the recent past (previous five years) but citation acquisition has improved suggesting that people have produced fewer but better papers.

Theme 6 - People

The UK has a weaker availability of highly skilled people with research training – in relation to population and to the workforce as a whole - than its competitors. However, there may be some shift in the skills balance among research personnel.

We can index each country's researchers and R&D personnel in relation to the general population and the national workforce. As we move towards an increasingly technology and knowledge based economy, these indicators may take on added significance as a measure of national capacity to absorb and use knowledge based opportunities. The Scandinavian countries are strong in this regard.

In the UK, only 0.3% of the population as a whole would be classified as a researcher (Indicator 6.01). This is less than the OST comparator group average, where the UK is ranked 15th, and is lowest in the G8 where no nation is much higher than 0.5%. The USA has reached 0.5% and is consistently improving whereas there has been little change in the last decade for the UK. Frequency of R&D personnel in the population is higher, typically 0.45% (Indicator 6.03) but the UK is again below OST comparator group and EU average and is the lowest except for Italy in the G8.

If comparison is made to the size of the national labour-force (Indicator 6.02, 6.04), the UK rank has slipped to 17th in the OST comparator group for researchers (0.6% of labour-force) and 15th for R&D personnel (0.88% down from 0.92% last year). In both cases, the UK is the lowest ranked except Italy among G8 nations.

Change in the structure of research personnel in the labour-force is reflected in a measure of researchers as a proportion of R&D personnel (Indicator 6.05). This may be an indication of increasing professionalisation of research work. The UK now ranks 8th in the OST comparator group, ahead of Denmark and Sweden, and 2nd to Japan in the G8. Its share of researchers as a proportion of R&D personnel is increasing faster than average.

Theme 7 - Business expenditure

The UK has performed relatively well in the past in terms of business investment in the HE research base as defined by OECD. Recent data suggest that this investment is not being sustained.

The Business Enterprise (BE) sector funds some of the research performed in the public sector. While business investment options are obviously affected by the general economic cycle, increases in BE within R&D may reflect relevance of public research to commercial objectives and confidence in the ability of the research base to produce returns on investment in one form or another.

Total PUBlic sector Expenditure on R&D is PUBERD. Business expenditure on R&D that is performed in the public sector (BE-PUBERD) is correlated with total spend (Indicator 7.01). The UK has performed well on this measure but has dropped to 8th overall and is now only 3rd in the G8 group. Among generally flat trends UK BE-PUBERD appears to be decreasing but it is difficult to forecast.

Business spend as a proportion of GOVERD (Indicator 7.02) is less well correlated. The UK has had a strong position and is still ranked 4th in the OST comparator group but BE as a proportion of GOVERD is falling from twice the OST comparator group average to less than one-third better than that. UK

business spend in regard to Private Non-Profit R&D (PNPERD, Indicator 7.03) is typical of the OST comparator group. There is little spread among the G8 apart from an exceptionally high result for Japan.

BE spending as a part of HERD (Indicator 7.04) increased in the UK in the mid-1990s but the UK has now fallen behind both OST comparator group and EU average and has fallen to 10th in rank. The UK profile for business spend as a proportion of HERD has consistently tracked the USA but there has been growth in Germany and some smaller countries whereas in other countries there have been marked falls. At the level of four OECD fields, a marked decrease for the UK is in the natural sciences – an area of strong performance - whereas there has been an improvement in the social sciences (Indicator 7.05).

Note that HERD as defined by the OECD covers more than just universities and the basket may vary between countries.

Indicator summary pages

The body of this report is a page by page summary of the detailed quantitative analyses for each indicator. The layout for each page follows a similar pattern:

- Report on indicator and the headline results.

- Table of key results (actual values and ranked performance among comparators) for the latest year for which data are available and the average value for the previous 5 years. The Table also shows current <u>change</u> in performance (ratio of activity between latest and recent, or difference in rank) and then ranks that change among the OST comparator group and G8 competitors to reflect the relative as well as absolute shift in current UK performance.

- Charts of data for UK and competitors (usually G8 plus select others) showing trends.

Additional explanatory notes are in the Background section at the end of this document.

Description of performance indicator
Condition signalling improvement

Biological Sciences

Indicator Headline

In Biological Sciences, the UK citation share overall is 2nd to the USA.

The UK's rank citation count remained 2nd highest to the USA for both 1997-2001 and 2002 periods (difference = 0 - remaining the same).

The change in UK citation share ratio of 1.046 between periods 1997-2001 and 2002 is second among G8 nations to Germany which had a ratio of 1.092, indicating that Germany's citation share is growing at a slightly faster rate than the UK.

The UK ranked position of 9th on change in OST citation share is because other countries, notably Poland and Spain in this case, are increasing their citation share at a faster rate than the UK - even though their citation counts are smaller than the UK. The average citation share ratio of the 8 countries ahead of the UK is 1.331.

Between the periods 1997-2001 and 2002 the USA has shown a decrease in citation share by a ratio of 0.978.

Although there were reductions in UK citation share in both 1996 and 2001 there is a slight but progressive rise across the period.

Indicator identification and description

Headline outcome of analyses describing UK status and recent performance

One or more graphs illustrating data scatter and performance trend of UK and OST group or G8

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2 Citations in main research fields (SUoAs): national count and share of OST comparator group total
Increased national count and share

	Average 1997 - 2001	Actual 2002	Ratio or difference	Ranked change in per... UK - all OST	UK - G8
UK citation count - Actual	168,098.8	10,323	0.0614		
OST average citation count	65,102.2	3,814	0.0648		
UK citation count - Rank among OST group	2	2	0		
UK citation count - Share of OST group	0.100	0.104	1.046	9	2
UK citation count - Share of world	0.123	0.133	1.083		

Note that this table ranks both performance and change in performance

Citation share among OST group for G8 nations (USA omitted) for SUoA Biological Sciences

Key results for UK (or OST group) actual and ranked performance in latest data year and average for previous 5 years

Change (ratio or difference) between last year and recent

Change in UK performance ranked among total OST group and G8

Graphs may omit USA & EU 15 if inclusion would distort vertical axis

Text may include commentary on additional issues arising from data or indicators

Description of performance indicator
Condition signalling improvement

1.01 GERD relative to GDP (R&D intensity)
Increased proportion of R&D specific spend

	Average 1998 - 2002	Actual 2003	Ratio or difference
UK GERD as a percentage of GDP - Actual	1.85	1.84	0.99
OST average GERD as percentage of GDP	2.15	2.29	1.06
UK GERD per GDP - Rank	16	17	-1
UK GERD per GDP / OST average GERD per GDP	0.86	0.80	0.93

Indicator Headline

The relative size of GERD (the most general measure of the share of total GDP that is spent on research and development, R&D) is an indication of the relative research intensity of the economy as a whole. GERD is an input measure rather than a measure of research performance. Nonetheless it is an important contextual indicator alongside output measures (Theme 2).

UK GERD makes up about 4% of the comparator group total (this contrasts with UK outputs which make up 9% of the comparator group total outputs - see Indicator 2.03). In absolute terms, adjusted for PPP, it is just over 10% of that of the USA and is smaller than that of both France and Germany. In relative terms, it is a lower percentage of GDP at 1.84% (as measured in million 2000 $ - constant prices and PPP, this compares with 1.89% when measured in million current PPP $) than for the OST group average and has fallen in recent years by comparison to that average. It has also fallen below the average for the EU15 nations.

The most rapid rate of increase in GERD is that for China, for which no time series data were available until this year. Although it has only reached 1.3% of GDP, this is a relative doubling over the decade and a fourfold increase in absolute value. China's GERD ($80Bn PPP 2000) now exceeds all but the USA and Japan and will soon approach 50% of the EU15 total ($190Bn). We draw attention to increasing China research activity on a number of indicators.

cont./

GERD as a percentage of GDP - G8 nations (Russia not included)

Data: OECD (MSTI)

Description of performance indicator
Condition signalling improvement

1.01 GERD relative to GDP (R&D intensity)
Increased proportion of R&D specific spend

Indicator Headline cont.

GERD is progressively increasing for the comparator group as a whole, although the increase to 2003 was the smallest for ten years.

Sweden, Finland and Switzerland all have GERD over 2.5% as a share of GDP as do Israel and South Korea. Most other G8 nations also have a flat or declining profile, although Italy has maintained its GERD and Canada has moved ahead of the UK.

The figures in this report are affected by the inclusion of some countries where data were previously unavailable, including China. All the data are now rebased to year 2000 purchasing power parity instead of 1995.

GERD includes both public and private sector spend and is thus related to a country's industrial R&D structure, the balance of different industries and their investment in research. It is only a partial measure as regards the influence of domestic policy on R&D. However, the tendency of industry to invest is likely to be affected by public policy and its relationship to both general competitiveness and the specific value of the public sector research base.

Specific data on business expenditure (BERD) are considered further in Theme 7.

GERD relative to GDP - OST comparator nations, 2003

Data: OECD (MSTI)

Description of performance indicator
Condition signalling improvement

1.02 Publicly performed R&D (PUBERD) as a proportion of GDP
Increased proportion of R&D specific spend
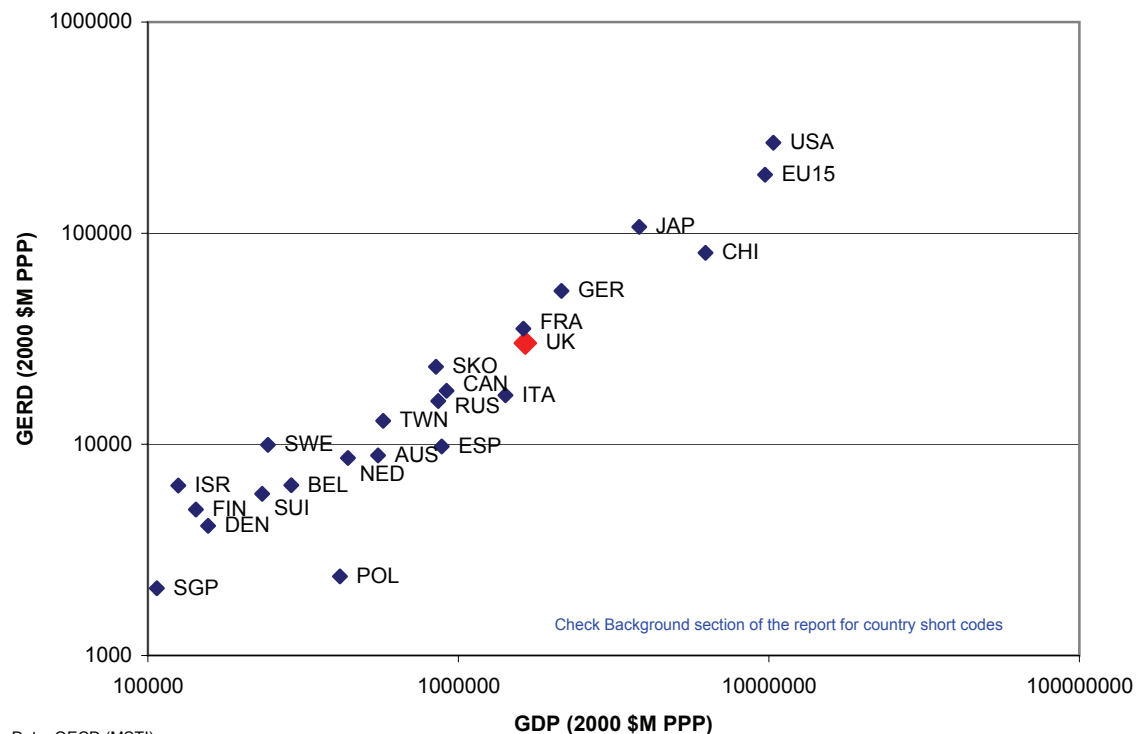
Indicator Headline

PUBERD is the sum of GOVERD (expenditure on R&D performed in the Government sector) and HERD (R&D in the higher education sector). This thus accounts for the bulk of public sector R&D expenditure. This is an input measure, not an index of performance.

UK PUBERD is only just over 4% of the OST comparator group total. In terms of PUBERD relative to GDP, the UK has dropped three places since 1998 and its PUBERD has fallen slightly while the group average has increased. It is therefore now at 80% of group average whereas it had been ahead of the OST comparator group average in 1995.

The UK ranks last in the G7 group on PUBERD relative to GDP. It slipped behind the USA in 2001 and Italy last year. It is well below the EU15 average.

The main trend over the period has for UK PUBERD to be relatively static, as it has for France and Germany. Elsewhere, there have been significant increases for the USA, Canada, Scandinavian nations, China, and other Asian nations.

China is included in this data analysis for the first time. It has clearly the fastest rate of increase and its PUBERD has trebled in value since 1995, increasing by 50% as a share of GDP. It now stands at $30Bn (2000 PPP) slightly les than half the total for the EU15 ($65Bn). China is on track to overtake the UK on PUBERD/GDP (this indicator) in the next few years.

	Average 1998 - 2002	Actual 2003	Ratio or difference
UK PUBERD as a percentage of GDP - Actual	0.60	0.57	0.96
OST comparator group average PUBERD as percentage of GDP	0.68	0.72	1.07
UK PUBERD per GDP - Rank	15	18	-3
UK PUBERD per GDP / OST comparator group av'ge PUBERD per GDP	0.88	0.79	0.90

PUBERD as a percentage of GDP - G8 nations (Russia not included)
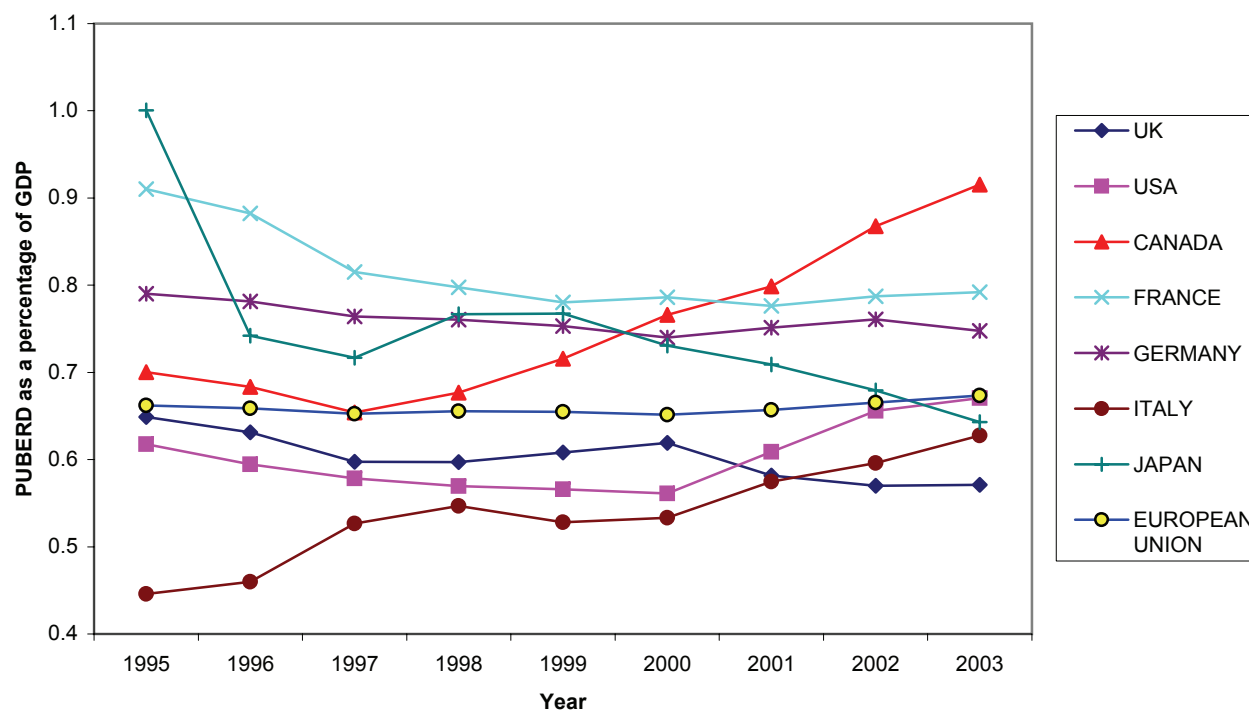
Data: OECD (MSTI)

Description of performance indicator
Condition signalling improvement

1.02 Publicly performed R&D (PUBERD) as a proportion of GDP
Increased proportion of R&D specific spend

PUBERD compared to GDP - OST comparator nations, 2003

Data: OECD (MSTI)

Description of performance indicator
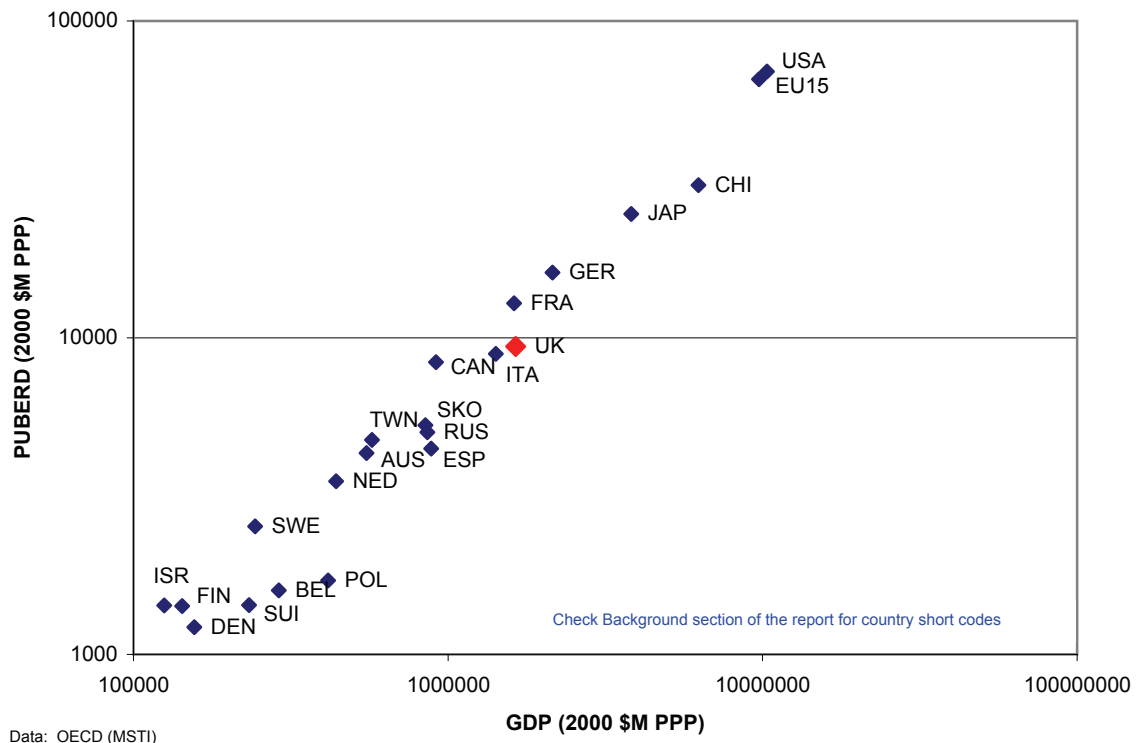## Condition signalling improvement

2.01 Number and share of OECD PhD awards
Increased count and increased share by comparison with competitors

Indicator Headline

There are only 5 years' data on PhD awards in the OECD Education database. There are also some data gaps among the OST comparator group countries. Data are present for G7 countries, although recent years are missing for Canada. The data have proved stable and the trends appear fairly level.

The UK's count and share have risen over the period although this has not affected its ranked position. Its share of PhD awards is similar to its share of publication outputs (Indicator 2.03) and much greater than its share of input funding (Theme 1).

The USA is the major producer of PhD students with a slightly declining 44,000 annual out-turn, which is about 30% of the OST comparator group total. This compares with about 50% for the EU15.

Germany (16% down from 18%) ranks 2nd to the USA, with the UK 3rd at just under 10% of the group total. A number of countries do not yet return OECD data on this indicator, including China and India.

This is an important indicator because people are a key output from the research base. Absolute numbers indicate sustainable capacity, but the share of the group total is also valuable as a comparator with other measures of input and output. Highly skilled people reflect the capacity to make use of knowledge, where other indicators indicate its generation and impact. The numbers of people available to the public and private sector research base may also be critical to economic innovation.

	Average 1998 - 2001	Actual 2002	Ratio or difference
UK PhDs count - Actual	12012	14232	1.18
OST comparator group average PhDs count	8948	9372	1.05
UK PhD count - Ranked performance	3	3	0
UK PhD count - Share OECD comparator nations (%)	8.64	9.76	1.13

Note that this table ranks both performance and change in performance

G8 nations: PhD share among OST comparator group (USA & Canada omitted; no data for Russia)
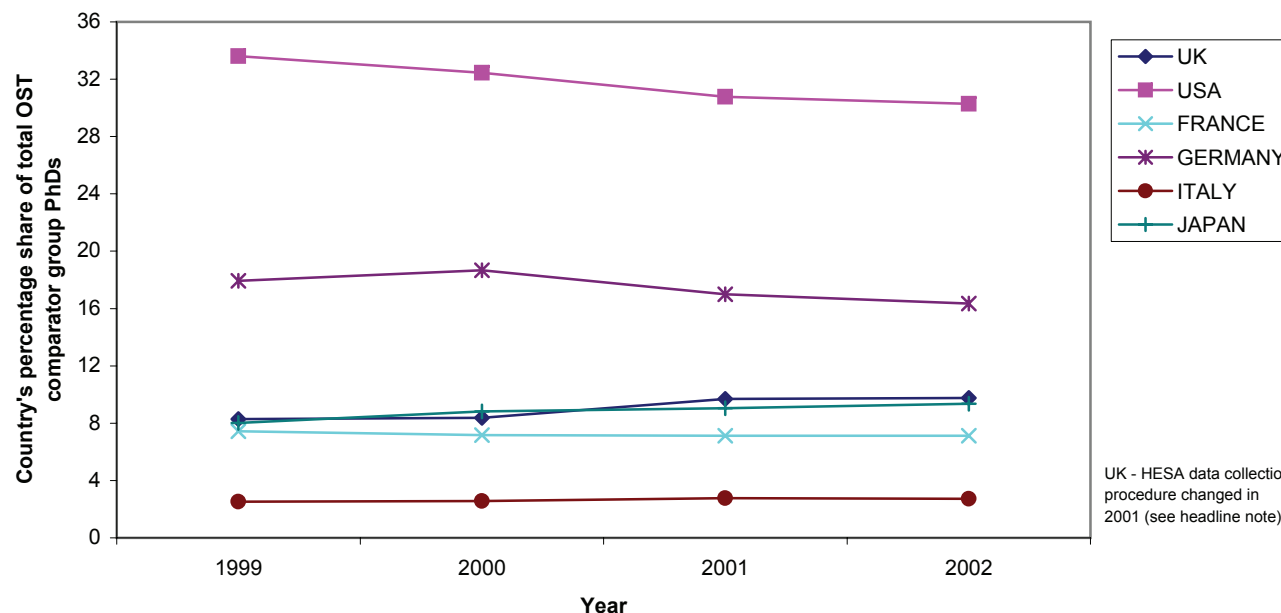
UK - HESA data collection procedure changed in 2001 (see headline note)

Data: OECD Education Database

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Description of performance indicator
Condition signalling improvement

2.02 PhDs awarded per head of population
Increased ratio

Indicator Headline

The UK is ranked 2nd behind Germany within the G8 in terms of PhD awards per head of population (Germany produced 15% more PhDs per head of population than the UK, 0.29 c.f. 0.24 PhDs per 1000 population), and 5th amongst all OST comparator group nations for which there are data. The UK remained close to the OST comparator group and EU average throughout the period. Its apparent improvement in the last two years is attributable partly to data revision and partly to cuts elsewhere.

Outside the G8, the OST comparator group rankings are led by Sweden (average 0.39 PhDs per 1000 population), Switzerland (0.38), and Finland (0.35). There are no data for China or India. The EU average is 0.19 and the USA average is 0.15, so Europe is producing more PhDs and many of these come from leading research nations.

People are a key output from the research base and form a key input of highly skilled people to the workforce. The numbers of PhDs awarded relative to population size as a whole is a broad measure of the relative training capacity and productivity of different countries. Comparison between trainee output and the size of the training population is made in indicator 5.1.

cont./

	Average 1998 - 2001	Actual 2002	Ratio or difference
UK PhDs awarded per 1000 population - Actual	0.20	0.24	0.04
OST comparator group average - PhDs awarded per 1000 population	0.20	0.21	0.01
UK PhDs awarded per 1000 head of population - Rank	6	5	1
UK PhDs awarded per 1000 population / OST comparator group average PhDs awarded per 1000 population	1.01	1.12	0.10

PhDs output per capita, G8 nations (no data for Russia)
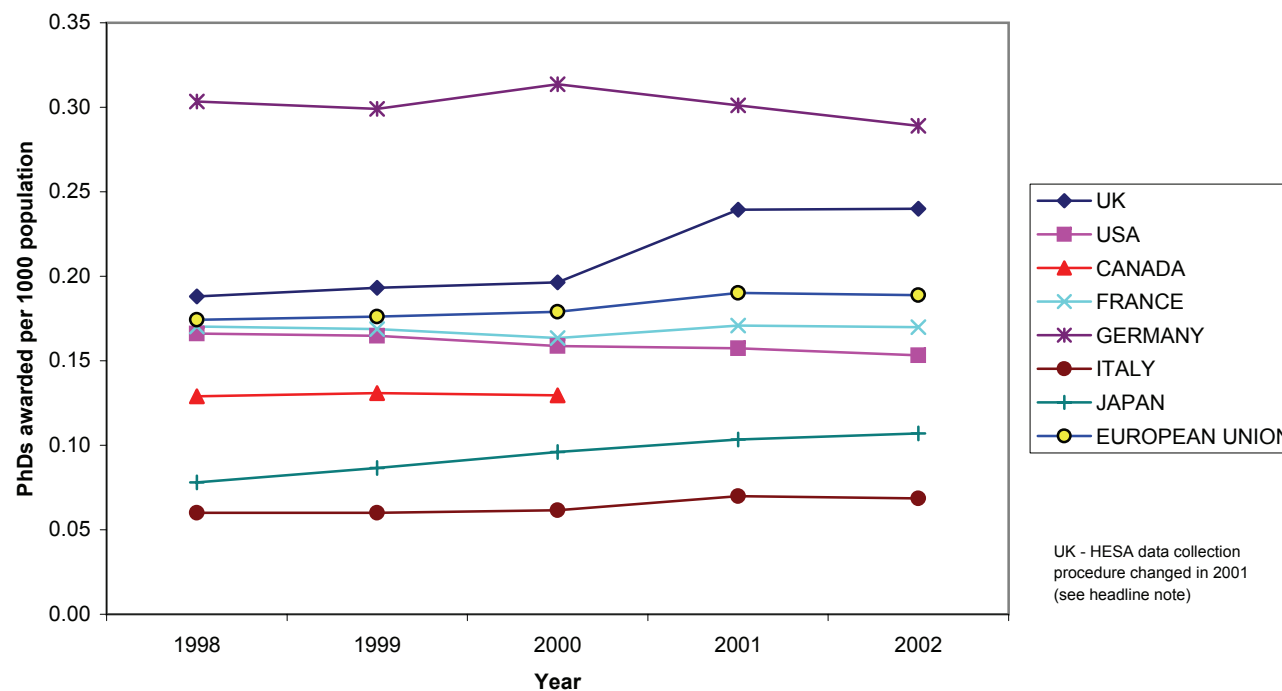
UK - HESA data collection procedure changed in 2001 (see headline note)

Data: OECD (MSTI), OECD Education Database

Description of performance indicator
Condition signalling improvement

2.02 PhDs awarded per head of population
Increased ratio

Indicator headline cont.

This indicator is relevant to both this 'outputs' theme and to the 'people' theme as discussed in the thematic commentary to this report.

UK data in 2001 were affected by a change in HESA data collection (see Background) but have now settled at a new level. There are no Canada data after 2000. There are now 5 year's data for PhD awards available on the OECD Education database. Trend analyses using these data have not been as informative as for some other indicators but the pattern is now becoming clear and the levels of reported activity are evidently stable.

PhDs awarded per head of population - OST comparator group nations, 2002

Data: OECD (MSTI), OECD Education Database
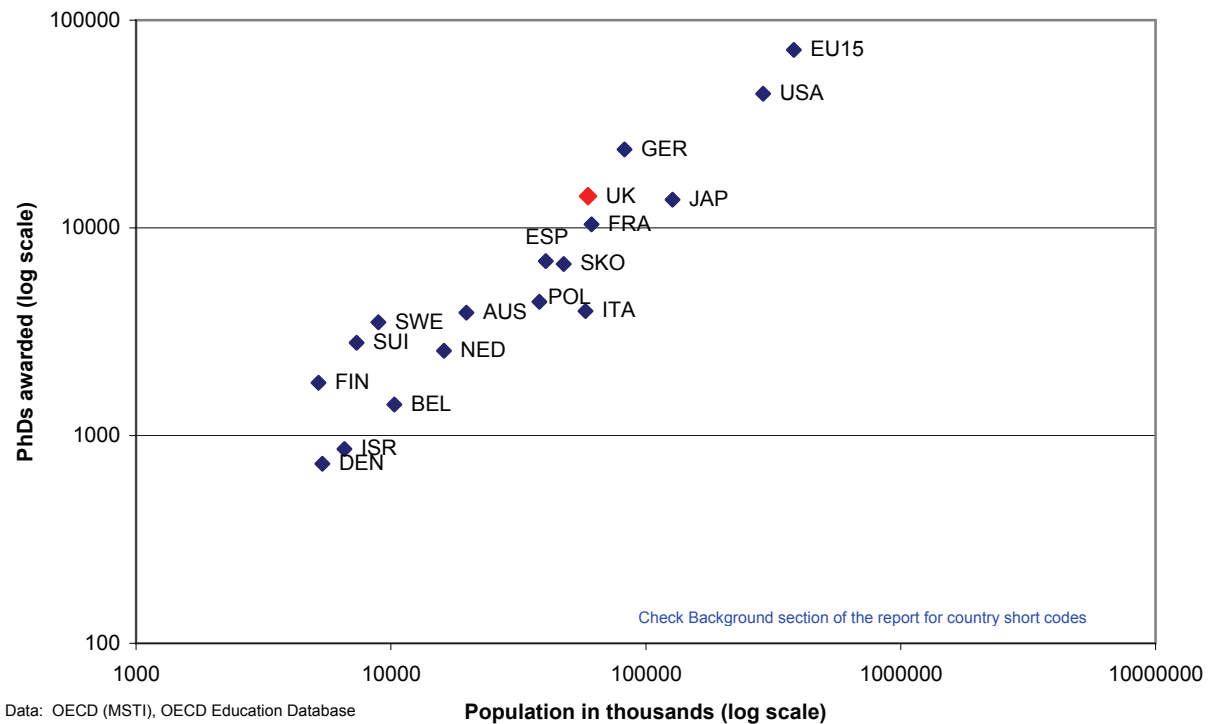
Indicator Headline

Publication share is a measure of research activity relative to the rest of the world. Volume is a scale measure of significance and changes in share are an important indicator of performance.

The UK is ranked 2nd behind the USA in national share of global publications for 2004, the most recent year. This means it has regained its position relative to Japan.

The UK's publication count has not increased markedly, however, since it reached 70,000 outputs per year in 1999. There is some periodicity in UK output associated with assessment cycles. From 2001 there may be some shift from greater volume to better quality (see later indicators on citations).

Since 1998, the 5 year rolling average growth for the OST comparator group has been around 3%. In that period, the UK publication total has been flat and therefore growth is consistently less than the group as a whole, but the USA's annual growth has also fallen from 1% to 0.2%, and Japan from 5.4% to 2.3%. The UK ranked change in performance (publication share 2004 compared with 1999-2003 average) is 22nd among all the nations in the OST comparator group, up from 25 last year (France, Germany and Japan rank lower).

The UK had just under 8% of OST comparator group publications, or 8.8% of global publications, for 2004 [this difference is because the sum of the OST comparator group publications includes some duplication so the individual national shares of the total are uniformly depressed compared to true global values (see methodology notes in Background)].

2.03 Number and share of world publications
Increased count and increased share by comparison with competitors

	Average 1999 - 2003	Actual 2004	Ratio or difference	Ranked change in performance	
				UK - all OST	UK - G8
UK publication count - Actual	70348	69419	0.99		
OST comparator group average publication count	32219	33783	1.12		
UK publication count - Ranked performance	3	2	1		
UK publication count - % share of OST comparator group	8.41	7.90	0.94	22	4
UK publication count - % share of world	9.26	8.81	0.95	22	4

Note that this table ranks both performance and change in performance

Sum of comparator nations exceeds actual world total.

World total is corrected for international co-authorship, which creates duplication in OST total.

Publication share among OST comparator group for G8 nations (USA omitted)

Description of performance indicator
Condition signalling improvement

2.03 Number and share of world publications
Increased count and increased share by comparison with competitors

Indicator headline cont.

China has more than trebled its output from 13,500 publications in 1995 to 46,000 publications in 2004 and is ranked 2nd on growth (Iran is ranked 1st and has increased nearly ten-fold). Italy (at 10) and Canada (13) are the only G8 counties ranked better than 20th on performance change. This indicates that the smaller countries in the OST comparator group are increasing their publication share at a faster rate than the G8.

The consequence of the relative changes in output, and the growth of new research economies, is that the UK's outputs will progressively index less than in the past as a share of world, although it may be greater absolutely. It is inevitable that UK share will continue to fall if growth elsewhere is sustained, but this need not affect quality.

China's total is now almost the same size as France at just over 46,000. Together with South Korea (19,000), Taiwan (13,000) and Singapore (5,000), this Asia-Pacific group now exceeds any one European country in terms of publication volume. The opportunities for international collaboration and the implications for the balance of research endeavour are likely to be very significant.

In 1998 the EU15 total outputs passed that of the USA and now clearly exceeds it (2004: EU = 37.9% of world, USA = 33.6%).

Publication share among fast-growing nations (Russia and China on second axis)
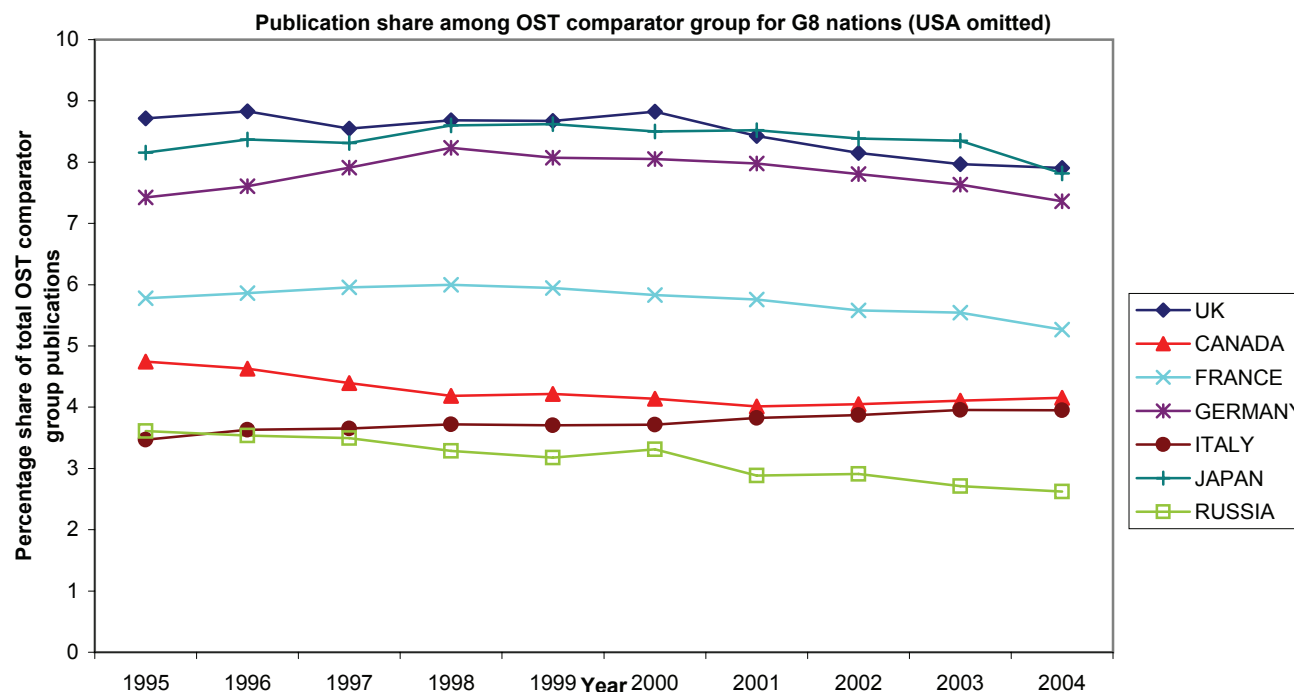

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3.01 Number and share of world citations
Increased count and increased share by comparison with competitors

	Average 1999 - 2003	Actual 2004	Ratio or difference	Ranked change in performance	
				UK - all OST	UK - G8
UK citation count - Actual	555364	33426	0.06		
OST comparator group average citation count	232286	13955	0.06		
UK citation count - Ranked performance	2	2	0		
UK citation count - % share OST comparator group	9.14	9.21	1.01	16	4
UK citation count - % share of world	11.52	12.23	1.06	16	4

Note that this table ranks both performance and change in performance
Sum of comparator nations exceeds actual world total.
World total is corrected for international co-authorship, which creates duplication in OST total.

Indicator headline

Relative citations counts are the most general measure of research excellence because esteem is related to citation frequency. The more times an article is cited by others, the greater its influence is deemed to be.

The UK has improved on this indicator relative to 2003. There is significant continuing growth in China.

The UK is ranked 2nd to the USA in terms of national share of global citations for 2004, the most recent year. It has about 12% of global citations (but 9% of OST comparator group for reasons noted below).

UK rank has remained 2nd to the USA both as an average for the recent period (1999-2003) and for 2004 (difference in table = 0). Citation counts are fewer in more recent years, but the rate at which the count falls may vary between nations.

UK citation share rose slightly between the period 1999-2003 and 2004. The change (ratio = 1.01) is better than that of other leading research nations. Germany had been catching up to the UK but has now plateaued while France and Japan have fallen back. The EU15's combined share has declined slightly, but the USA is also dropping – by about 0.5% per year for several years.

One of the biggest increases is that for China, which has accelerated to a more than four-fold change over the decade (from 0.92% to 3.78%) and approaches the citation volume of Italy (but the publication volume of France - see 2.03). Ranked 18th in 1995 it now ranks 8th by volume.

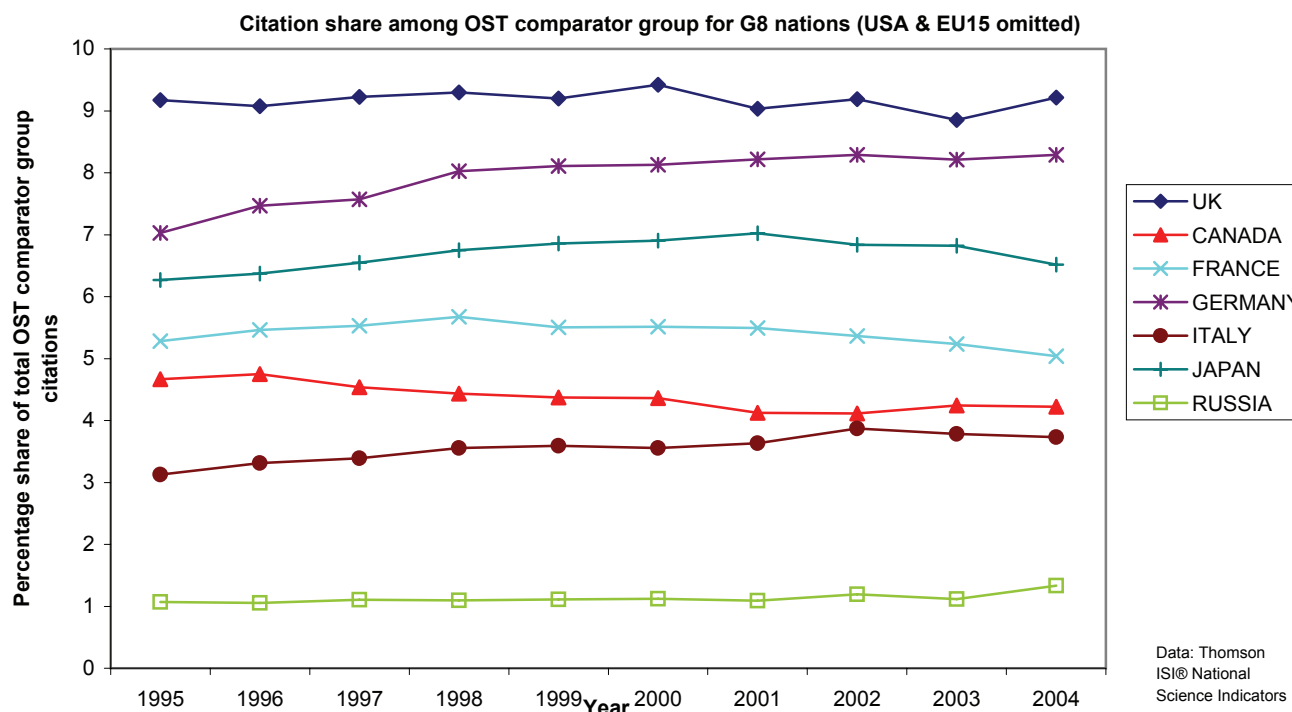**Citation share among OST comparator group for G8 nations (USA & EU15 omitted)**

Percentage share of total OST comparator group citations (y-axis), Year (x-axis)

Legend: UK, CANADA, FRANCE, GERMANY, ITALY, JAPAN, RUSSIA

Data: Thomson ISI® National Science Indicators

Description of performance indicator
Condition signalling improvement

3.01 Number and share of world citations
Increased count and increased share by comparison with competitors

Indicator headline cont.

India is growing too, but much more slowly and has not changed its rank position. Some smaller countries, such as Iran (0.02 to 0.15%), Singapore (0.15 to 0.49%) and South Korea (0.44 to 1.68%), have substantially increased their citation share over the period but their citation counts remain small compared to G8 competitors.

Total citation count might seem to provide the simplest measure of recognition, but total citation count is dependent on output or source volume. An increase in citations might therefore be due to an increase in output rather than esteem. World levels of publication have also risen over the years.

A measure that helps to benchmark national citation counts is to consider not numbers but the share that each nation has of the world total. Even this may be misleading, however, because some nations that have recently become more scientifically active are increasing their share of world cites. It may therefore be appropriate to look at annual change in global share for each country by comparison with close competitors. Where all drop in global share – because of emerging research nations – those that drop less than others are clearly suffering less from competition elsewhere.

The analysis is carried out by year for the national research system across all subjects. The sum of OST comparator group citations includes some duplication (see notes on methodology) so individual national shares of total are uniformly depressed compared to true global values.

Description of performance indicator
Condition signalling improvement

3.02 Number and share of world citations in ten main research fields
Increased national count and share

Clinical Sciences

Indicator Headline

See 3.01 for background and 3.03 for summary.

In Clinical Sciences, the UK citation share overall is 2nd to the USA. Its share of world citations has improved compared to the previous year.

The UK's ranked citation count remained 2nd highest to the USA for both 1999-2003 and 2004 periods.

UK citation count reduced at a ratio of 0.05 between the periods 1999-2003 and 2004. This is very similar to the OST comparator group average. (Citations are always fewer in more recent years).

The change in UK citation share ratio between periods 1999-2003 and 2003 (1.04) is second only to Russia within the G8 nations. Germany's citation share had been growing at a slightly faster rate than the UK but this trend seems to have levelled off while some other nations have declined slightly.

The USA has shown little change in citation share between the periods 1999-2003 and 2004 and seems to be stabilising after a long period of reducing share.

The UK ranked position of 14th on change in OST comparator group citation share is because other countries, notably Poland, India, Singapore and China in this instance, are increasing their citation share at a faster rate than the UK - although their citation counts are smaller than the UK. China's rapid growth seems to be levelling off in this field.

	Average 1999 - 2003	Actual 2004	Ratio or difference	Ranked change in performance	
				UK - all OST	UK - G8
UK citation count - Actual	415,732	22,616	0.05		
OST comparator group average citation count	158,355	8,342	0.05		
UK citation count - Rank among OST comparator group	2	2	0		
UK citation count - % share of OST comparator group	10.05	10.43	1.04	14	2
UK citation count - % share of world	12.82	13.86	1.08		

Note that this table ranks both performance and change in performance

Citation share among OST comparator group for G8 nations (USA omitted) for SUoA Clinical
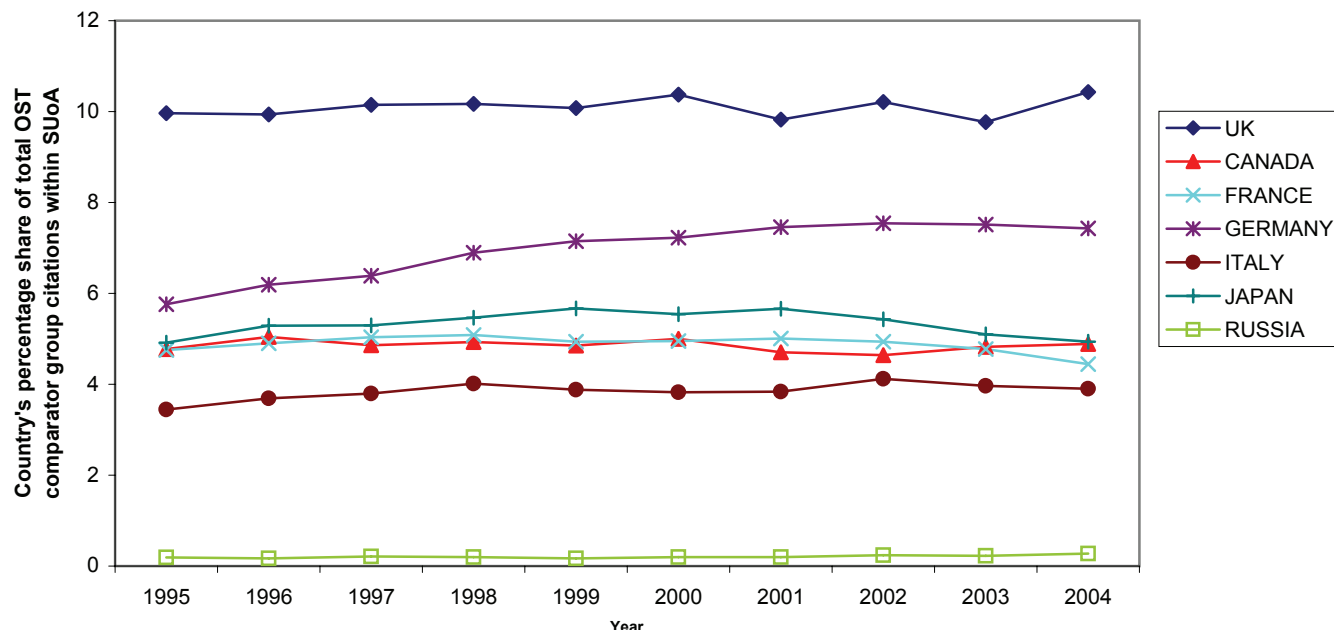
Data: Thomson ISI® National Science Indicators

Description of performance indicator
Condition signalling improvement

3.02 Number and share of world citations in ten main research fields
Increased national count and share

Pre-Clinical and Health-Related Sciences

Indicator Headline

See 3.01 for background and 3.03 for summary.

In the Pre-Clinical and Health-Related Sciences, the UK citation share overall is 2nd to the USA.

There is a considerable gap between UK citation share 1995 - 2004 and the next closest competitor (Germany). Consequently, the UK's rank citation count remained 2nd highest to the USA for both 1999-2003 and 2004 periods (difference in rank = 0).

UK citation count reduced at a rate similar to the OST comparator group as a whole over the period 1999-2004.

The improvement in UK citation share ratio of 1.08 between periods 1999-2003 and 2004 places it third among G8 nations behind Russia and Japan, indicating that these nations citation share are growing at a faster rate than the UK.

The USA had shown a decrease in citation share over the period since 1995 but recovered slightly in 2004.
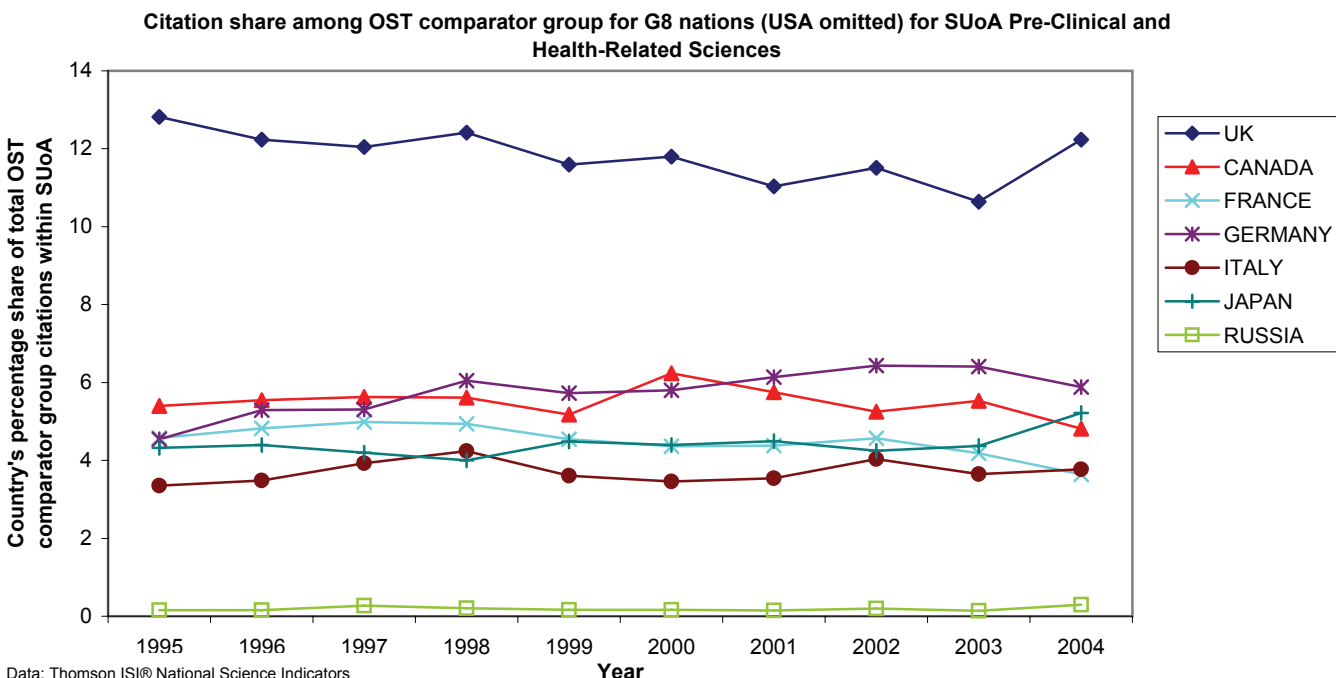
The UK ranked position of 12th on change in OST comparator group citation share is because other countries, notably China, India and South Korea in this case, are increasing their citation share at a faster rate than the UK - even though their citation counts are less than the UK. The average citation share growth ratio of the countries ahead of the UK is +1.44.

	Average 1999 - 2003	Actual 2004	Ratio or difference	Ranked change in performance	
				UK - all OST	UK - G8
UK citation count - Actual	54,882	3,341	0.06		
OST comparator group average citation count	18,441	1,051	0.06		
UK citation count - Rank among OST comparator group	2	2	0		
UK citation count - % share of OST comparator group	11.31	12.23	1.08	12	3
UK citation count - % share of world	14.66	16.60	1.13		

Note that this table ranks both performance and change in performance

Citation share among OST comparator group for G8 nations (USA omitted) for SUoA Pre-Clinical and Health-Related Sciences

Data: Thomson ISI® National Science Indicators

Description of performance indicator
Condition signalling improvement

3.02 Number and share of world citations in ten main research fields
Increased national count and share

Biological Sciences

Indicator Headline

See 3.01 for background and 3.03 for summary.

In Biological Sciences, the UK citation share overall is 2nd to the USA. The UK's rank citation count remained 2nd highest to the USA for both 1999-2003 and 2004 periods (difference in rank = 0). The overall picture for the G8 has changed little this year.

The marginal change in UK citation share ratio of 0.99 between periods 1999-2003 and 2004 is fourth among G8 nations behind the USA, Canada and Russia. Germany, which is third to the UK and USA in citation share, had a ratio of 0.98, indicating that its citation share is affected by similar factors. Canada has recovered slightly from a period of decline.
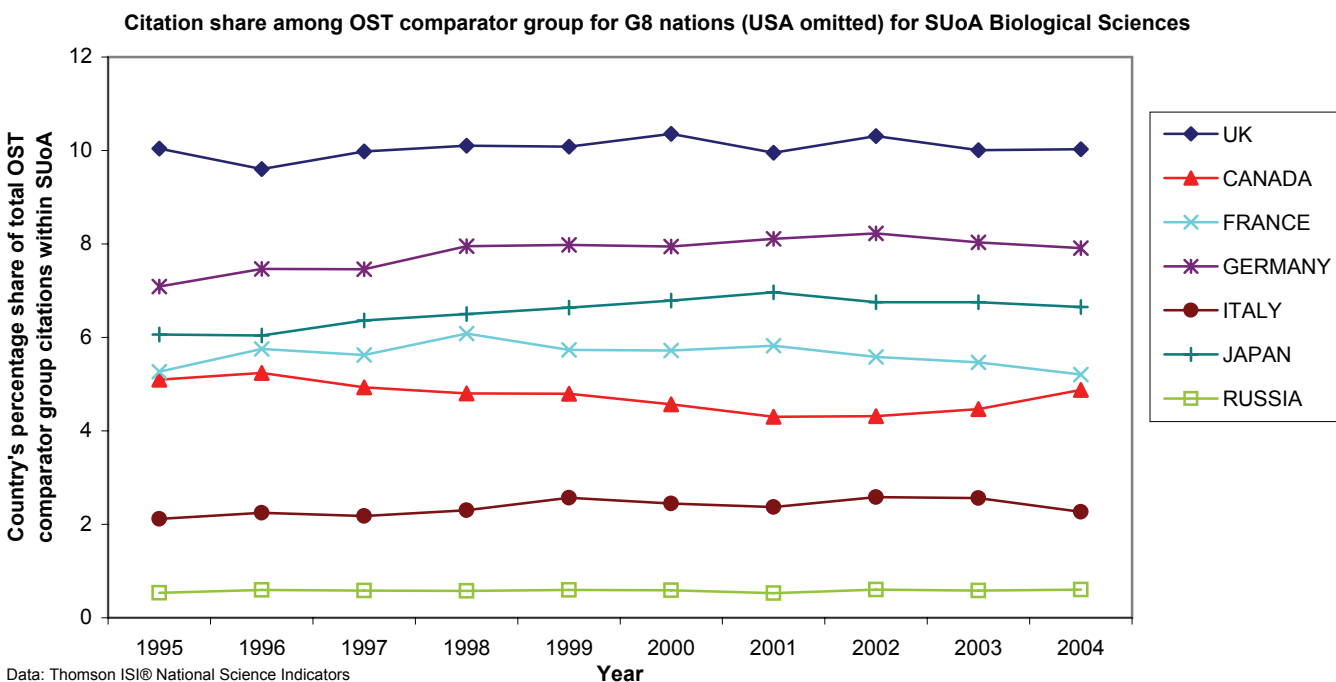
The UK rank of 14th on change in OST comparator group citation share is because other countries, notably China (three-fold over ten years), Singapore and Iran in this case, are increasing their citation share at a faster rate than the UK - though their citation counts are smaller than the UK. China (1.6%) now exceeds Belgium and Denmark and is of similar scale to Sweden.

The USA has stabilised after a period of decrease in citation share between 1995 and 2000 and has remained level at just under 40% since 2001.

Although there are fluctuations in UK citation share across the period, the trend is for a consolidated performance at just over 10% of OST group, but its share of world has actually improved marginally over the ten year period. This may reflect increasing UK collaboration within the G8.

	Average 1999 - 2003	Actual 2004	Ratio or difference	Ranked change in performance	
				UK - all OST	UK - G8
UK citation count - Actual	208,262	11,724	0.06		
OST comparator group average citation count	78,877	4,496	0.06		
UK citation count - Rank among OST comparator group	2	2	0		
UK citation count - % share of OST comparator group	10.14	10.03	0.99	14	4
UK citation count - % share of world	14.36	14.58	1.02		

Note that this table ranks both performance and change in performance

Citation share among OST comparator group for G8 nations (USA omitted) for SUoA Biological Sciences

Data: Thomson ISI® National Science Indicators

Description of performance indicator
Condition signalling improvement

3.02 Number and share of world citations in ten main research fields
Increased national count and share

Environmental Sciences

Indicator Headline

See 3.01 for background and 3.03 for summary.

In Environment the UK citation share overall is 2nd to the USA. The UK's rank citation count remained 2nd highest to the USA for both 1999-2003 and 2004 periods (difference = 0).

The change in UK citation share ratio of 0.90 between periods 1999-2003 and 2004 is 7th among G8 nations and reflects a progressively declining share since 2000. Germany's share also decreased where it had been growing and seemed likely to overtake the UK. Canada is now improving markedly.

The UK ranked position of 21st on change in OST comparator group citation share is because other countries, notably South Africa, Poland and Iran in this case, are increasing their citation share at a faster rate than the UK - even though their citation counts are only a tenth of the UK. The average citation share ratio of the countries ahead of the UK is 1.1.

The USA has shown a marked decline in citation share by over 2%, or a ratio of 0.95 between the periods 1999-2003 and 2004. China citation share has been level at 2.5% since 2001.

	Average 1999 - 2003	Actual 2004	Ratio or difference	Ranked change in performance	
				UK - all OST	UK - G8
UK citation count - Actual	37,647	2,265	0.06		
OST comparator group average citation count	13,554	920	0.07		
UK citation count - Rank among OST comparator group	2	2	0		
UK citation count - % share of OST comparator group	10.50	9.47	0.90	21	7
UK citation count - % share of world	13.40	13.10	0.98		

Note that this table ranks both performance and change in performance

Citation share among OST comparator group for G8 nations (USA omitted) for SUoA Environment
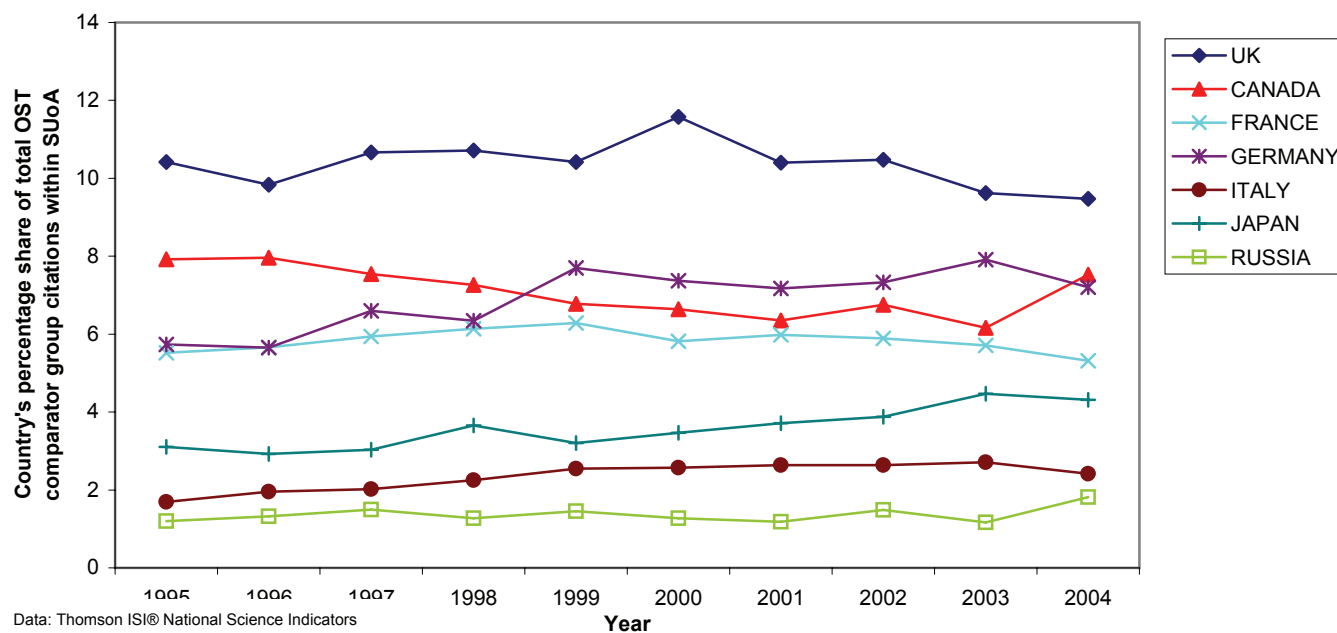
Data: Thomson ISI® National Science Indicators

Description of performance indicator
Condition signalling improvement

3.02 Number and share of world citations in ten main research fields
Increased national count and share

Mathematics

Indicator Headline

See 3.01 for background and 3.03 for summary.

In Mathematics, the UK citation share overall has been 3rd to the USA and (since 1998) France. It has significantly improved its position in 2004, with other G8 nations generally dropping back in share. However, it is now 3rd to the USA and China which has moved up to 2nd - with 9.6% of OST group citations - from 8th in 1995.

The change in UK citation share ratio of 1.10 between periods 1999-2003 and 2004 is 1st among G8 nations Its position of 6th on change in OST comparator group citation share is a marked change from recent years (it had been 15th last year). Only Belgium and China were substantially better in improvement.

The USA had suffered a decreasing citation share since 1995 but this pattern appears to have stabilised between the periods 1999-2003 and 2004.

The UK's citation share has been more variable over the period than for some other fields. From the mid-1990s UK share has fluctuated whilst France had increased steadily to overtake the UK. This is an area which needs further monitoring to verify that the UK's changed position is real and sustained rather than a statistical aberration.

	Average 1999 - 2003	Actual 2004	Ratio or difference	Ranked change in performance UK - all OST	UK - G8
UK citation count - Actual	5,743	339	0.06		
OST comparator group average citation count	2,852	156	0.05		
UK citation count - Rank among OST comparator group	3	3	0		
UK citation count - % share of OST comparator group	7.63	8.36	1.10	6	1
UK citation count - % share of world	9.03	10.02	1.11		

Note that this table ranks both performance and change in performance

Citation share among OST comparator group for G8 nations (USA omitted) for SUoA Mathematics
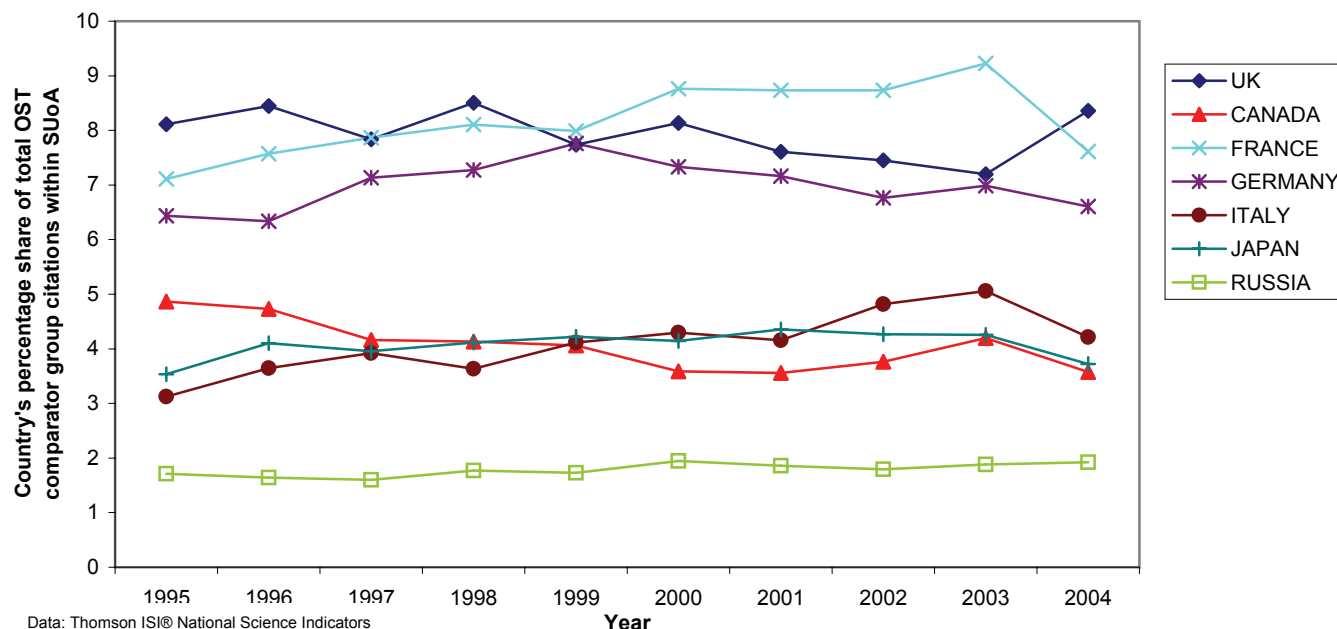
Data: Thomson ISI® National Science Indicators

Description of performance indicator
Condition signalling improvement

Physical Sciences

Indicator Headline

See 3.01 for background and 3.03 for summary.

In Physical Sciences, the UK citation share overall is 4th to the USA, Germany and Japan.
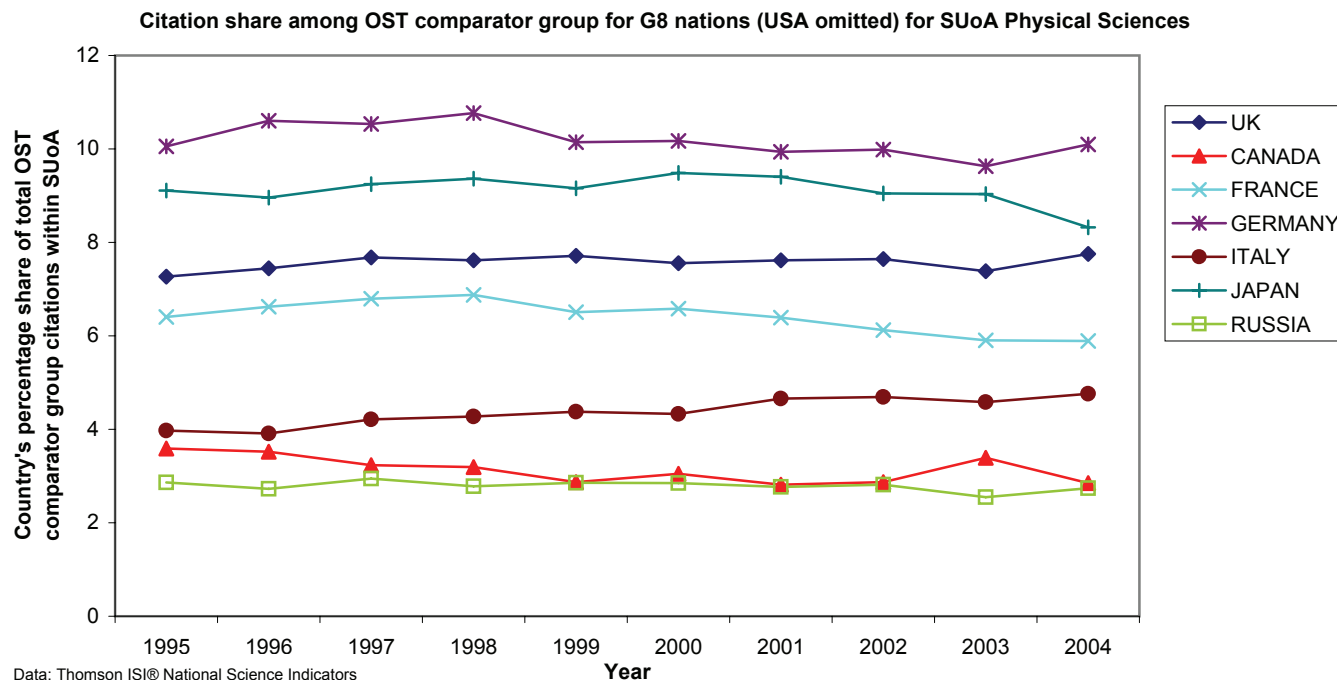
The UK's rank citation count remained 4th highest to the USA, Germany and Japan for both 1999-2003 and 2004 periods (difference = 0). The UK appears to have lagged significantly on these nations in the recent past, but its relative impact has been well ahead of Japan and moved ahead of Germany. There is sustained evidence of slow but continuing growth in UK citation share, and it is ranked 2nd on change among G8 nations. It has moved well ahead of France (at 5th in the group) and seems likely to overtake Japan.

China has moved up from 13th to 6th globally on share in this area. moving ahead of Italy with 4.8% of group citations. The UK ranked position of 12th on change in OST comparator group citation share is because other countries, notably China, India and Poland in this case, are increasing their citation share at a faster rate than the UK.

USA share has dropped from over 35% to less than 29%. The EU15, at 38%, has broadly maintained its total share over the last ten years.

3.02 Number and share of world citations in ten main research fields
Increased national count and share

	Average 1999 - 2003	Actual 2004	Ratio or difference	Ranked change in performance UK - all OST	UK - G8
UK citation count - Actual	154,044	11,671	0.08		
OST comparator group average citation count	77,813	5,788	0.07		
UK citation count - Rank among OST comparator group	4	4	0		
UK citation count - % share of OST comparator group	7.58	7.76	1.02	12	2
UK citation count - % share of world	10.65	12.09	1.13		

Note that this table ranks both performance and change in performance

Citation share among OST comparator group for G8 nations (USA omitted) for SUoA Physical Sciences

Data: Thomson ISI® National Science Indicators

Description of performance indicator
Condition signalling improvement

3.02 Number and share of world citations in ten main research fields
Increased national count and share

Engineering

Indicator Headline

See 3.01 for background and 3.03 for summary.

In Engineering, the UK citation share overall is 4th to the USA, Japan and Germany.

The UK's rank of citation count remained 4th highest to the USA, Japan and Germany for both 1999-2003 and 2004 periods (difference = 0).

While the UK's ranked position is unchanged, a trend of falling UK share of world citations over the period from 1994 has been halted and some uplift is emerging. A growing gap between the UK and Germany has narrowed. The flat UK citation share ratio is average among G8 nations, and ahead of USA, Japan and France.

China has moved up to 5th in OST group share with 6.3% of citations, up from 11th in 1995, and thus just behind the UK.

The UK ranked position of 17th on change in OST comparator group citation share is because other countries, notably Singapore, China, Denmark and Finland in this case, are increasing their citation share at a faster rate than the UK - even though their citation counts are smaller than the UK.

UK average research impact in Engineering has improved and leading units are outstanding. We have previously noted the significant diversity in performance within the UK research base.

	Average 1999 - 2003	Actual 2004	Ratio or difference	Ranked change in performance	
				UK - all OST	UK - G8
UK citation count - Actual	58,774	3,082	0.05		
OST comparator group average citation count	32,026	1,732	0.05		
UK citation count - Rank among OST comparator group	4	4	0		
UK citation count - % share of OST comparator group	6.90	6.85	0.99	17	4
UK citation count - % share of world	8.51	8.69	1.02		

Note that this table ranks both performance and change in performance

Citation share among OST comparator group for G8 nations (USA omitted) for SUoA Engineering
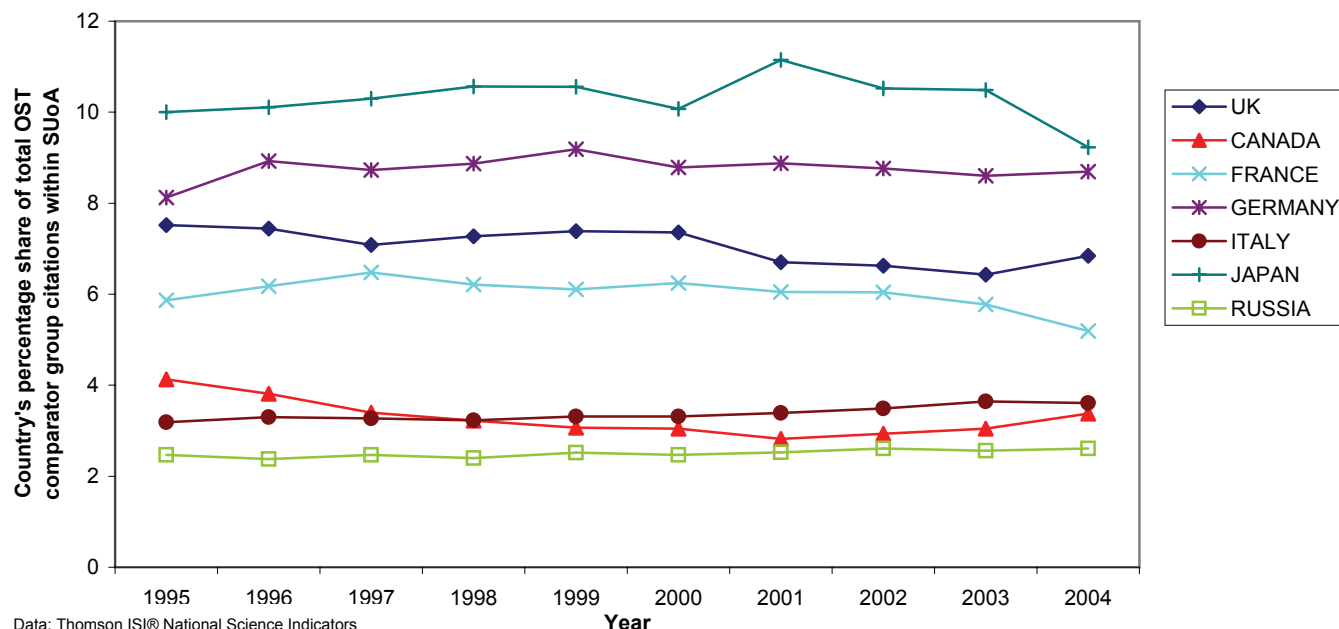
Data: Thomson ISI® National Science Indicators

Description of performance indicator
Condition signalling improvement

3.02 Number and share of world citations in ten main research fields
Increased national count and share

Social Sciences

Indicator Headline

See 3.01 for background and 3.03 for summary.

Bibliometric data for the Social Sciences cannot be compared directly with other disciplines (see Background). Recent work has shown that European comparisons must be made with caution because Anglophone journals are over-represented.

In the Social Sciences, the UK citation share overall is 2nd to the USA. It remained 2nd highest to the USA for both 1999-2003 and 2004 periods (difference = 0).

The change in UK citation share ratio between periods 1999-2003 and 2004 is fifth among G8 nations and follows an earlier period of rapid UK expansion. Evidence from research assessment suggests that journal publication is becoming increasingly important in this field.

The UK ranked position on change in OST comparator group citation share is only 12th. A number of other countries, notably Germany but also Belgium and India in this case, are increasing their citation share at a faster rate than the UK - even though their citation counts are smaller than the UK.

The USA has shown a decrease in citation share of over 10% between 1995-2004. This is partly accounted for by substantial shifts in the database coverage to include a wider range of European journals. This will make the data more valuable in the future although it makes current trends less clear.

China has less than 1% of citations in the OST comparator group.

	Average 1999 - 2003	Actual 2004	Ratio or difference	Ranked change in performance UK - all OST	UK - G8
UK citation count - Actual	9,703	600	0.06		
OST comparator group average citation count	3,401	212	0.06		
UK citation count - Rank among OST comparator group	2	2	0		
UK citation count - % share of OST comparator group	11.08	10.87	0.98	12	5
UK citation count - % share of world	11.98	11.90	0.99		

Note that this table ranks both performance and change in performance

Citation share among OST comparator group for G8 nations (USA omitted) for SUoA Social Science
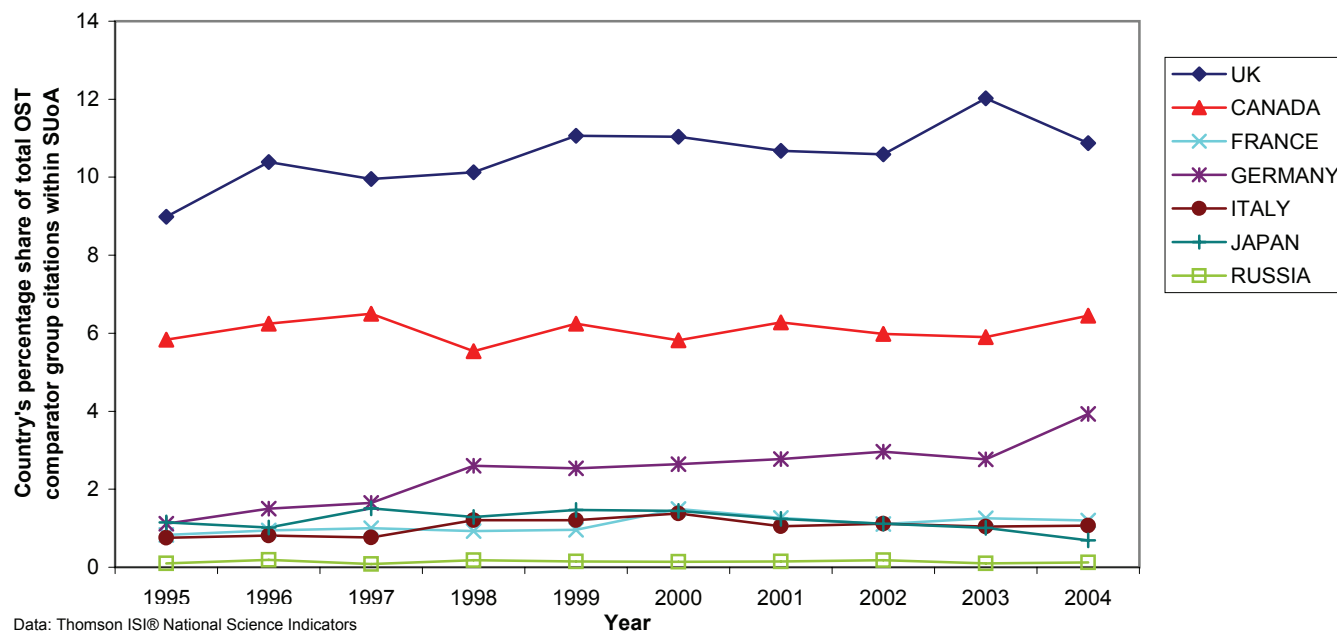
Data: Thomson ISI® National Science Indicators

Description of performance indicator
Condition signalling improvement

3.02 Number and share of world citations in ten main research fields
Increased national count and share

Business

Indicator Headline

See 3.01 for background and 3.03 for summary.

Bibliometric data for Business, like the Social Sciences, should be treated with caution and cannot be compared directly with other disciplines.

In Business, the UK citation share overall is 2nd to the USA.

The UK's rank of citation count remained 2nd highest to the USA for both 1999-2003 and 2004 periods.

The UK ranked position of 13th on change in OST comparator group citation share is because other countries, notably Singapore, South Africa and Switzerland in this case, are increasing their citation share at a faster rate than the UK - even though their citation counts are smaller than the UK.
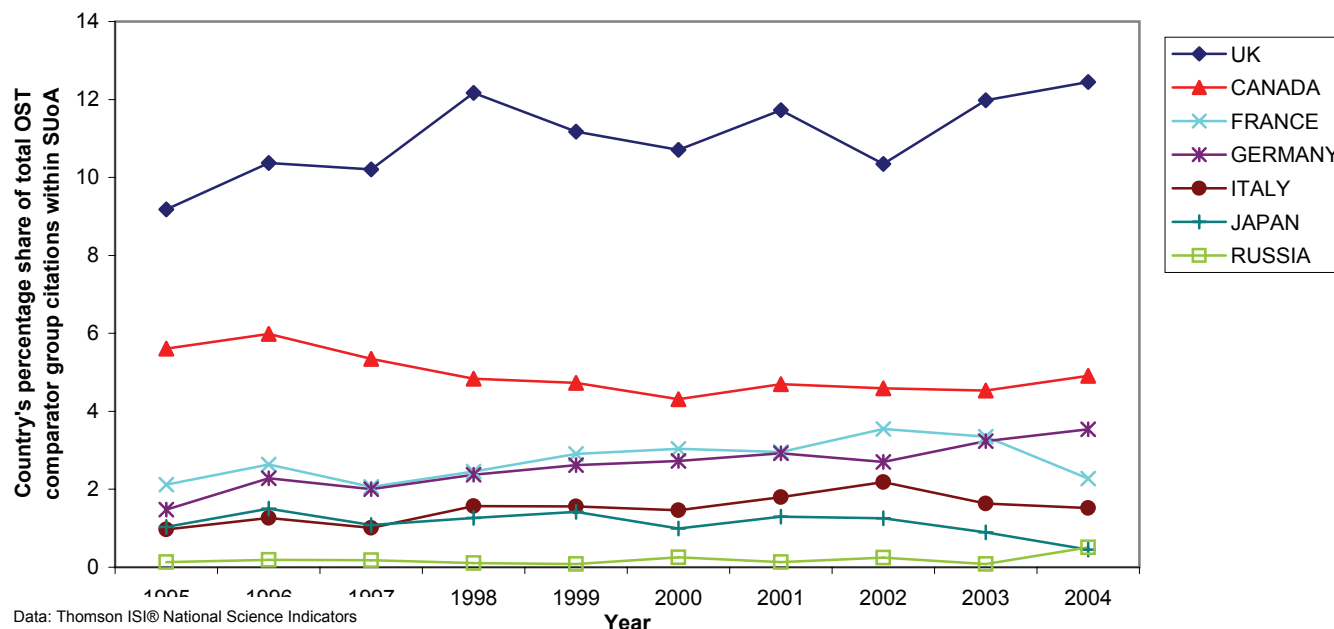
USA citation share has fallen from 65% to just over 51% in this area. EU15 share has risen from less than 20% to 27% over the same period, of which the UK has been a significant part. China has more than doubled its share, but only to 2.6%.

	Average 1999 - 2003	Actual 2004	Ratio or difference	Ranked change in performance	
				UK - all OST	UK - G8
UK citation count - Actual	4,683	246	0.05		
OST comparator group average citation count	1,625	76	0.05		
UK citation count - Rank among OST comparator group	2	2	0		
UK citation count - % share of OST comparator group	11.19	12.45	1.11	13	3
UK citation count - % share of world	13.13	15.25	1.16		

Note that this table ranks both performance and change in performance

Citation share among OST comparator group for G8 nations (USA omitted) for SUoA Business

Data: Thomson ISI® National Science Indicators

Description of performance indicator
Condition signalling improvement

3.02 Number and share of world citations in ten main research fields
Increased national count and share

Humanities

Indicator Headline

This is the first year in which any bibliometric data for the Humanities and Arts have been analysed in this report. It is necessary to treat these data with great caution as other analyses have confirmed the degree to which these subjects continue to make use of other modes of output, notably books, for their key publications.

With that caveat in mind, and recognising that citation counts are very low compared to the numbers of researchers working in these disciplines, we can nonetheless see that the UK has a strong and improving position in the database.
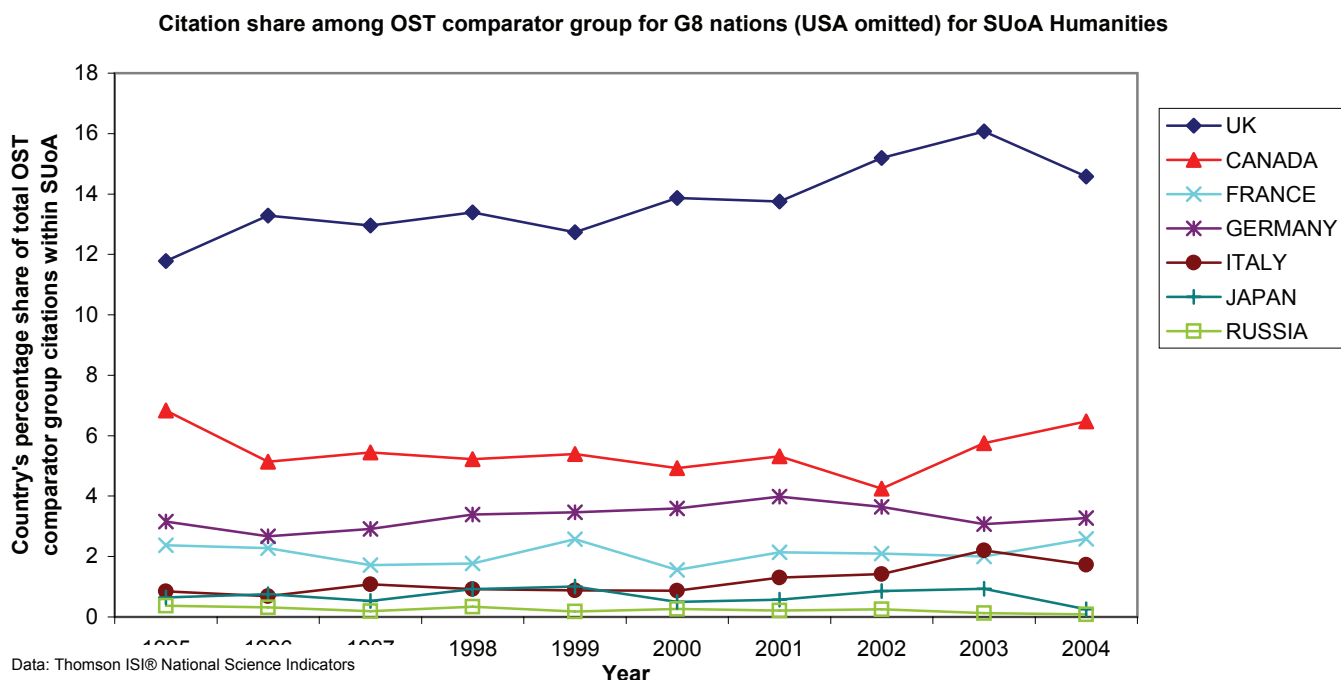
That said, it must be noted that non-Anglophone journal coverage is inevitably rather poor, and the literature is said to be parochial where journal content and usage would be more international for natural sciences and technology.

We will continue to monitor the UK's position and will work with other agencies, including the newly established UK Arts & Humanities Research Council, to explore the value and relevance of these and other research performance indicators in these fields. For the present, we take the outcome reported here as a very positive reflection of the health of the UK research base in this area.

	Average 1999 - 2003	Actual 2004	Ratio or difference	Ranked change in performance	
				UK - all OST	UK - G8
UK citation count - Actual	1,915	169	0.09		
OST comparator group average citation count	533	45	0.08		
UK citation count - Rank among OST comparator group	2	2	0		
UK citation count - % share of OST comparator group	14.33	14.58	1.02	16	4
UK citation count - % share of world	15.19	15.34	1.01		

Note that this table ranks both performance and change in performance

Citation share among OST comparator group for G8 nations (USA omitted) for SUoA Humanities

Data: Thomson ISI® National Science Indicators

Description of performance indicator
Condition signalling improvement

3.03 Rank of share of world citations by nine research fields
More frequent presence in top three among fields

	Average 1999 - 2003	Actual 2004	Ratio or difference
UK frequency (out of 9) in top 3	6.6	7	1.061

Indicator Headline

The comparative level of national share of world citations (3.02) is a good measure of strength in a research field. This may be an isolated peak of strength, however, or it may be typical of general performance.

This indicator extends indicator 3.02 by looking across the level of nine main research fields to assess consistency of performance. The fields roughly correspond to a University 'Faculty' or group of Schools, and are defined by grouping cognate Units of Assessment (i.e. those units using similar literature). UoAs are subject categories used in UK research assessment.

Nine main fields are used rather than ten because we are as yet uncertain about the value of national ranked position in regard to the Humanities.

The measure is simply a count of the occurrence of a country in the top 3 by rank citation share. The UK ranks in the top 3 by citation count for 7 of the nine main research fields (indicator 3.02). This is a reflection of strength in depth in comparative international research performance. This has placed the UK second to the USA, which wins in all nine fields, in almost every year of the last ten. It improved over Germany compared to 2003.

Only G8 countries appear in this ranking, since smaller research nations are unable to compete on volume. The performance profile of Germany is notable, improving from placing in 4 to placing in 6 fields last year but only 5 in 2004. Canada, by contrast, slipped back and now ranks in 2-3 fields.

If the EU15 grouping were to be analysed in the same way as the USA, it too would be placed in the top 3 in 9 out of 9 categories.

Leading nations for ranked citation volume in nine research fields
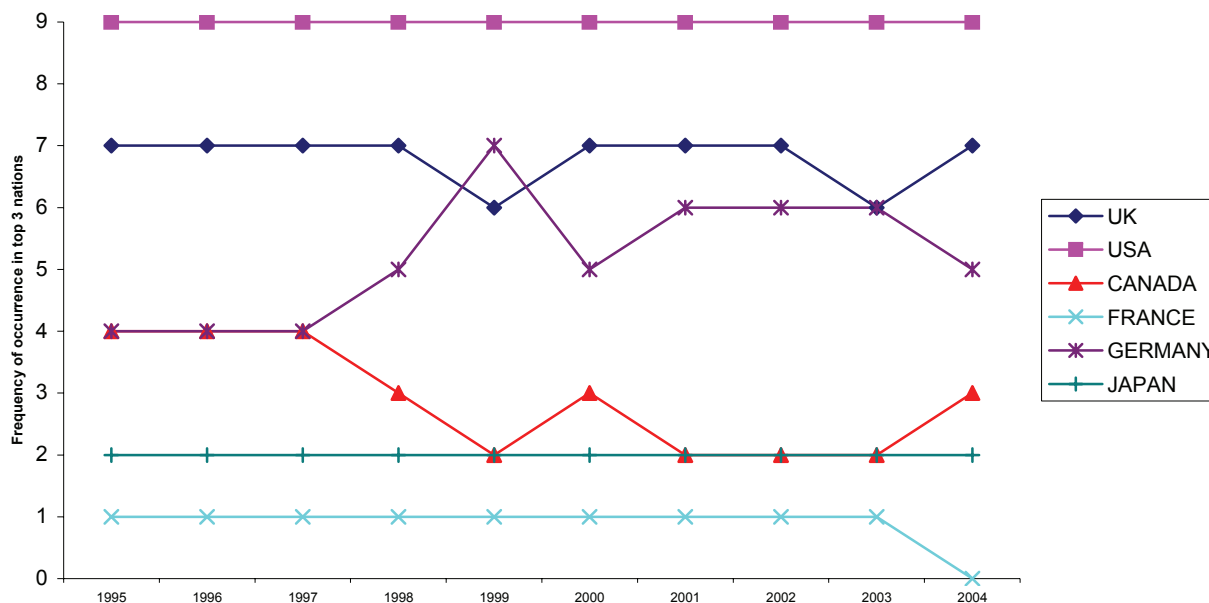
Data: Thomson ISI® National Science Indicators

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Description of performance indicator
Condition signalling improvement

3.04 Share of citations relative to share of publications
Increase in citation share compared to share of papers within field

Indicator Headline

The difference between a country's share of world papers (sources) and its share of world citations is like a balance in trading. There is an investment in publications and there is an acquisition of international recognition in citations. Stronger research is reflected in a greater citation share than source share.

The UK has a positive difference between its share of world citations and its share of world sources in eight of ten areas.
The analysis is carried out for a recent five-year window at the level of Super-UoAs, with Humanities introduced for the first time this year.

The USA has a strong positive balance in all areas. Some other countries (Switzerland, the Netherlands, Denmark, Sweden) also have positive differences across multiple subject areas but the absolute values of these differences are generally less than that of the UK. Germany has a marked positive balance in Biological, Environmental and Physical Sciences and Engineering. China has a growing output but is generally in citation 'deficit'.

For smaller countries the trading balance is mostly negative. This reflects the general scaling relationship between output volume and citation share, also seen at institutional level within countries.

The balances in social sciences, business and humanities are skewed towards the USA. The balance of journal coverage in these areas is not as representative as in the natural sciences.

The intention of this indicator is to identify more effective research systems by comparing each country's share of OST group citations with its share of outputs within a field. Citation impact (cites per paper) is analysed in 3.09.
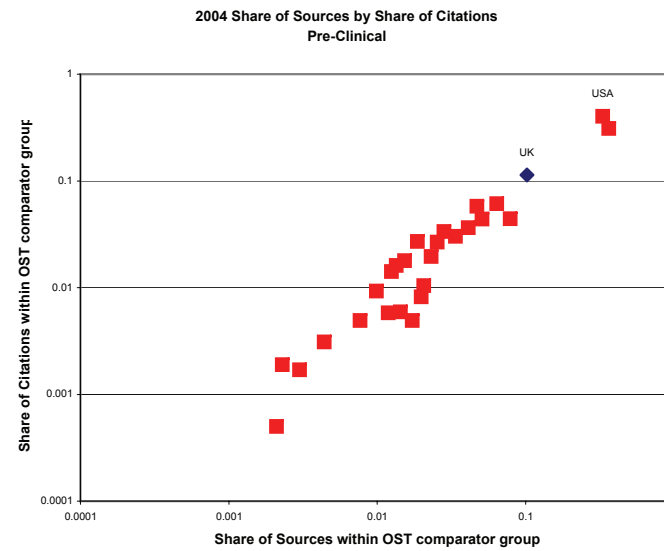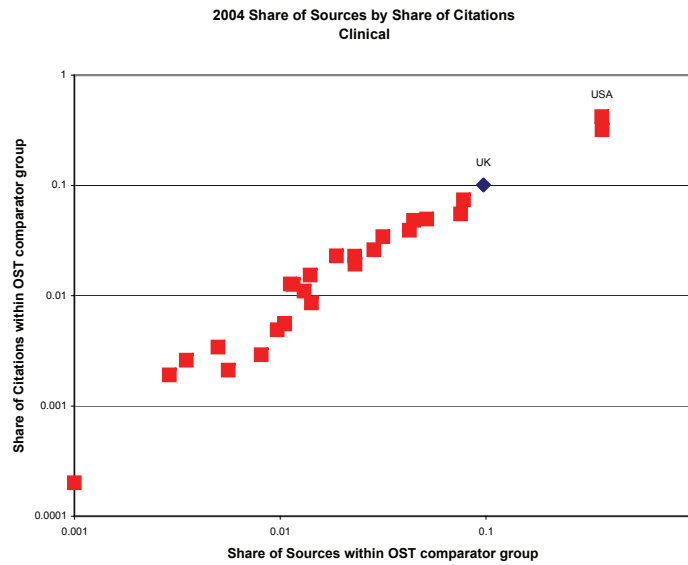
Percentage difference between share of citations and share of publications within OST group of countries for most recent 5 years											
Country	Year	Clinical	Pre-Clinical	Biological Sciences	Environment	Mathematics	Physical Sciences	Engineering	Social Science	Business	Humanities
UK	2004	0.38	1.18	2.02	1.43	0.94	1.27	0.27	-1.7	-0.88	0.87
USA	2004	5.39	7.07	8.59	4.63	6.34	8.09	5.36	5.53	11.63	6.73
CANADA	2004	0.37	1.08	-0.62	0.27	-0.34	0.44	-0.32	0.12	-0.71	-0.86
FRANCE	2004	-0.21	-0.73	0.13	0.37	0.45	-0.06	0.44	-0.22	-0.3	-3.98
GERMANY	2004	-0.4	-0.32	0.88	0.92	0.23	0.98	1.49	-1.25	-0.62	-2.46
ITALY	2004	-0.35	-0.49	-0.67	-0.56	-0.07	0.17	-0.35	0.18	-0.62	-0.43
JAPAN	2004	-2.03	-3.48	-1.34	-1.28	-1.89	-1.79	-0.72	-0.45	-0.85	-0.02
RUSSIA	2004	-0.35	-0.13	-1.04	-1.99	-1.35	-2.98	-1.43	-0.18	-0.03	-0.41
AUSTRALIA	2004	-0.26	-0.36	-0.69	0.14	0.23	0.09	-0.15	-0.45	-0.92	-0.4
BELGIUM	2004	0.13	0.26	-0.15	-0.07	0.25	-0.1	0.17	-0.1	-0.02	-0.15
BRAZIL	2004	-0.5	-1.16	-1.15	-0.46	-0.29	-0.51	-0.34	-0.35	-0.2	-0.15
DENMARK	2004	0.15	0.25	-0.06	0.26	0.14	0.26	0.26	0.03	-0.1	0.39
FINLAND	2004	0.1	0.16	-0.11	0.07	0.01	-0.02	0.01	0.16	-0.15	0.23
NETHERLANDS	2004	0.25	0.52	0.19	0.26	0.34	0.67	0.48	0.19	-0.27	0.98
POLAND	2004	-0.16	-0.28	-0.79	-0.44	-0.48	-0.63	-0.46	-0.06	-0.03	-0.09
SPAIN	2004	-0.38	-0.36	-1.18	-0.62	-0.36	-0.1	0.09	-0.07	-0.93	-0.92
SWEDEN	2004	-0.02	0.11	0.08	0.47	0.06	0.13	0.28	0.43	-0.12	-0.02
SWITZERLAND	2004	0.41	0.83	0.61	0.65	0.18	0.66	0.64	0.17	0.13	-0.33
CHINA	2004	-0.56	-1.03	-1.22	-1.55	-2.05	-3.34	-2.16	-0.52	-0.85	0.45
INDIA	2004	-0.52	-1.24	-1.93	-1.13	-0.83	-1.35	-0.97	-0.27	-1.37	-0.02
IRAN	2004	-0.08	-0.16	-0.14	-0.1	-0.23	-0.17	-0.15	-0.02	-0.06	0.01
ISRAEL	2004	-0.21	-0.06	0.14	-0.13	0.06	0.18	0.09	-0.41	0	0.07
SINGAPORE	2004	-0.1	-0.04	-0.03	-0.08	0.19	-0.25	-0.37	-0.15	-0.39	0.13
SOUTH AFRICA	2004	-0.09	-0.13	-0.47	-0.19	-0.07	-0.08	-0.12	-0.16	-0.25	-0.06
SOUTH KOREA	2004	-0.49	-0.85	-0.63	-0.46	-0.94	-0.93	-1.01	-0.23	-0.72	0.4
TAIWAN	2004	-0.48	-0.61	-0.45	-0.41	-0.49	-0.61	-1.05	-0.25	-1.41	0.05

The analysis assumes that each country 'uses' journals in a field in the same way. It is, in practice, evident that the general assumption is incorrect for the Social Sciences and Humanities. Some countries' national publishing bases are less well covered by ISI and only more international work is included in the common database. In these areas the USA also has an exceptional positive balance and comparative outcomes may thus be further flawed.
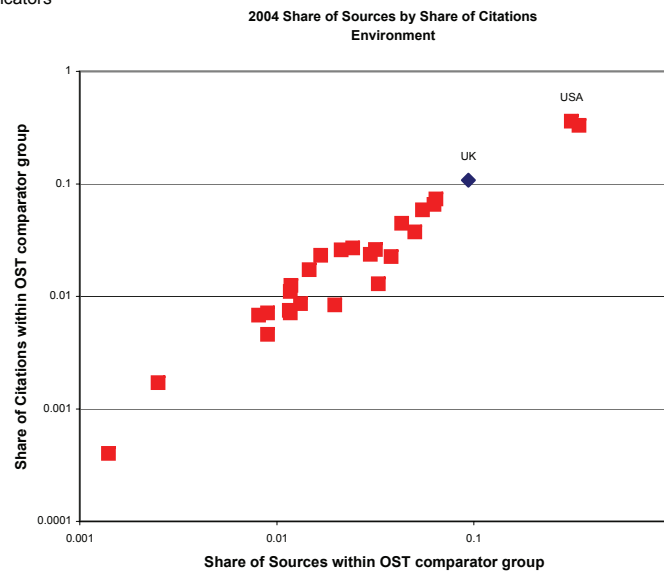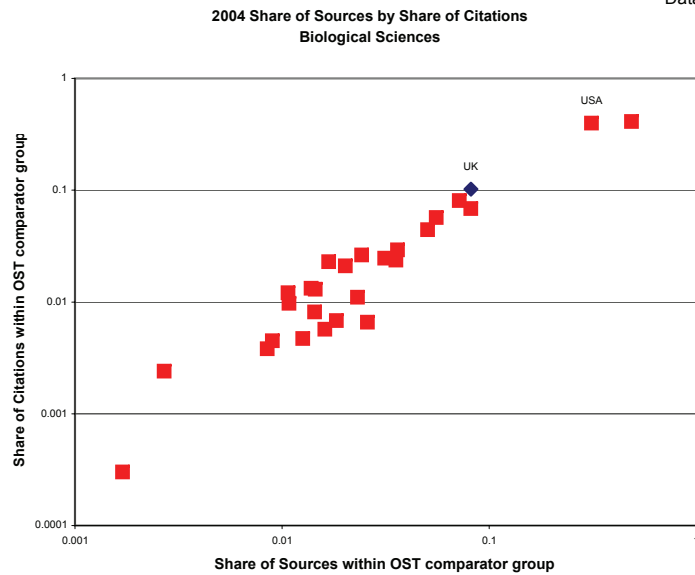
Bibliometric data for Social Sciences and Humanities should always be treated with caution and cannot be compared directly with other disciplines. In other indicators, the analysis for these disciplines focuses essentially on the year to year trend. Only here is the comparison solely between countries.

3.04 Share of citations relative to share of publications
Increase in citation share compared to share of papers within field

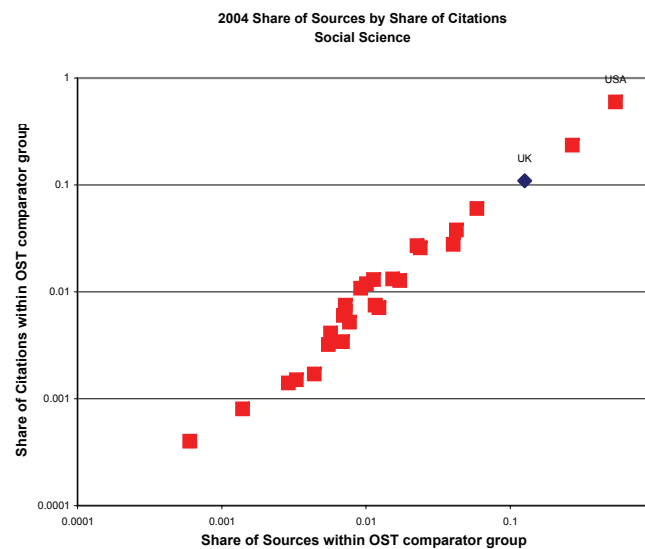**2004 Share of Sources by Share of Citations**
Clinical

2004 Share of Sources by Share of Citations
Pre-Clinical

Data: Thomson ISI® National Science Indicators

2004 Share of Sources by Share of Citations
Biological Sciences

2004 Share of Sources by Share of Citations
Environment

Description of performance indicator　　**3.04 Share of citations relative to share of publications**
Condition signalling improvement　　　　**Increase in citation share compared to share of papers within field**

2004 Share of Sources by Share of Citations
Mathematics

2004 Share of Sources by Share of Citations
Physical Sciences

2004 Share of Sources by Share of Citations
Engineering

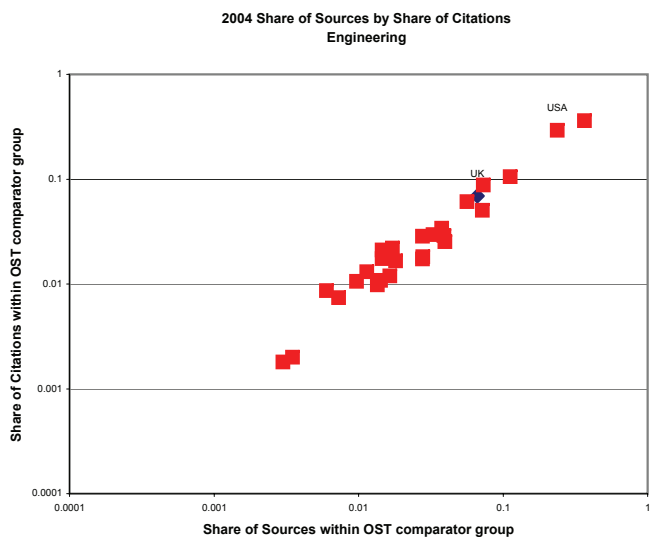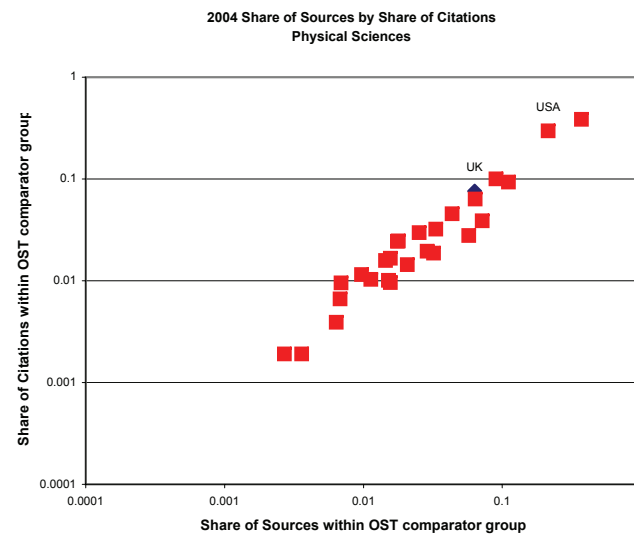2004 Share of Sources by Share of Citations
Social Science

Data: Thomson ISI® National Science Indicators

Description of performance indicator
Condition signalling improvement

3.04 Share of citations relative to share of publications
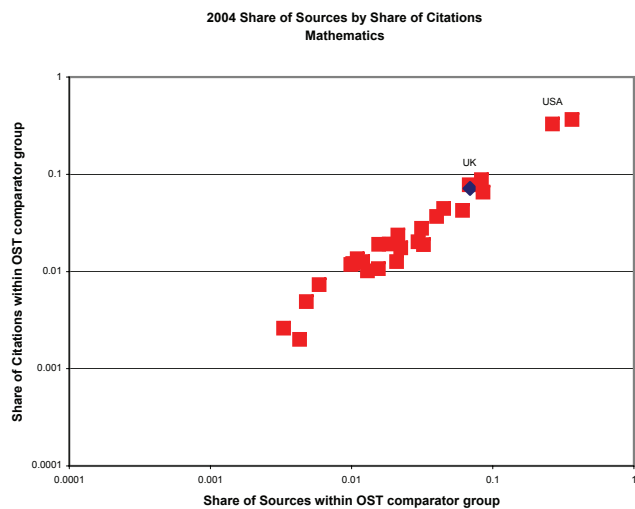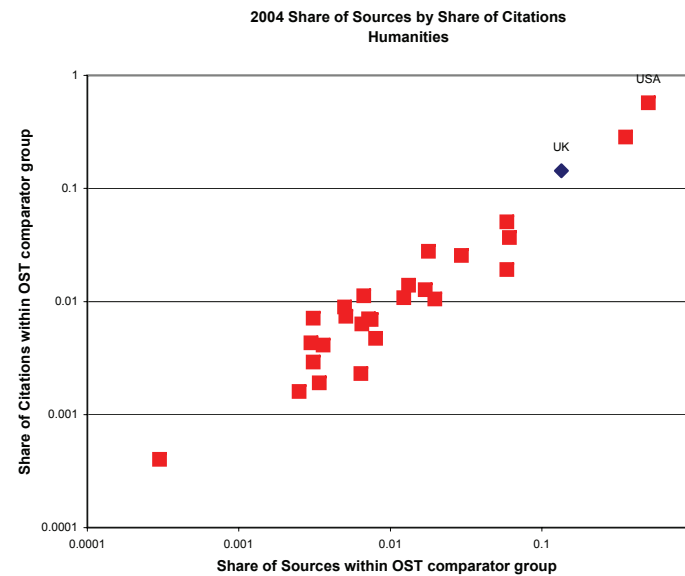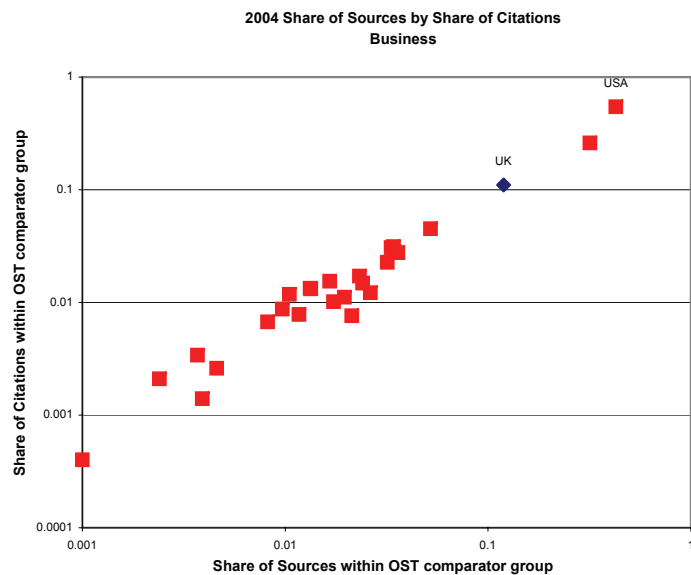**Increase in citation share compared to share of papers within field**

2004 Share of Sources by Share of Citations
Business

2004 Share of Sources by Share of Citations
Humanities

Data: Thomson ISI® National Science Indicators

49

Description of performance indicator
Condition signalling improvement

3.05 Number and share of uncited publications
Decrease in ratio of uncited to total sources

Part 1 - UK SUoA analysis

Indicator Headline

The status of uncited papers is disputed. Papers that receive no subsequent attention are different in kind to papers that are even infrequently cited. It is argued that negative reports may be uncited yet can be important in identifying blind alleys and other unfruitful areas.

Nonetheless, since uncited work has no measurable influence, it may be inefficient to invest undue resources in research that has no apparent value to other researchers. It is assumed that research management should work towards a minimisation in the proportion of papers that are uncited.

The UK has been successful in progressively reducing both the proportion of its papers that remain uncited in a five-year period (35% down from 38.5%) and its share of the world's uncited papers. Its total output increased but a smaller number of these papers remained uncited at the end of the period. It has improved its performance in this regard relative to the EU competitors and to Japan.

Note that in this indicator, a time factor needs to be considered (see background notes). The proportion of papers published in any one year that remain uncited in later years will decline with time. Thus a progressive year by year decrease would be observed in the proportion of any cohort that remains uncited. Fixed citing windows are therefore used here for analyses of uncited papers in different periods, to allow the appropriate comparisons to be made. We compare papers published in a 5 year period with citations over the same years rather than the paper's lifetime.

	NSI5 2000	NSI5 2004	Ratio
UK uncited papers	130544	122771	0.94
UK published papers	338273	351230	1.04
UK uncited papers as a percentage of all sources	38.59	34.95	0.91

NSI5 data make use of papers in a five year period and citations to those papers within the same specified period.
Volume is therefore about five times the annual average in Indicator 2.03

G8 share of world uncited papers (USA & EU15 omitted)
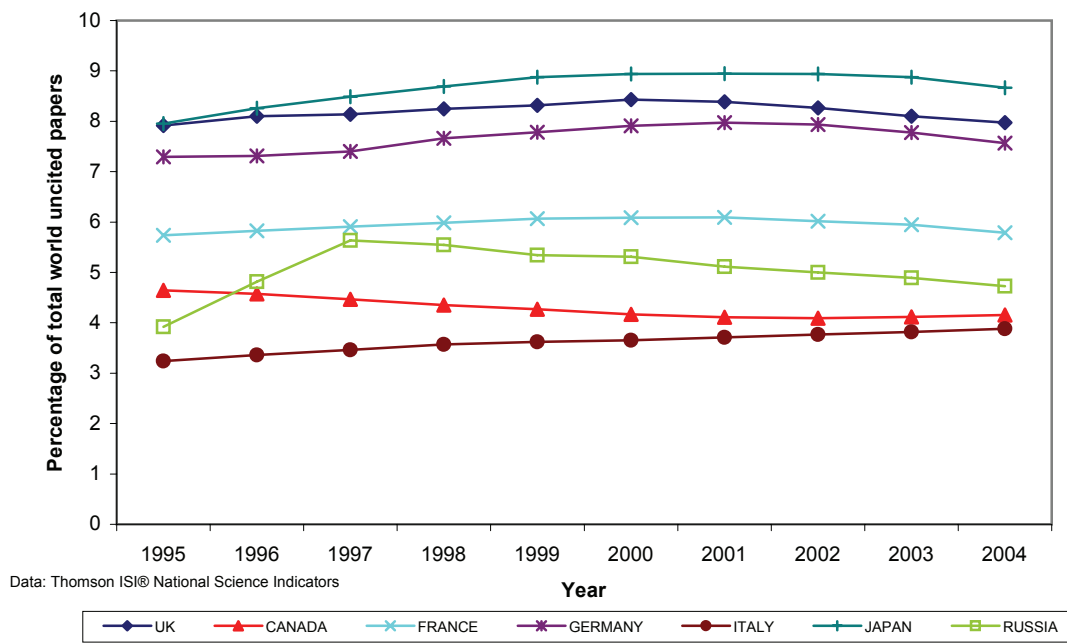
Data: Thomson ISI® National Science Indicators

Description of performance indicator
Condition signalling improvement

3.05 Number and share of uncited publications
Decrease in ratio of uncited to total sources

Indicator Headline cont.

The analysis is carried out both at a national level for comparisons between countries and at a more detailed SUoA level to develop our understanding of the distribution of uncitedness.

Within specific SUoA fields: Pre-Clinical & Health, Biological Sciences, Physical Sciences and Engineering all saw a decrease in the number of uncited papers between the 5 years preceding 2000 and the 5 years preceding 2004. This indicates an improvement in performance.

In the Social Sciences, Business and Humanities' SUoAs there was an increase in the number of uncited papers but this is accompanied by increases in volume. The proportion uncited decreased in all areas and the UK now has the lowest proportion uncited in Social Sciences among G8 countries.

Bibliometric data for the Social Sciences and Humanities should be treated with caution and cannot be compared directly with other disciplines.

UK - numbers of uncited papers in main subject areas (SUoAs) in overlapping 5 year windows											
	Clinical	Pre-Clinical & Health	Biological Sciences	Environment	Mathematics	Physical Sciences	Engineering	Social Science	Business	Humanities	Total UK uncited papers
2000	95220	13039	37691	11622	6251	43883	44802	9223	5511	9444	130544
2003	94139	11991	36651	11797	6237	43072	42360	9695	5632	9358	124904
2004	93175	11665	35761	11576	6261	41891	41119	9803	5753	9585	122771
Percentage change 2000 - 2004	*2.19*	*11.78*	*5.40*	*0.40*	*-0.16*	*4.76*	*8.96*	*-5.92*	*-4.21*	*-1.47*	*6.33*

Description of performance indicator   **3.05 Number and share of uncited publications**
Condition signalling improvement   **Decrease in ratio of uncited to total sources**

Part 2 - Comparison between UK and other countries

Indicator Headline

Across almost all subject areas, the UK produces fewer papers that remain uncited than does the OST comparator group on average. The UK had more uncited papers than average for the first time in Pre-clinical and health sciences in 2003 and this increased in 2004.

Changes in the UK's proportion of uncited papers follow the OST comparator group trend across most SUoA fields. For both the UK and OST comparator group average there is usually a fall between the two five-year periods to 2000 and to 2004. The exception is the Humanities, but citation rates are fundamentally lower in this area. Here too, however, the UK is more often cited than the group as a whole or any other G8 country.
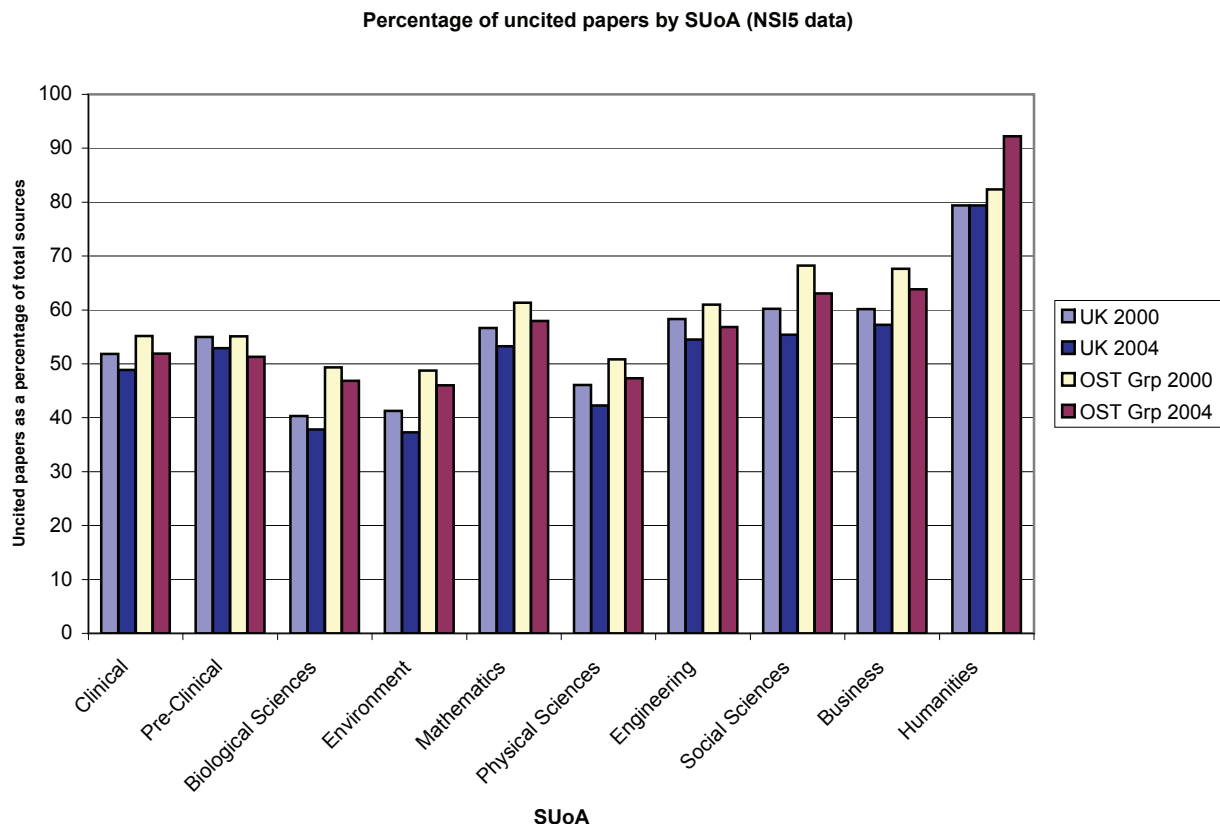
Percentage of uncited papers by SUoA (NSI5 data)

Data: Thomson ISI® National Science Indicators

Description of performance indicator   **3.05 Number and share of uncited publications**
Condition signalling improvement   **Decrease in ratio of uncited to total sources**

G8 - Percentage of papers remaining uncited within period

	Clinical	Pre-Clinical	Biological Sciences	Environment	Mathematics	Physical Sciences	Engineering	Social Science	Business	Humanities	Total uncited papers
Five year period ending in 2000											
UK	51.8	55.0	40.3	41.3	56.6	46.1	58.3	60.2	60.2	79.4	130544
USA	48.4	48.0	40.1	43.7	55.3	45.2	58.2	58.0	57.5	79.4	466361
CANADA	49.6	53.4	42.3	40.9	58.5	45.6	58.5	59.7	60.8	82.3	64556
FRANCE	52.8	56.0	42.9	41.6	58.7	48.1	57.8	71.1	63.3	92.2	94260
GERMANY	51.4	52.2	43.1	43.5	59.9	45.0	56.8	72.4	64.0	86.3	122440
ITALY	53.0	54.5	46.1	48.8	58.9	46.8	59.6	66.5	64.3	87.0	56572
JAPAN	53.2	47.2	48.4	49.5	67.9	52.3	61.5	72.0	68.6	81.6	138398
RUSSIA	69.7	53.5	67.1	66.1	73.1	62.7	71.2	84.3	80.3	93.3	82266
Five year period ending in 2004											
UK	48.9	52.9	37.8	37.3	53.3	42.3	54.5	55.4	57.2	77.5	122771
USA	46.3	45.8	39.1	42.0	53.2	42.3	55.4	56.7	55.0	78.8	447314
CANADA	47.5	52.9	41.3	41.1	58.3	44.7	56.4	56.2	60.8	81.6	63910
FRANCE	50.7	53.9	40.7	38.3	54.7	44.5	53.6	64.3	60.8	92.3	89049
GERMANY	47.7	50.3	40.8	38.9	54.9	41.6	52.8	64.7	60.4	83.9	116494
ITALY	49.7	50.1	44.3	44.9	56.7	43.8	56.4	61.7	64.4	83.6	59796
JAPAN	48.6	43.7	46.5	46.7	64.0	48.6	57.9	67.8	67.7	79.1	133342
RUSSIA	68.5	50.4	63.8	66.0	68.9	59.1	65.2	82.8	63.6	91.5	72761
Difference between earlier and later periods (2000 value - 2004 value, +ve result = decrease in uncitedness)											
UK	3.0	2.1	2.5	4.0	3.4	3.8	3.8	4.8	2.9	1.9	7773
USA	2.1	2.3	1.0	1.7	2.1	2.9	2.9	1.4	2.5	0.6	19047
CANADA	2.1	0.5	1.0	-0.2	0.2	0.9	2.1	3.5	0.1	0.7	646
FRANCE	2.2	2.1	2.2	3.2	4.0	3.6	4.3	6.7	2.5	-0.1	5211
GERMANY	3.7	1.9	2.3	4.6	5.0	3.3	4.0	7.7	3.6	2.4	5946
ITALY	3.3	4.4	1.8	3.8	2.2	3.0	3.2	4.7	-0.1	3.4	-3224
JAPAN	4.6	3.5	1.9	2.8	3.9	3.7	3.6	4.2	0.9	2.5	5056
RUSSIA	1.2	3.1	3.2	0.1	4.2	3.6	6.0	1.5	16.8	1.8	9505

Description of performance indicator
Condition signalling improvement

3.06 Number and share of cited publications
Increase in ratio of cited to total sources

Part 1 - UK SUoA analysis

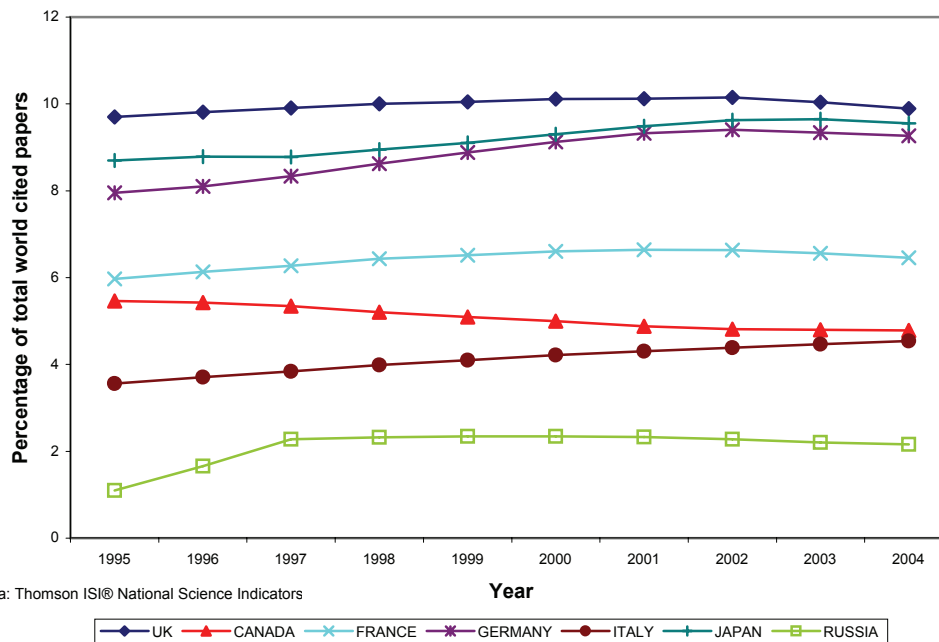| **Indicator Headline** |
|---|
| Number and share of cited papers is the positive counterpart of indicator 3.05, the number and share of uncited papers. |
| Whereas uncited papers are a well defined category, cited papers are a rather more diffuse group including both low and high impact papers. They are therefore more difficult to define in terms of a performance indicator. |
| The UK's cited papers have increased recently at a relatively faster rate than the total national output (ratio 2004 vs. 2000). |
| The UK's cited papers as a proportion of all outputs has consequently improved from 61 to 65%. The UK's share of world cited papers increased to 2002 but has now fallen back slightly. |
| The general G8 trend has been for an increase in citedness between the 5 year periods to 2000 and to 2004, with improvements for most EU countries. The immediate trend is for some levelling in this pattern. |
| Citedness for China outputs has improved substantially between the two five year periods but remains significantly below the OST group averages for the present. |

	NSI5 2000	NSI5 2004	Ratio
UK cited papers	207729	228459	1.10
UK published papers	338273	351230	1.04
UK cited papers as a percentage of all sources	61.4	65.0	1.06

NSI5 data make use of papers in a five year period and citations to those papers within the same specified period.

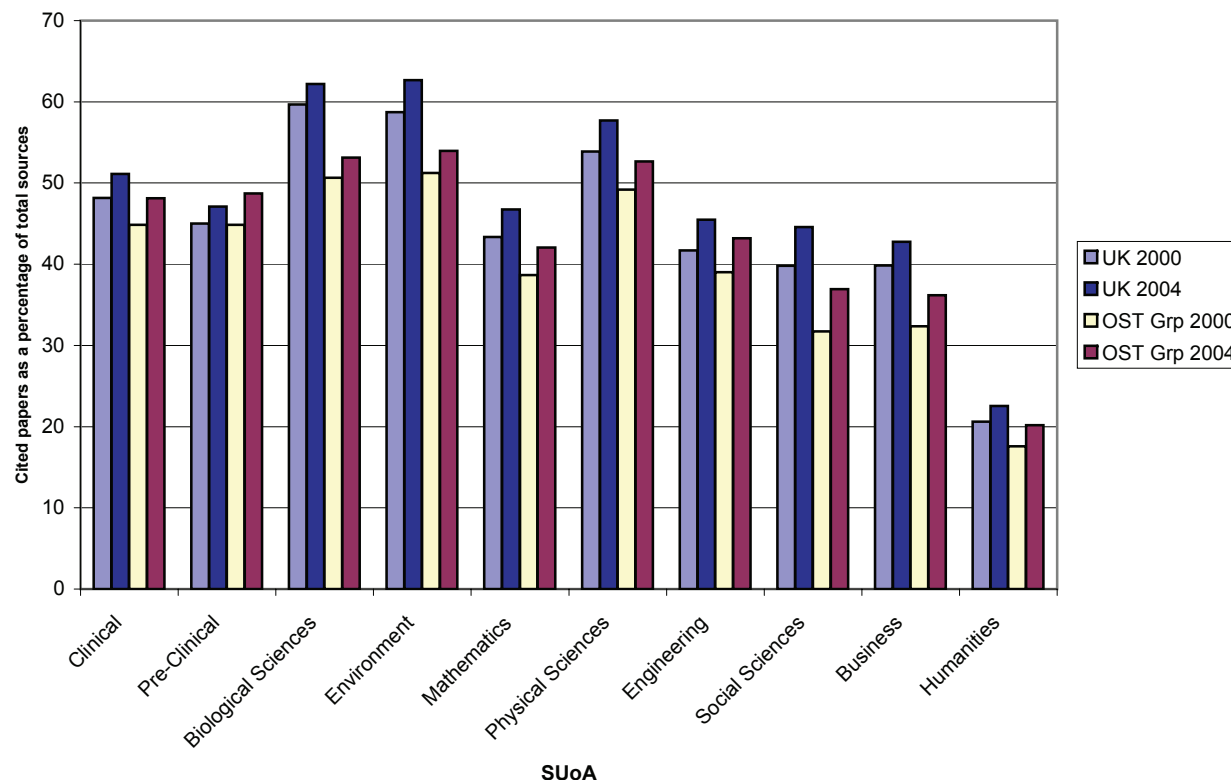**G8 share of world cited papers (USA & EU15 omitted)**

Data: Thomson ISI® National Science Indicators

Legend: UK — CANADA — FRANCE — GERMANY — ITALY — JAPAN — RUSSIA

Description of performance indicator   **3.06 Number and share of cited publications**
Condition signalling improvement   **Increase in ratio of cited to total sources**

Percentage of cited papers by SUoA (NSI5 data)

Data: Thomson ISI® National Science Indicators

UK - numbers of cited papers in main subject areas (SUoAs) in overlapping 5 year windows											
	Clinical	Pre-Clinical	Biological Sciences	Environment	Mathematics	Physical Sciences	Engineering	Social Science	Business	Humanities	Total UK uncited papers
2000	88451	10669	55803	16534	4786	51299	32057	6098	3651	2452	207729
2003	96798	10527	58942	19218	5490	56411	34536	7651	4210	2689	226837
2004	97398	10379	58828	19449	5493	57152	34304	7889	4299	2788	228459
Percentage change 2000 - 2004	*10.1*	*-2.7*	*5.4*	*17.6*	*14.8*	*11.4*	*7.0*	*29.4*	*17.7*	*13.7*	*10.0*

Description of performance indicator
Condition signalling improvement

3.07 Number and share of publications in top 1% by citation count
Increase in share

Indicator Headline

Some publications have exceptional citation rates compared to others in their field. The national share of the most cited 1% of papers is an indicator of interest. The data reported here cover the five-year period 2000-2004. The citation counts are not directly comparable to last year because the point at which we sampled the papers was later in the cycle (November instead of January). Paper counts and rank position are comparable, although the total of papers in the set is greater as Thomson journal coverage has increased.

The UK has increased its share from 12.9% to 13.2%, which is a further improvement over each previous 5-year window. The UK is second in volume of highly cited papers to the USA. Its share (13.2%) is high relative to its share of all papers (about 9%, see Indicator 2.03).

The UK has moved from 10th to 6th in the OST comparator group in terms of average impact of highly cited papers, and is 2nd to Canada in the G8. The absolute volume of other countries is, however, much lower.

On volume, the USA has fallen further back from its 62.7% last time. The biggest improvement among the G8 is for Germany, by a further 0.5% on top of +0.4% last year. China has also significantly improved its position, up from 1% two years ago to 3% now. It continues to have an atypical distribution of peak activity, in relatively low citation areas, thus resulting in a low average impact.

cont./

Country	Papers exceeding threshold	Rank by Papers	Papers as % share OST Group	Citations for these papers	Rank by Citations	Average impact of highly cited papers	OST group rank by impact	G8 rank by impact
USA	25,746	1	61.4%	2,208,042	1	85.76	8	4
UK	5,528	2	13.2%	482,795	2	87.34	6	2
GERMANY	4,715	3	11.3%	384,599	3	81.57	15	7
JAPAN	2,921	4	7.0%	251,576	4	86.13	7	3
FRANCE	2,847	5	6.8%	240,515	5	84.48	10	5
CANADA	2,435	6	5.8%	214,811	6	88.22	5	1
ITALY	1,878	7	4.5%	156,234	7	83.19	14	6
SWITZERLAND	1,683	8	4.0%	148,561	8	88.27	4	
NETHERLANDS	1,678	9	4.0%	141,250	9	84.18	11	
AUSTRALIA	1,353	10	3.2%	113,567	10	83.94	12	
CHINA	1,251	11	3.0%	66,017	13	52.77	25	
SWEDEN	1,102	12	2.6%	101,435	11	92.05	3	
SPAIN	1,100	13	2.6%	93,051	12	84.59	9	
BELGIUM	775	14	1.8%	62,757	14	80.98	16	
DENMARK	712	15	1.7%	59,708	15	83.86	13	
ISRAEL	607	16	1.4%	56,291	16	92.74	2	
RUSSIA	586	17	1.4%	44,730	18	76.33	19	8
SOUTH KOREA	560	18	1.3%	35,043	19	62.58	23	
FINLAND	478	19	1.1%	46,109	17	96.46	1	
POLAND	374	20	0.9%	29,984	20	80.17	17	
INDIA	354	21	0.8%	26,291	21	74.27	20	
BRAZIL	321	22	0.8%	22,805	22	71.04	21	
TAIWAN	290	23	0.7%	17,652	23	79.35	18	
SINGAPORE	169	24	0.4%	9,878	24	58.45	24	
SOUTH AFRICA	129	25	0.3%	8,193	25	63.51	22	
IRAN	14	26	0.0%	405	26	28.93	26	
EUROPEAN UNION	15,972			1,267,368				

Description of performance indicator
Condition signalling improvement

3.07 Number and share of publications in top 1% by citation count
Increase in share

Indicator headline cont.

The USA has also dropped from 6th on average impact to 8th in the OST group and is behind the UK, Canada and Japan. Finland has moved up to 1st overall on average impact although only 18th on volume.

The USA has an exceptional share of highly cited papers (62.7% compared with just over 33.7% of global output). The EU total (de-duplicated to take account of co-authorship between countries within the EU) shows that Europe remains behind the USA in this respect despite now exceeding it in terms of total outputs at 35.9%.

Being above world average is a good initial sign of quality, whatever the specific indicator. As a general rule, however, the research that lies in the far upper end of the quality distribution is most likely to have a long lasting impact on its research field and - perhaps - the economy more widely.

'Exceptional' could have a number of definitions. We use the Thompson Scientific® benchmark of the top 1% of papers by citation count for each field and year for international research comparisons. The ISI data are compensated for differences between fields in their size and citation behaviour.

Numbers of highly cited papers to 2000-2004 for OST comparator group
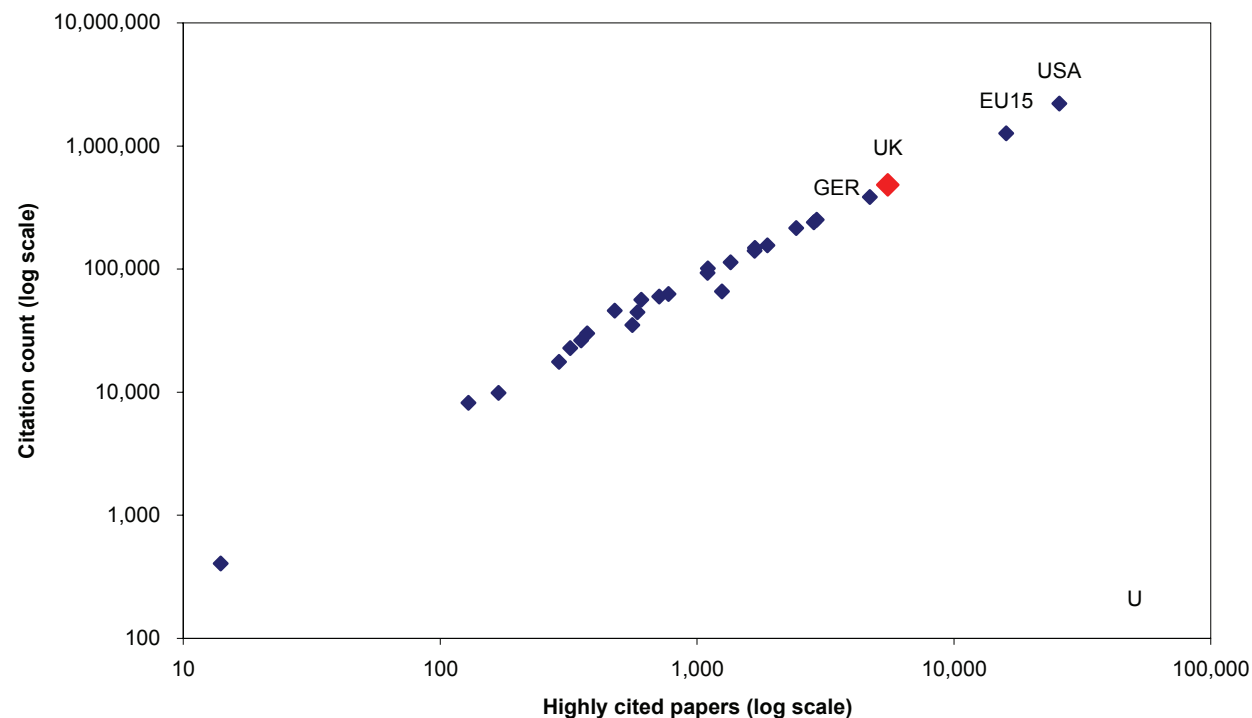
Data: Thomson ISI® Essential Science Indicators

Description of performance indicator
Condition signalling improvement

Indicator Headline

The most frequently used index of research performance is that of impact, measured as citations per paper. This is widely accepted internationally as an index of research quality.

The UK has improved its relative international performance (Rebased Impact (RBI) of 1.37 [rebased against world = 1.0, see below] in 2004, 1.25 recent average) and its overall rank (now 5th from 7th). It is 2nd to the USA (1.45 average recent impact) among G8 nations, and is evidently closing the gap as it has done throughout the last decade.

Germany has significantly improved its position, from around world average in 1993 to a 1.34 average RBI in 2003 and will continue to challenge the UK and the USA.

The USA lies 2nd globally to Switzerland (1.74 average recent impact). Denmark lies 3rd overall with the Netherlands 4th. Sweden is 6th but with a slightly higher recent average impact than the UK.

China, which has had a major increase in investment and output, has an average impact of around 0.63 and lies 24th in the OST comparator group. Its average RBI had improved over the decade but has plateaued in the last few years.

Citation rates vary between fields, and older papers have more time to accumulate citations. A common baseline is therefore created to compare impact data. This baseline is the world average figure for the stated field and year. Setting actual performance figures against a common reference point is called 'rebasing' (or normalisation) and the figure usually quoted will be ReBased Impact (RBI). [Data by field are shown in indicator 3.09.]

3.08 Citation impact (citations/publication) relative to world baselines
Increased national impact

	Average 1999 - 2003	Actual 2004	Ratio or difference	Ranked performance change	
				UK - all OST	UK - G8
UK impact - Actual	7.91	0.48	0.06		
OST comparator group average impact	6.23	0.36	0.06		
UK impact - Rank	7	5	2		
UK rebased impact - Actual	1.25	1.37	1.10	6	3
OST comparator group average rebased impact	0.98	1.02	1.05		

Note that this table ranks both performance and change in performance

Rebased average impact (world = 1.0) for G8 nations
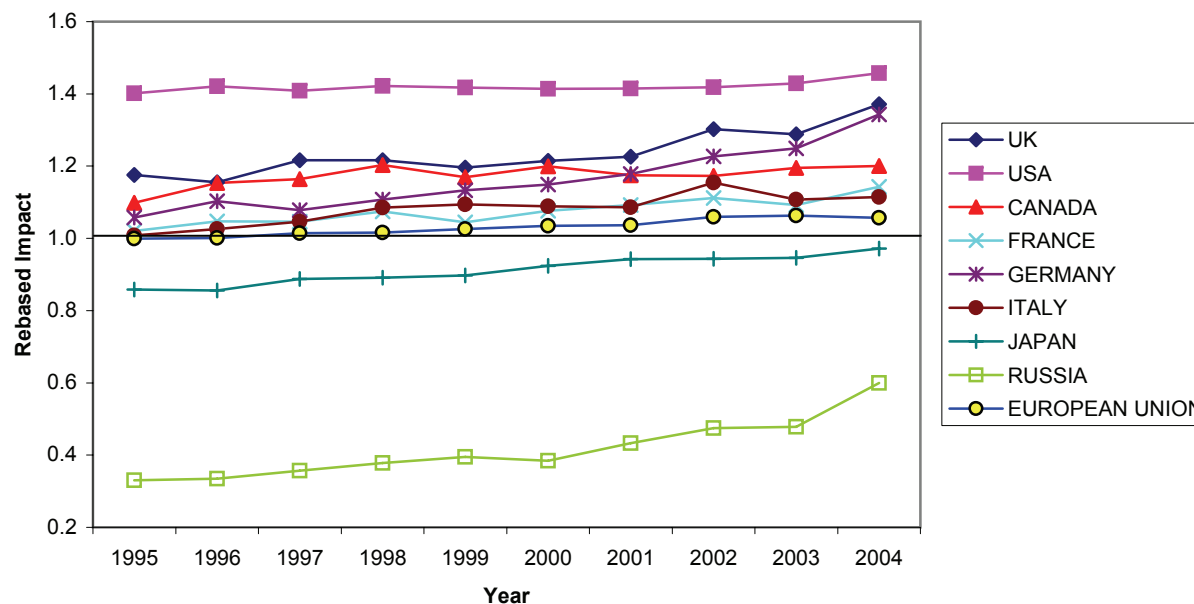
Data: Thomson ISI® National Science Indicators

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Description of performance indicator
Condition signalling improvement

3.09 Citation impact relative to world baselines in ten main research fields
Increased impact in main research fields

Clinical Sciences

Indicator Headline

For Clinical Sciences, the UK is ranked 4th in terms of impact for 2004, the most recent year. This is a significant uplift from last year and places it 2nd among G8 nations to the USA.

The UK has moved ahead of other competitors, has caught up with Canada as predicted last year, but remains behind Switzerland and Belgium within Europe.

UK rebased impact rose from 1.09 in 1995, to 1.18 for the period 1999-2003 and 1.3 for 2004 (world average = 1.0). The step up in 2002 seemed exceptional but is now seen to be part of a sustained trend. This degree of performance change (ratio = 1.10) is first among G8 nations, except Russia where performance is currently erratic. It is 8th among the OST comparator group, up from 12th last year, where improvement is led by South Africa and Poland. These improvements among smaller nations are rather variable from year to year.

USA impact has been more or less static. China had risen above world average in 2003 but has slipped back to an RBI of 0.85 (0.81 over the recent past).

	Average 1999 - 2003	Actual 2004	Ratio or difference	Ranked performance change	
				UK - all OST	UK - G8
UK impact - Actual	10.91	0.60	0.06		
OST comparator group average impact	8.83	0.46	0.05		
UK impact - Rank	8	4	4		
UK rebased impact - Actual	1.18	1.30	1.10	8	2
OST comparator group average rebased impact	0.96	1.00	1.04		

Note that this table ranks both performance and change in performance

Clinical - Rebased Impact
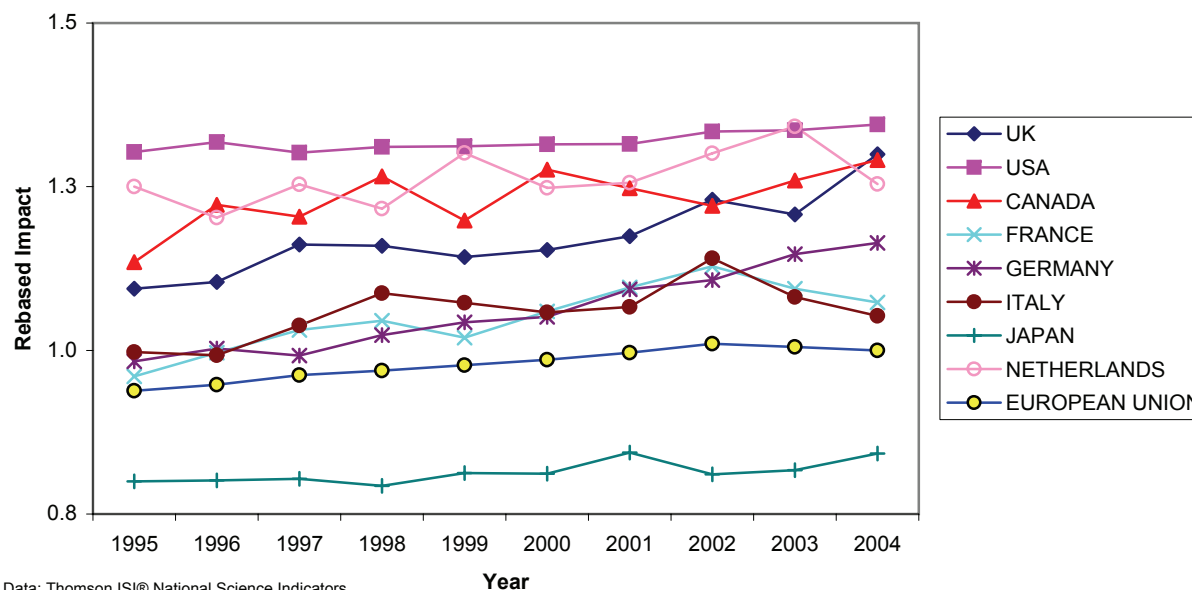
Data: Thomson ISI® National Science Indicators

Description of performance indicator
Condition signalling improvement

3.09 Citation impact relative to world baselines in ten main research fields
Increased impact in main research fields

Pre-Clinical & Health-Related Sciences

Indicator Headline

In Pre-Clinical & Health-Related Sciences, the UK is ranked 3rd in terms of impact for 2004, the most recent year. Among G8 nations, it is now ahead of both the USA and Canada. The UK's performance has improved markedly throughout the recent period (1999 to present).

UK rebased impact rose from 1.2 in 1996, to 1.3 on average for the period 1999-2003 and was 1.54 in 2004 (world average = 1.0). The degree of rebased performance change (ratio = 1.19) is 6th among OST comparator group nations, and 3rd to Japan and Russia within the G8 group.

USA impact has been fairly flat through the last ten years. The EU15 has shown a slow but progressive average improvement. China does not have a major research presence in this area.

In 2003, a number of less research intensive countries showed an exceptional improvement in citation impact in this area. In Europe, the Netherlands, Denmark and Switzerland are leaders, but only the latter sustained this improvement into 2004.

Japan's improvement is particularly marked while France has performed rather less well in this area than would be expected for its research base generally.

	Average 1999 - 2003	Actual 2004	Ratio or difference	Ranked performance change	
				UK - all OST	UK - G8
UK impact - Actual	12.05	0.79	0.07		
OST comparator group average impact	9.28	0.55	0.06		
UK impact - Rank	8	3	5		
UK rebased impact - Actual	1.30	1.54	1.19	6	3
OST comparator group average rebased impact	1.01	1.07	1.06		

Note that this table ranks both performance and change in performance

Pre-Clinical - Rebased Impact
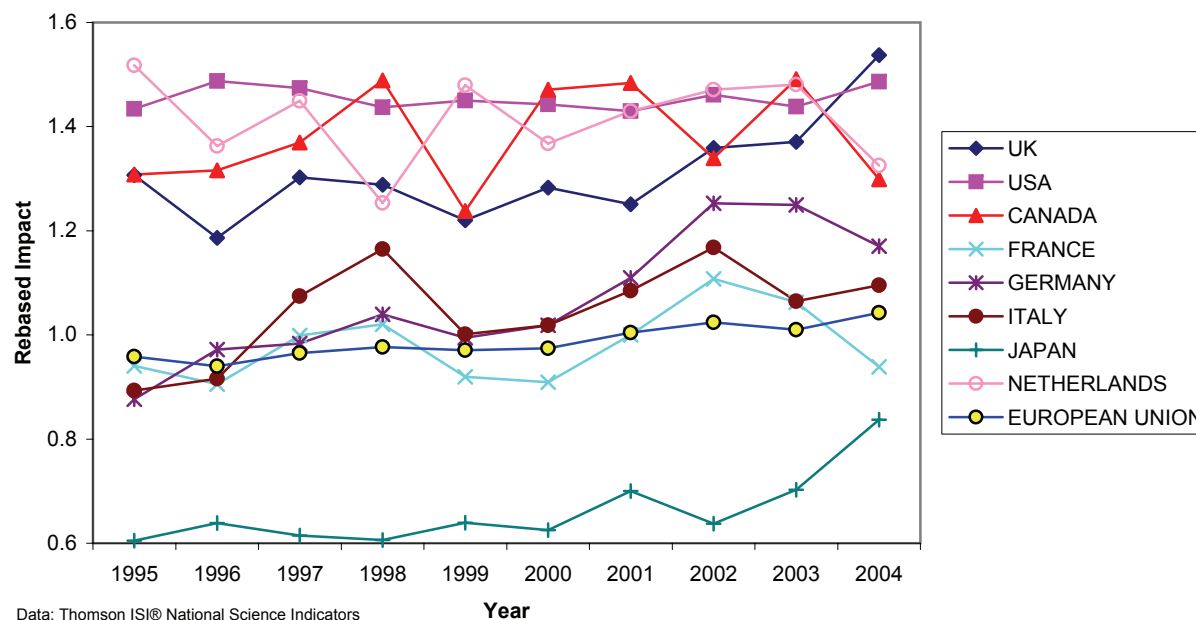
Data: Thomson ISI® National Science Indicators

Description of performance indicator
Condition signalling improvement

3.09 Citation impact relative to world baselines in ten main research fields
Increased impact in main research fields

Biological Sciences

Indicator Headline

In Biological Sciences, the UK is ranked 3rd. It has sustained the trend of the last ten years and has caught up with the USA in terms of performance. It remains behind Switzerland.

A possibly maverick result in 2004 (based on a small number of papers) is that of Singapore which has moved into 2nd place, from an average of 9th in the recent past. This unexpected result will need to be reviewed next year.

There has been a relative international improvement in UK rebased impact which rose from 1.28 to 1.4 between the period 1999-2003 and 2004. UK average of 1.28 for the recent period compares to 1.34 for the USA and 1.44 for Switzerland. However, neither of these countries has shown the trend of improvement that the UK has achieved. Only Germany's relative position has improved as consistently over the period.

This is an area of strength in terms of volume and performance for the UK. It is well ahead of OST comparator group average and only those nations mentioned above have consistently competitive performances. It makes a significant contribution to the overall performance of the EU15 which has otherwise slipped back slightly.

	Average 1999 - 2003	Actual 2004	Ratio or difference	Ranked performance change	
				UK - all OST	UK - G8
UK impact - Actual	10.89	0.64	0.06		
OST comparator group average impact	7.24	0.40	0.06		
UK impact - Rank	3	3	0		
UK rebased impact - Actual	1.28	1.40	1.09	6	3
OST comparator group average rebased impact	0.84	0.88	1.04		

Note that this table ranks both performance and change in performance

Biological Sciences - Rebased Impact
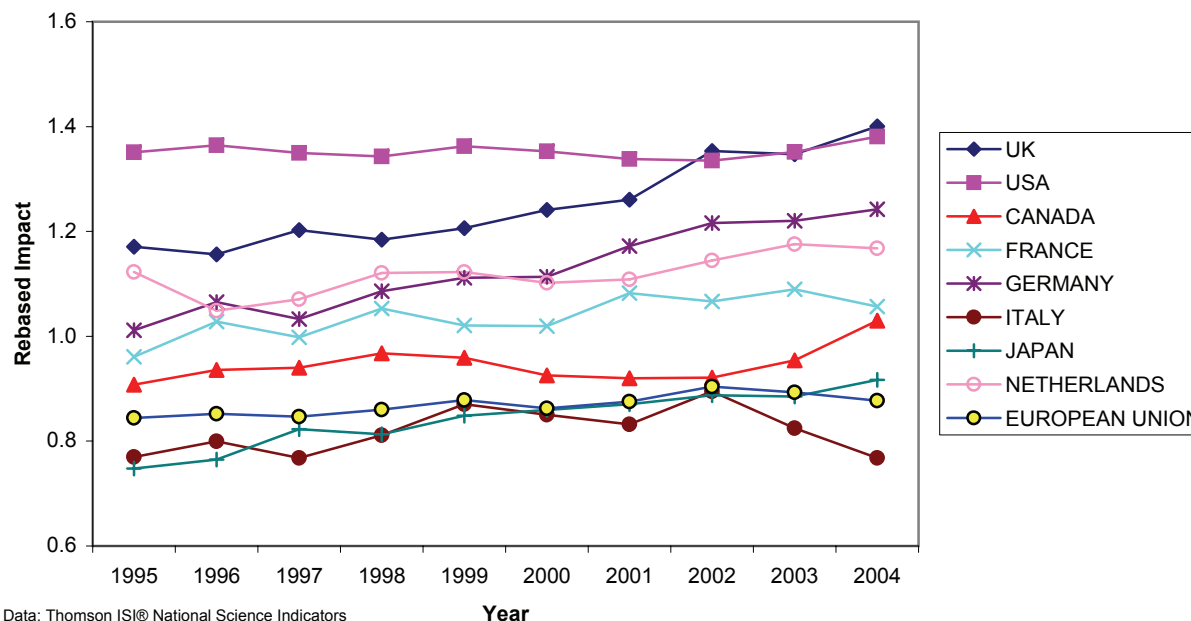
Data: Thomson ISI® National Science Indicators

Description of performance indicator
Condition signalling improvement

3.09 Citation impact relative to world baselines in ten main research fields
Increased impact in main research fields

Environmental Sciences

Indicator Headline

Research performance in the Environmental Sciences has been quite variable between years. The UK has improved relative to the USA and Germany, but its ranked impact in the OST comparator group has slipped to 9th.

UK rebased impact has risen from below 1.1 in the early 1990s to 1.23 for the period 1999-2003 and 1.36 in 2004. Nonetheless, the degree of rebased performance change (ratio = 1.10) is only 12th among OST comparator group nations. This is because a number of smaller nations (including South Africa, for which we noted last year that the values appear exceptional) have improved their performance to an even greater degree. These include the Netherlands and the Scandinavian group.

While the UK has shown consistent improvement in relative international performance over the period, and has thus overtaken the USA, this is a field in which a number of countries have similar performance and the degree of competition is therefore marked. The Scandinavian countries have better impact than the G8 lead group. Germany's recent performance had taken it well ahead but it has now been pegged back. EU networks will, of course, allow the research elsewhere in Europe to be accessed by other nations in global environment networks.

	Average 1999 - 2003	Actual 2004	Ratio or difference	Ranked performance change	
				UK - all OST	UK - G8
UK impact - Actual	6.09	0.37	0.06		
OST comparator group average impact	4.96	0.30	0.06		
UK impact - Rank	8	9	-1		
UK rebased impact - Actual	1.23	1.36	1.10	12	4
OST comparator group average rebased impact	0.992	1.10	1.10		

Note that this table ranks both performance and change in performance

Environment - Rebased Impact
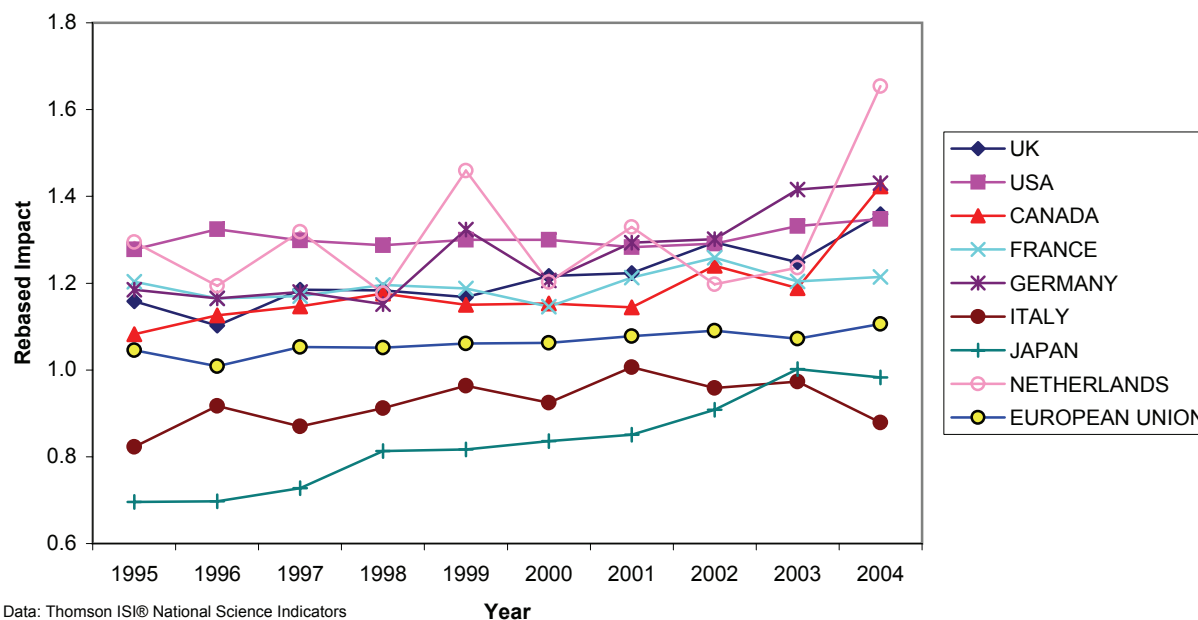
Data: Thomson ISI® National Science Indicators

Description of performance indicator
Condition signalling improvement

3.09 Citation impact relative to world baselines in ten main research fields
Increased impact in main research fields

Mathematics

Indicator Headline

In Mathematics, the UK is ranked 4th in terms of impact for 2004, the most recent year. There has been a notable improvement in the last two years and the UK's rank has changed from 8th for the recent period (1999-2003).

UK rebased impact has fluctuated in this area. It dropped to and moved around 1.2 for much of the last ten years but has risen steeply since 2002. The degree of rebased performance change this year is 2nd among OST comparator group nations, and 1st within the G8 group. This suggests something of a welcome renaissance amongst UK mathematics.

Mathematics is a field in which smaller countries can be competitive. Singapore had improved to achieve a similar impact to the UK but this year has fallen back. Australia has also shown a sawtooth performance. Belgium, Denmark and Switzerland have all been ranked 1st in the recent past. China has improved to around world average.

The USA was consistently around 4th among the OST comparator group. Within the G8, France improved its performance to 2001 but then fell back while Germany has shown significant recent improvement.

	Average 1999 - 2003	Actual 2004	Ratio or difference	Ranked performance change	
				UK - all OST	UK - G8
UK impact - Actual	2.46	0.15	0.06		
OST comparator group average impact	2.14	0.11	0.05		
UK impact - Rank	8	4	4		
UK rebased impact - Actual	1.17	1.38	1.18	2	1
OST comparator group average rebased impact	1.02	1.00	0.98		

Note that this table ranks both performance and change in performance

Mathematics - Rebased Impact
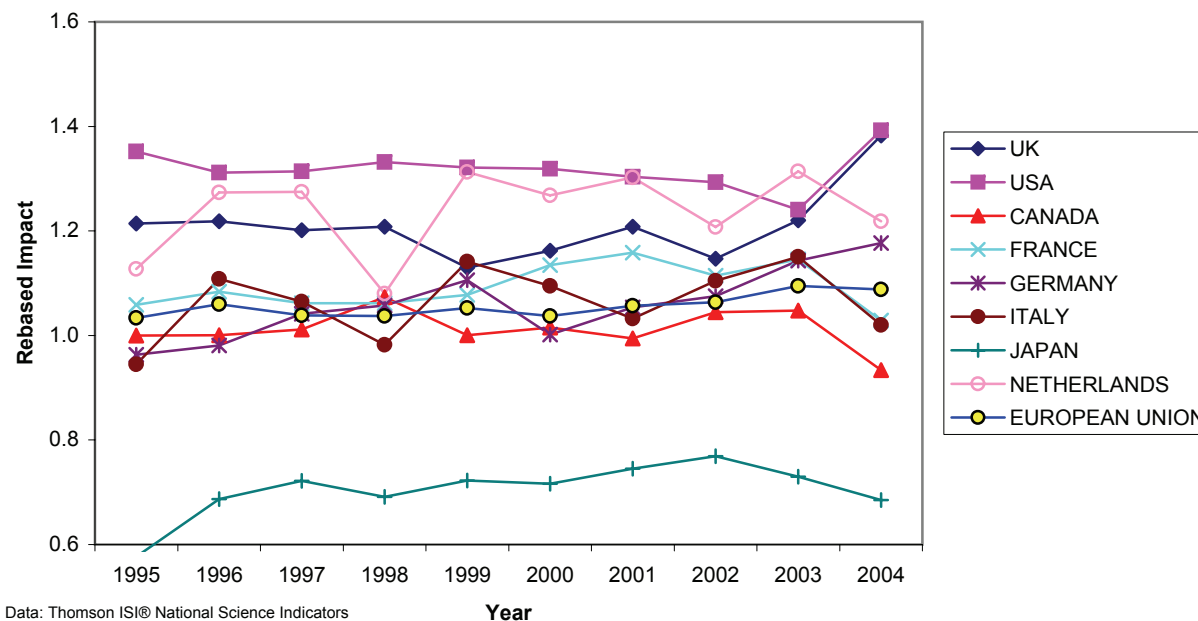
Data: Thomson ISI® National Science Indicators

Description of performance indicator
Condition signalling improvement

3.09 Citation impact relative to world baselines in ten main research fields
Increased impact in main research fields

Physical Sciences

Indicator Headline

In Physical Sciences, the UK is ranked 5th in terms of impact for 2004. The UK's rank has improved from 9th in the mid-1990s to 7th on average for the recent period (1999-2003).

There has been a sustained rise in UK rebased impact from 1.14 in 1994 to 1.37 in the period 1999-2003 and an exceptional 1.67 in 2004, overtaking Canada (1.45) which fell back steeply this year. The UK's recent rebased performance change is 4th among OST comparator group nations. Whether the upturn in performance for the Netherlands is real or artefactual will need examination next year, as will the upward move for the UK, Germany, France and Italy.

Physical Sciences are an important part of the underpinning research for engineering and technology development. The UK's improvement in performance and its relative citation impact should be seen against a backdrop of a relatively low share of world citations (Indicator 3.02), which may reflect a limited capacity.

China has increased capacity but not performance in this area and it remains at around 0.7 RBI against the world average. Denmark, Israel and Australia have been strong performers in recent years.

	Average 1999 - 2003	Actual 2004	Ratio or difference	Ranked performance change	
				UK - all OST	UK - G8
UK impact - Actual	7.76	0.60	0.08		
OST comparator group average impact	6.22	0.43	0.07		
UK impact - Rank	7	5	2		
UK rebased impact - Actual	1.37	1.67	1.22	4	2
OST comparator group average rebased impact	1.09	1.21	1.11		

Note that this table ranks both performance and change in performance

Physical Sciences - Rebased Impact
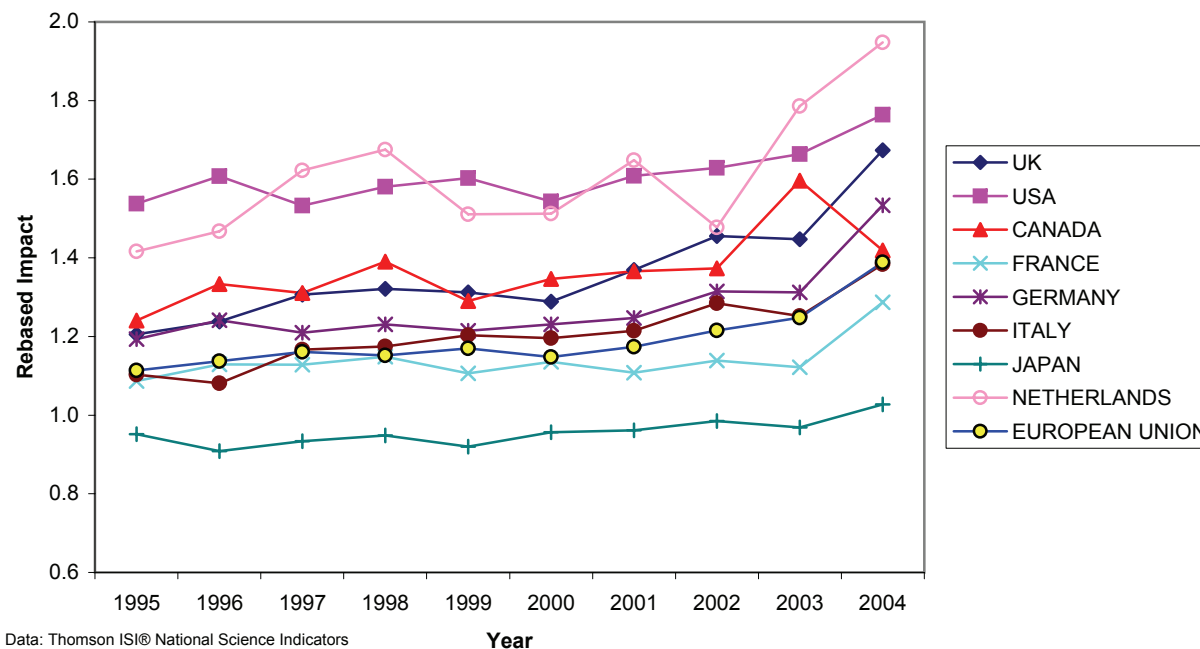
Data: Thomson ISI® National Science Indicators

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Description of performance indicator
Condition signalling improvement

3.09 Citation impact relative to world baselines in ten main research fields
Increased impact in main research fields

Engineering

Indicator Headline

In Engineering, the UK is ranked 9th in terms of impact for 2004, the most recent year. The UK's rank has improved from 14th in the early 1990s and an average of 11th for the recent period (1999-2003).

UK rebased impact rose from close to world average in the mid-1990s to 1.21 for 2003 (world average = 1.0). The degree of rebased performance change (ratio = 1.14) is 5th among OST comparator group nations, and 1st within the G8 group (excepting Russia). There has been a relative international improvement in the UK's performance, which has been behind not only the USA among G8 nations but also its close European competitors. The UK is now well ahead of EU15 average and has clearly overtaken France, with a sustained improvement over three years. Its performance remains behind some smaller European nations, however, including the Scandinavian countries (Denmark ranks 1st with RBI > 2), Belgium and the Netherlands as well as Switzerland and Germany.

China has improved its RBI from about 0.7 to about 0.8 but remains at 20th in the OST comparator group.

| | Average 1999 - 2003 | Actual 2004 | Ratio or difference | Ranked performance change | |
				UK - all OST	UK - G8
UK impact - Actual	3.78	0.21	0.06		
OST comparator group average impact	3.62	0.19	0.05		
UK impact - Rank	11	9	2		
UK rebased impact - Actual	1.06	1.21	1.14	5	2
OST comparator group average rebased impact	1.01	1.07	1.06		

Note that this table ranks both performance and change in performance

Engineering - Rebased Impact
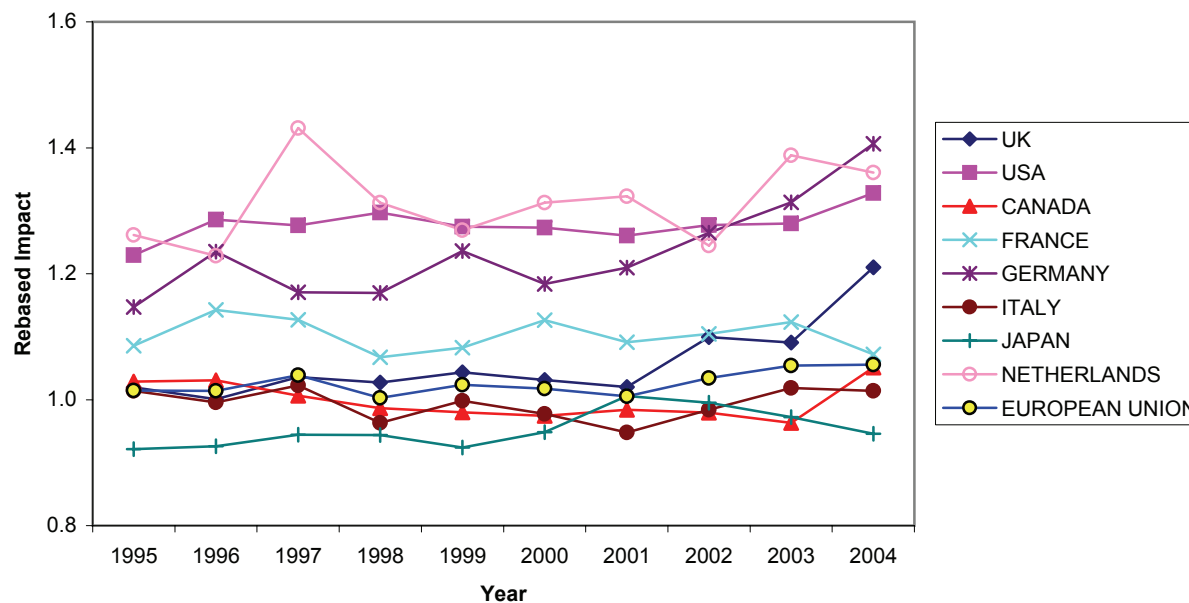
Data: Thomson ISI® National Science Indicators

Description of performance indicator
Condition signalling improvement

3.09 Citation impact relative to world baselines in ten main research fields
Increased impact in main research fields

Social Sciences

Indicator Headline

As we have noted in Indicator 3.02, bibliometric data for the Social Sciences should be treated with caution and cannot be compared directly with other disciplines. While the comparisons here are like-for-like, journal coverage for non-Anglophone European nations is probably in deficit so international comparisons must be interpreted with caution.

The UK is ranked 9th in terms of impact for 2003, the most recent year. Rank position is more volatile in this field (e.g. see Italy) than in the Natural Sciences but the UK's position as well as performance has been consistent over the decade.

UK rebased impact was below world average, although it improved between the period 1999-2003 and 2004. It is placed behind a number of smaller nations which have impact above world average. Coverage for these nations may be selective, Less international non-Anglophone journals and their contents may be absent from the database. Thus, whereas the UK has a diversity of journal articles in the database, for some smaller countries only exceptional items are covered and only the peak of performance is analysed.

Overall, the UK's trend against this backdrop is more important than its position. To that extent, the improvement in its impact and rank are a positive.

	Average 1999 - 2003	Actual 2004	Ratio or difference	Ranked performance change	
				UK - all OST	UK - G8
UK impact - Actual	2.86	0.17	0.06		
OST comparator group average impact	2.78	0.13	0.05		
UK impact - Rank	11	9	2		
UK rebased impact - Actual	0.92	0.94	1.02	9	5
OST comparator group average rebased impact	0.88	0.74	0.84		

Note that this table ranks both performance and change in performance

Social Science - Rebased Impact
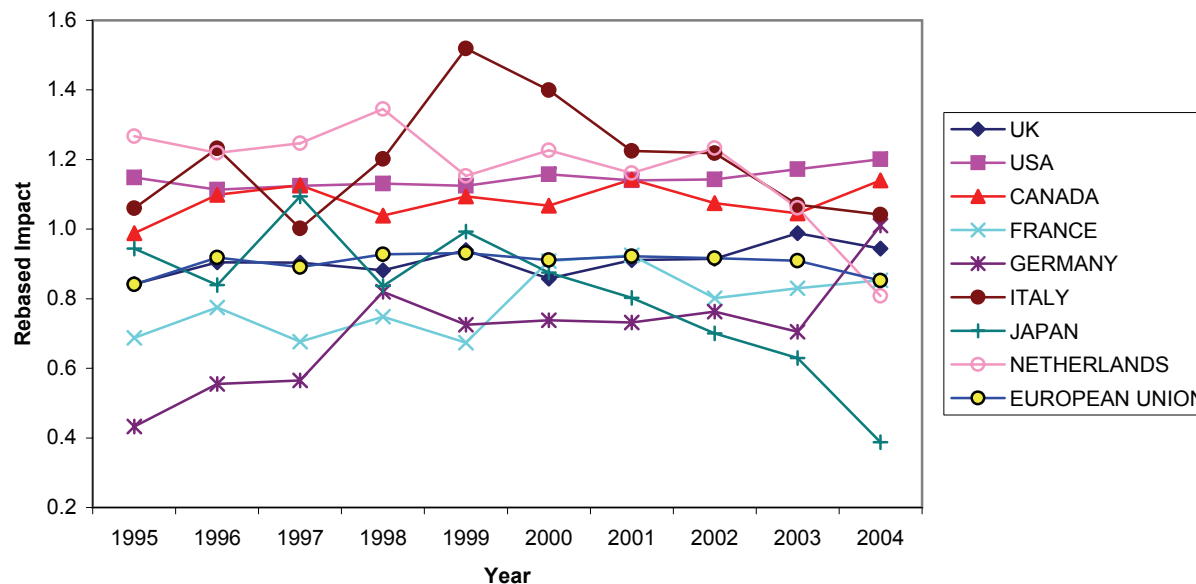
Data: Thomson ISI® National Science Indicators

Description of performance indicator
Condition signalling improvement

3.09 Citation impact relative to world baselines in ten main research fields
Increased impact in main research fields

Business

Indicator Headline

The UK is ranked 8th in terms of impact for 2004. The UK's rank is similar to that for the recent period (1999-2003). While the UK has been affected by a volatile performance profile with a peak in 1998 and a dip in 2000, it now seems to be on an upward trajectory.

UK rebased impact rose from below world average in 1994 to 1.1 in 1998 (world average = 1.0). The degree of rebased performance change (ratio = 1.01) is 7th among OST comparator nations, and 2nd only to Russia within the G8 comparator group.

There are similar fluctuations to those of the UK in some other G8 countries (see chart) and some very extreme variations in smaller countries (possibly due to the effects of small numbers of papers). Elsewhere, Belgium and Switzerland have performed well on average but otherwise only Sweden performs above world average for any extended period.

The USA has had a consistently strong position and dominates business and management coverage. This reflects the USA's dominance of the recorded and indexed literature in these fields and its influence on journal coverage.

	Average 1999 - 2003	Actual 2004	Ratio or difference	Ranked performance change	
				UK - all OST	UK - G8
UK impact - Actual	2.40	0.12	0.05		
OST comparator group average impact	2.14	0.09	0.04		
UK impact - Rank	8	8	0		
UK rebased impact - Actual	1.00	1.16	1.16	7	2
OST comparator group average rebased impact	0.85	0.93	1.09		

Note that this table ranks both performance and change in performance

Business - Rebased Impact
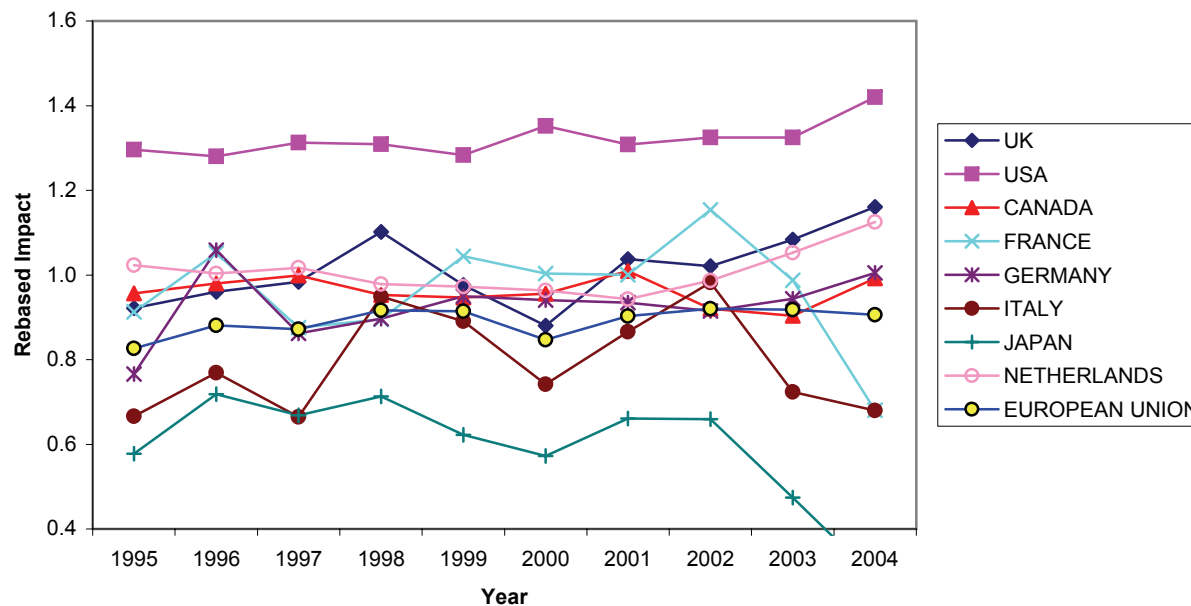
Data: Thomson ISI® National Science Indicators

Description of performance indicator
Condition signalling improvement

3.09 Citation impact relative to world baselines in ten main research fields
Increased impact in main research fields

Humanities

Indicator Headline
This is the first time that the Humanities and Arts have been covered for bibliometric analyses in this report. The data must be interpreted with caution.
Paper counts are often rather low in the national samples. We know that journal outputs are not usually a main mode of publication in these fields and that citation behaviour is different to the sciences. We are also aware that journal coverage is dominated by Anglophone sources and that there may be only limited input from non-European and non-American nations, perhaps only the very peak of their country's output.
In the context of those caveats the UK's position in the chart accompanying this text seems unexceptional. Its impact is above world average, is ahead of many G8 competitors and compares well with the USA which has much more diverse database coverage.
No immediate conclusions should be drawn but this indicator will be of widespread interest and we will monitor its change for future reports.

	Average 1999 - 2003	Actual 2004	Ratio or difference	Ranked performance change	
				UK - all OST	**UK - G8**
UK impact - Actual	0.78	0.06	0.08		
OST comparator group average impact	0.81	0.06	0.08		
UK impact - Rank	13	11	2		
UK rebased impact - Actual	1.17	1.15	0.99	15	5
OST comparator group average rebased impact	1.15	1.15	1.00		

Note that this table ranks both performance and change in performance

Humanities - Rebased Impact
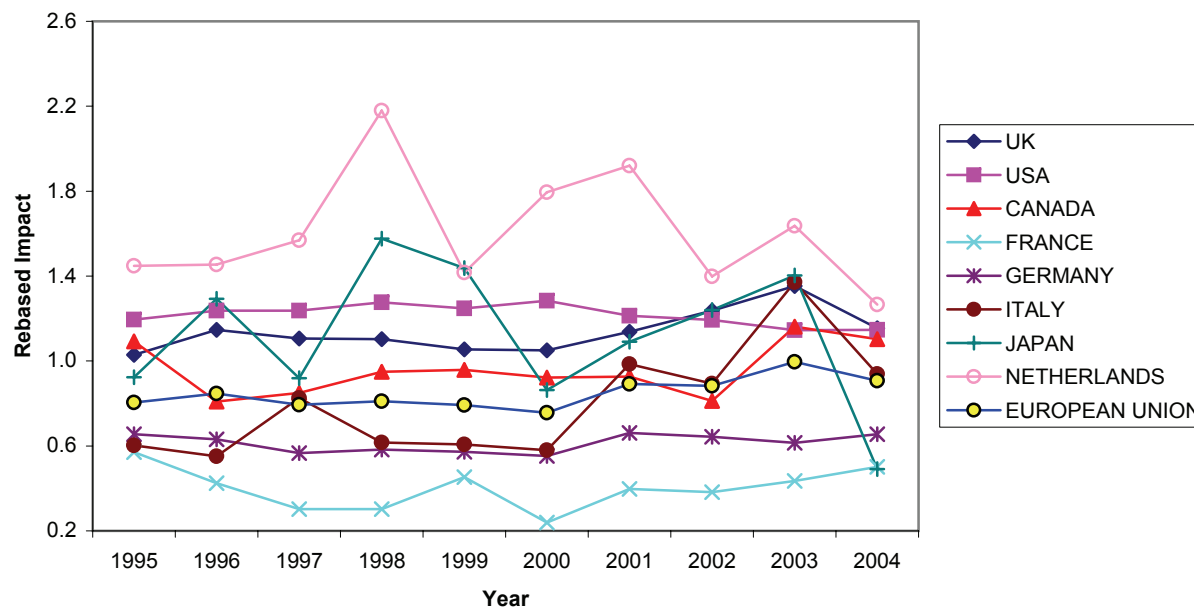
Data: Thomson ISI® National Science Indicators

Description of performance indicator
Condition signalling improvement

**3.10 Variety and consistency of research strength**
Reduced ratio between variance and average. Maximised ratio of average/variance.

Indicator Headline
See below for Methodology.

It is argued that a balanced research economy has both strength and evenness. That is, high average quality across fields would be enhanced by low variation between them.

This is a desirable combination because research strength should not be unduly concentrated. Investing in priorities is sensible but research is long term; capacity takes years to build. Not all needs and opportunities can be foreseen, so the flexibility to shift into new areas is worth paying for. It contributes to a national capacity to appraise research developments in other countries and to respond to research opportunities.

We can visualise this characteristic of the research base by looking simultaneously at average impact and the reciprocal of variance across fields. (We use the reciprocal because we are interested in systems that minimise variation; this is one of several alternative measures of variability). We then look for countries that maximise the net product.

For the UK, average impact is relatively high compared to most G8 countries but less than the USA. It is also less than the Netherlands (NED) and Switzerland (SUI). Both the smaller countries have greater variance between disciplines, however, which suggests that their research economy is relatively concentrated.

In the graph, the UK shows a positive shift in average impact with a decrease in variance for the two 5 year periods to 2000 and to 2004. For the Netherlands impact also increases (as it does for Switzerland), but variance increases markedly (decrease in 1/variance), reducing the net product.

Rebased bibliometric impact across SUoAs							
Country	5 years to	Average	1/Variance	Country	5 years to	Average	1/Variance
UK	2000	1.14	40.30	UK	2004	1.18	36.52
USA	2000	1.33	67.01	USA	2004	1.31	62.96
CAN	2000	1.05	32.52	CAN	2004	1.06	27.00
FRA	2000	0.86	11.03	FRA	2004	0.88	9.54
GER	2000	0.94	9.13	GER	2004	1.01	11.68
ITA	2000	0.87	19.57	ITA	2004	0.96	34.51
JAP	2000	0.87	38.85	JAP	2004	0.89	37.13
NED	2000	1.33	22.32	NED	2004	1.39	9.56
SUI	2000	1.12	2.97	SUI	2004	1.23	6.10

Analysis of rebased impact across SUoAs for select members of OST comparator group
Performance is maximised by combining high average impact with low variability
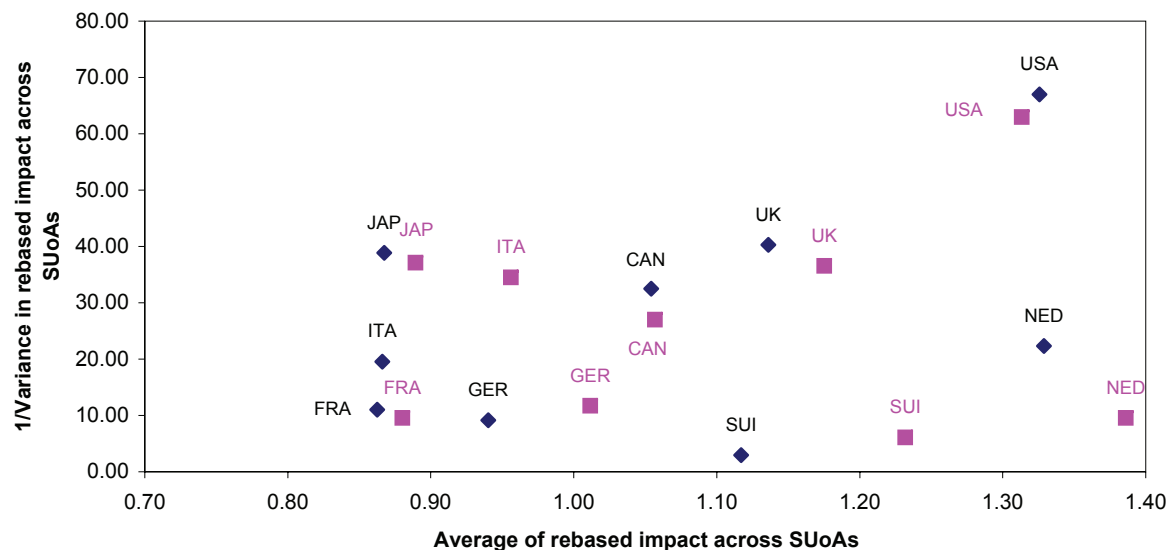
Data: Thomson ISI® National Science Indicators

Description of performance indicator
Condition signalling improvement

3.10 Variety and consistency of research strength
Reduced ratio between variance and average. Maximised ratio of average/variance.

Indicator headline cont.

The USA has increased variance and reduced average impact and has thus declined on both dimensions compared to other research economies. Germany is improving on both counts and has an improved net outcome.

Methodological note

To index consistency, average national impact across fields (SUoAs) has been compared with the variation between fields. Variation is measured here by calculating variance, but other statistical indexes may be preferred in later iterations of this indicator. Normally, variance will increase with the absolute value of the statistical mean so a relatively low mean/variance ratio reflects poor consistency.

Data are displayed as average national impact plotted against the inverse of variance. In this plot the more balanced economies will be those that maximise their mean/variance ratio, or optimise the product of mean and 1/variance and lie in the upper right sector of the graph.

There are, of course, a number of solutions to the same net product but generally an exceptionally high average impact will be required to offset high variability. It is very difficult to conceive of one country being able to establish such a global predominance in any one field that it could achieve this. More commonly, an optimal management solution is found by reducing variation in performance between fields.

Description of performance indicator
Condition signalling improvement

3.11 Relationship between distribution of research training across subjects and research quality
Improved match in distribution; improved research training power (product of volume and quality)

Indicator Headline

What is the quality of the researchers we train?

People are a key output from the research base and a major route for the transfer of knowledge and know-how from producers to users. Highly trained people with PhDs are a specialised part of that output. Direct measurement of people quality is unfeasible, but we can measure the association between the distribution of training and research quality.

This year, Humanities & Arts data have been added to the analytical coverage.

For the UK, there is a relative concentration of PhD awards in Natural Sciences where average research impact rebased against world benchmarks is also highest. The data points are too few to calculate a correlation but the general relationship between concentration of training and performance appears positive.

For the USA, the relationship between training volume and research performance is positive only for sciences and technology and a relative excess of PhDs is awarded in the Social Sciences and, to a lesser extent, in the Humanities and Arts.

There is no clear relationship between training concentration and research quality for other G8 countries for which data are available and there is a negative relationship for the OST comparator group average. For Germany and Japan, too, there appear to be relatively more PhDs awarded in fields where rebased impact is relatively lower.

If the benefits of training are related to research quality, then this positive relationship for the UK should bring wider benefits to the research base. This is therefore a marker of relative consistency in the structure of the research base.

	Medical Sciences	Natural Sciences	Engineering and Technology	Social Sciences	Humanities
UK average rebased impact 1998 - 2002	1.18	1.32	1.08	1.07	1.16
UK average PhDs awarded 1998 - 2002	1825	4823	2004	2179	1582
OST comparator group average rebased impact 1998 - 2002	0.94	0.96	0.99	0.91	0.97
OST comparator group average PhDs awarded 1998 - 2002	1415	2356	1132	1858	937

Indicator Headline cont.

We cannot assert that a country that manages its training so as to ensure that highly qualified people benefit from a rich research environment will necessarily benefit at an economic level, but it seems reasonable to suppose that where training is associated with research quality this is at least unlikely to be a disbenefit.

For this indicator, data are taken from the OECD Education Database. These data are disaggregated by fields that are most readily mapped to other OECD fields rather than SUoAs.

Detailed exploration and consideration of the data may reveal additional features. It is possible that a national policy might actually advocate increased PhD output in areas of relative weakness, to increase the pool of trained people.
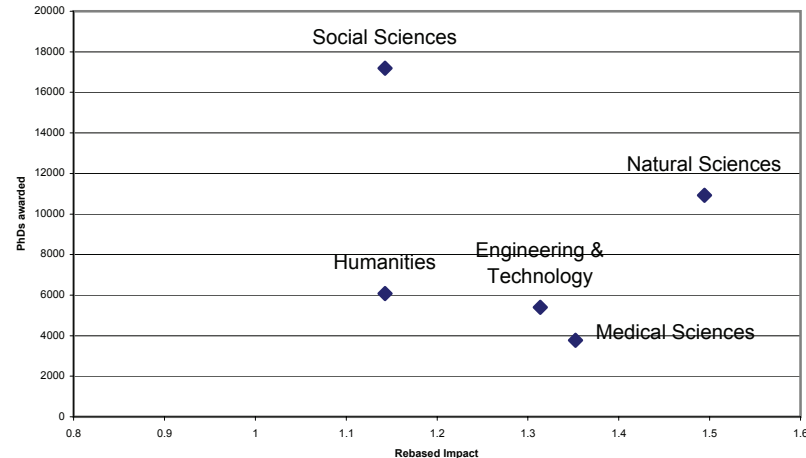
Description of performance indicator   **3.11 Relationship between distribution of research training across subjects and research quality**
Condition signalling improvement   **Improved match in distribution; improved research training power (product of volume and quality)**

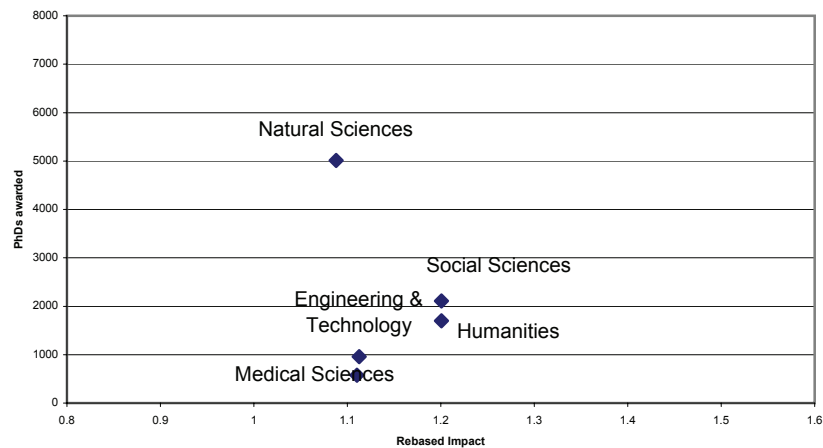**UK 2002 - rebased impact vs. PhDs awarded by OECD field**
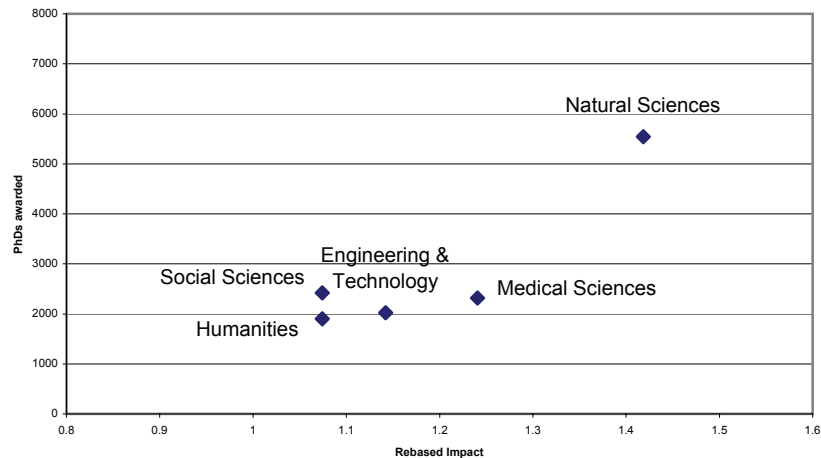
USA 2002 - rebased impact vs. PhDs awarded by OECD field
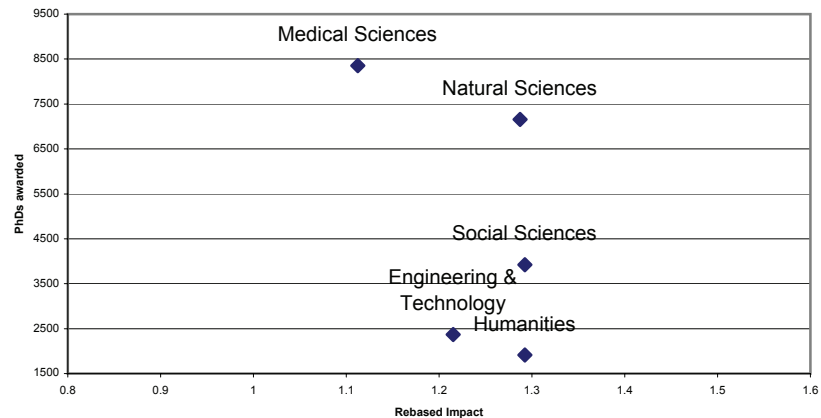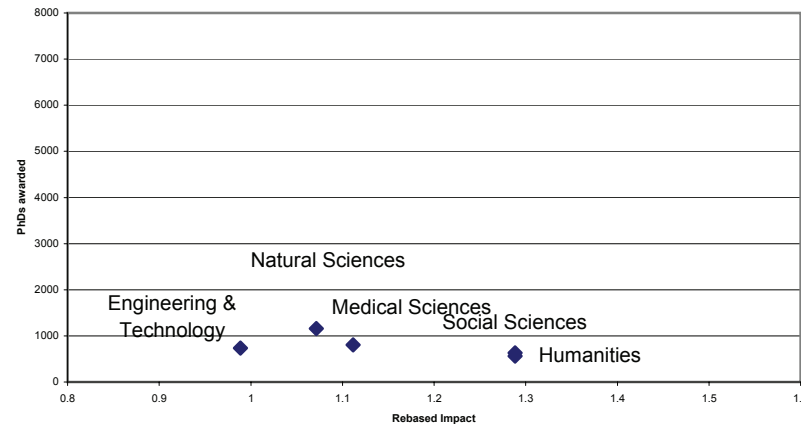

Data: Thomson ISI® National Science Indicators,
OECD Education Database

France 2002 - rebased impact vs. PhDs awarded by OECD field

Description of performance indicator   **3.11 Relationship between distribution of research training across subjects and research quality**
Condition signalling improvement   **Improved match in distribution; improved research training power (product of volume and quality)**

Germany 2002 - rebased impact vs. PhDs awarded by OECD field

Italy 2002 - rebased impact vs. PhDs awarded by OECD field

Data: Thomson ISI® National Science Indicators,
OECD Education Database

Japan 2002 - rebased impact vs. PhDs awarded by OECD field
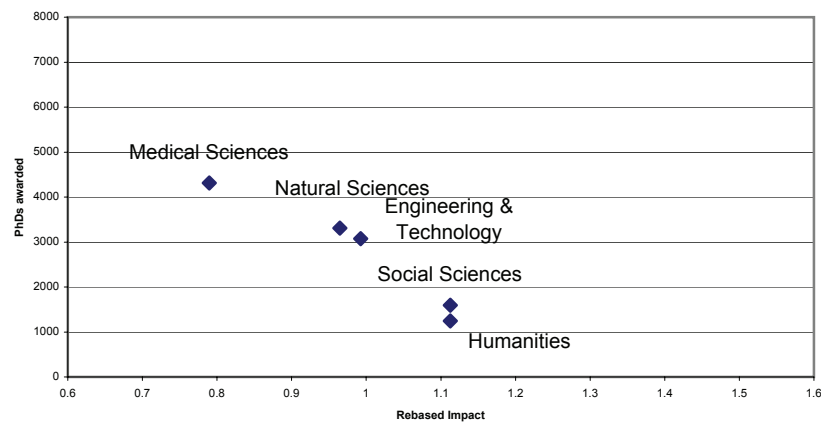
OST comparator group average 2002 - rebased impact vs. PhDs awarded by OECD field
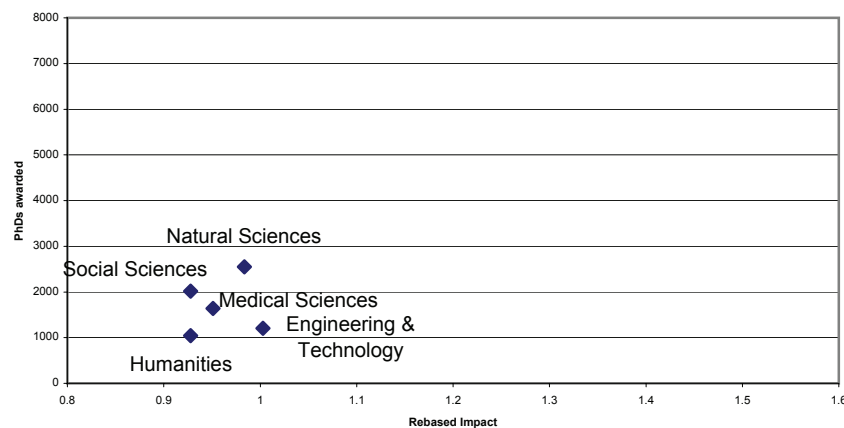
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Description of performance indicator
Condition signalling improvement

4.01 PhDs awarded relative to HERD
Increased ratio

Indicator Headline

This indicator compares the output of people with research degrees with the specific research spend in HE (HERD).

The UK produces more PhDs relative to HERD than the OST comparator group on average (for the 17 countries for which data were available). It is ranked 5th, behind Germany, South Korea and Spain, with a similar output to Switzerland and Finland. The EU15 is significantly more productive than the USA, which is ranked 11th.

The UK produces slightly in excess of 8% of the world's PhDs, rather more than most of the G8 nations (Indicator 2.01). The exceptions are Germany and the USA who produce twice and four times as many PhDs than the UK respectively.

The relative volume of PhDs for each nation is otherwise broadly similar to that for publication output. Note that the general trend for decreasing relative output is despite the data being adjusted for PPP.

Highly skilled postgraduates are a key output of the higher education sector. They transfer knowledge to users and, more generally, they transfer know-how and technological advances. It should not be assumed that all science and engineering postgraduates are necessarily employed in science and technology let alone research. More generally, the gain to the economy is in having a trained and technological workforce capable of assessing and responding to technology related opportunities and issues.

cont./

	Average 1998 - 2001	Actual 2002	Ratio or difference
UK PhDs awarded per $M HERD - Actual	2.15	2.15	1.00
OST comparator group average - PhDs awarded per $M HERD	1.85	1.77	0.96
UK PhDs awarded per unit $M HERD - Rank	5	5	0

G8 nations and EU15: PhDs per HERD (no data for Russia)
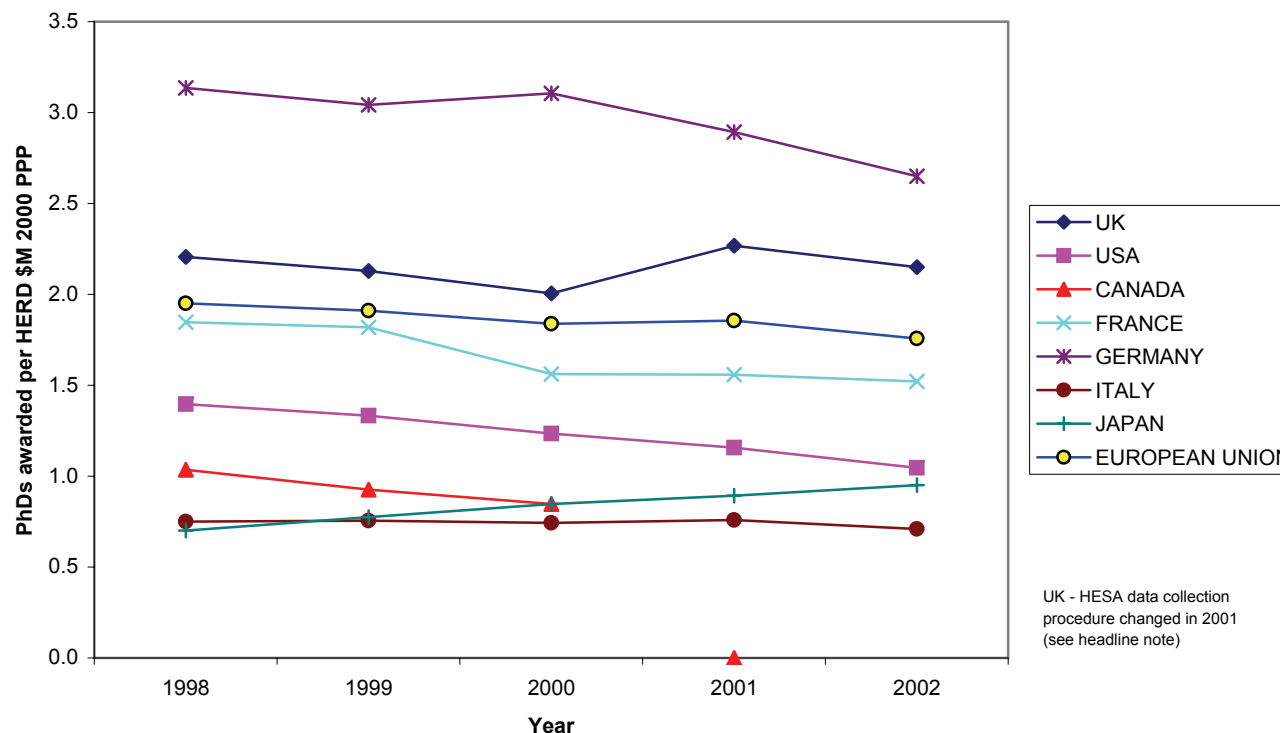
UK - HESA data collection procedure changed in 2001 (see headline note)

Data: OECD (MSTI), OECD Education Database

Description of performance indicator
Condition signalling improvement

4.01 PhDs awarded relative to HERD
Increased ratio

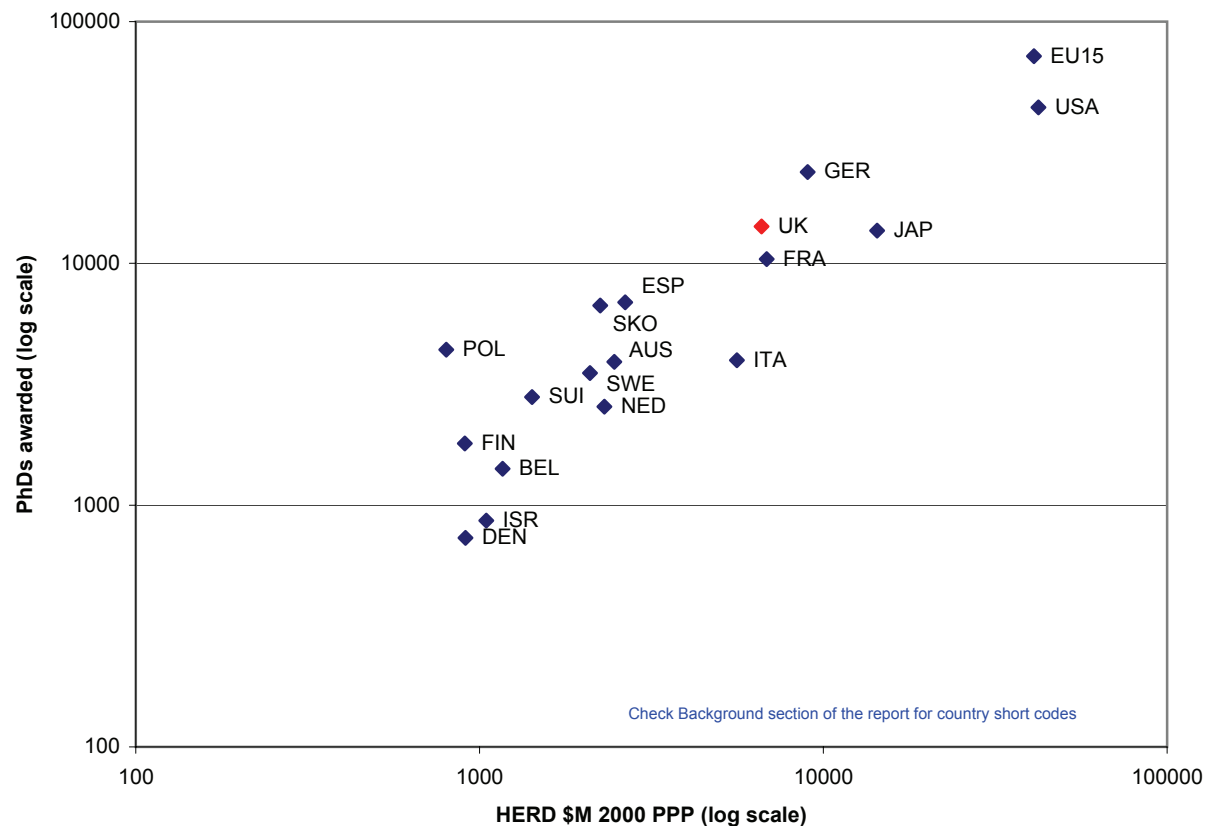---

Indicator Headline cont.

Total expenditure in the higher education sector is a broad overall measure of the cost of producing trained people. It might be reasonable to assume that there is also a research element to postgraduate training, either directly or through enhancement of the training environment, and this will be influenced by research specific expenditure.

It is not necessarily the case that low relative research spend (many PhDs awarded per $M R&D expenditure) is a good thing, since it may imply poor quality training.

UK PhD data are subject to a change in HESA data collection from 2001 (see Background).

PhDs awarded relative to HERD - OST comparator nations, 2002

Data: OECD (MSTI), OECD Education Database

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Description of performance indicator
Condition signalling improvement

4.02 PhDs awarded relative to HERD in five main research fields
Increased ratio

Medical Sciences

Indicator Headline

The indicator compares HERD expenditure allocated to the Medical Sciences with the numbers of PhDs awarded in this category. Medical Sciences include both clinical and pre-clinical areas, nursing and health.

The UK produces fewer PhDs per unit spend than the OST comparator group average. This is a much lower level of productivity per unit spend than Germany but similar to that of Finland, Australia and, amongst the G8 nations, Japan. The USA is substantially below the group average.

UK PhD data are subject to a change in HESA data collection from 2001 (see Background). In this field, the UK continues its recent trend of increasing PhD awards (rising from 2001 by more than 10%). The UK remains the 4th largest - 2,300 (behind Germany - 8,400, Japan - 4,300 and USA - 3,800) by volume.

There is only a poor correlation across countries between funding and PhD output, implying that although both may scale with an underlying size factor such as staff numbers, there are other factors affecting training and research volumes.

	Average 1998 - 2001	Actual 2002	Ratio or difference
UK PhDs awarded per HERD ($M 2000 PPP) - Actual	1.09	1.28	1.17
OST comparator group average - PhDs awarded per unit HERD ($M 2000 PPP)	1.92	1.81	1
UK PhDs awarded per unit HERD ($M 2000 PPP) - Rank	9	7	2

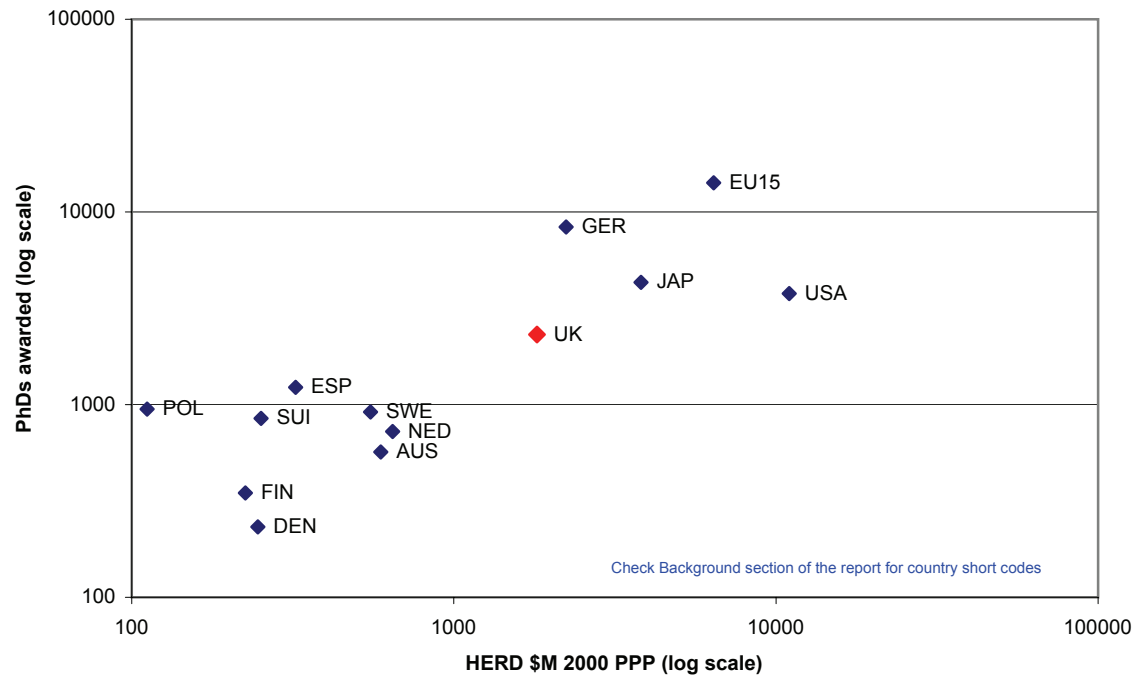**Medical Sciences - PhDs per HERD, G8 nations (no data for Canada, France, Italy or Russia)**
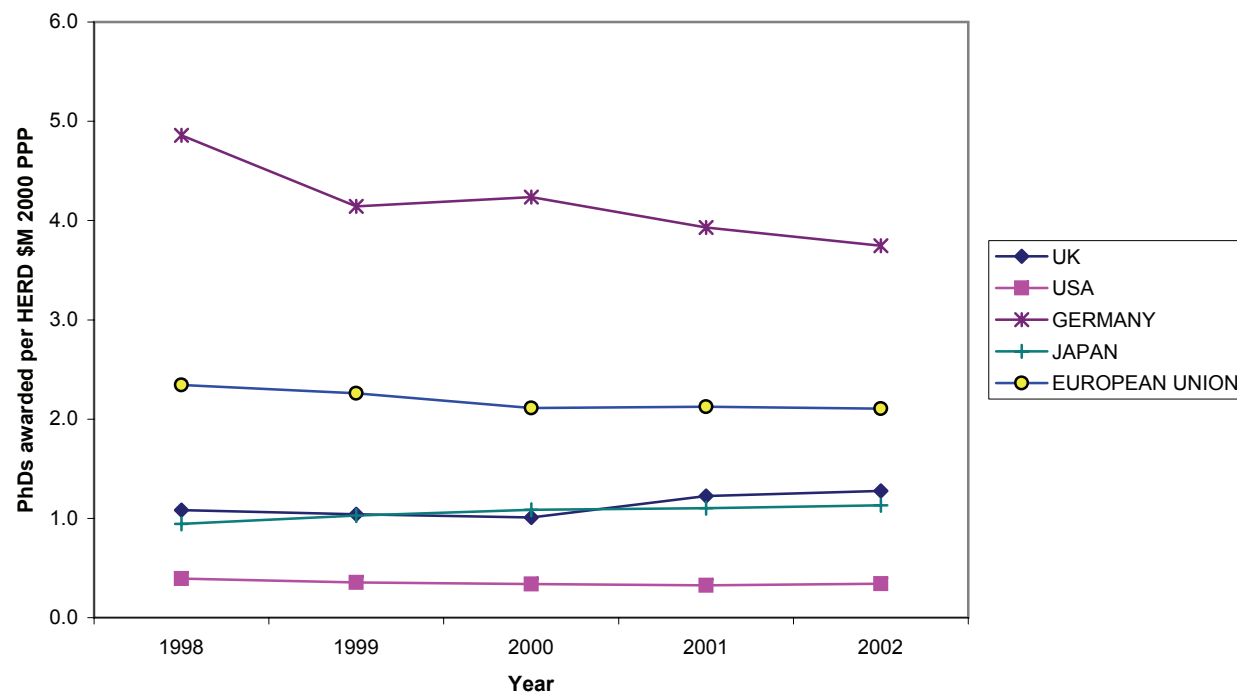
Data: OECD (RDS), OECD Education Database, UK SET statistics and HESA data

Description of performance indicator
Condition signalling improvement

4.02 PhDs awarded relative to HERD in five main research fields
Increased ratio

Medical Sciences - PhDs awarded relative to HERD - OST comparator group nations, 2002

Data: OECD (RDS), OECD Education Database, UK SET statistics and HESA data

Description of performance indicator
Condition signalling improvement

4.02 PhDs awarded relative to HERD in five main research fields
Increased ratio

Natural Sciences

Indicator Headline

The indicator compares HERD expenditure allocated to the Natural Sciences with the numbers of PhDs awarded in this category. Here, the Natural Sciences include biological, physical, environmental and agricultural fields.

The UK produces about 1.5 times as many PhDs per unit spend as the OST comparator group average. This is a similar level of productivity per unit spend to Germany. The USA is just below the group average and Japan are just above the group average.

UK PhD data are subject to a change in HESA data collection from 2001 (see Background). In this field, the UK currently awards over 5,500 PhDs per year and is the 3rd largest (behind USA - 11,000 and Germany - 7,000) by volume.

There is a clear correlation across countries between funding and PhD output, implying that probably both scale with an underlying size factor such as staff numbers, which affect training and research volumes.

	Average 1998 - 2001	Actual 2002	Ratio or difference
UK PhDs awarded per HERD ($M 2000 PPP) - Actual	2.49	2.59	1.04
OST comparator group average - PhDs awarded per unit HERD ($M 2000 PPP)	1.83	1.76	1
UK PhDs awarded per unit HERD ($M 2000 PPP) - Rank	2	3	-1

Natural Sciences - PhDs per HERD, G8 nations (no data for Canada, France, Italy or Russia)
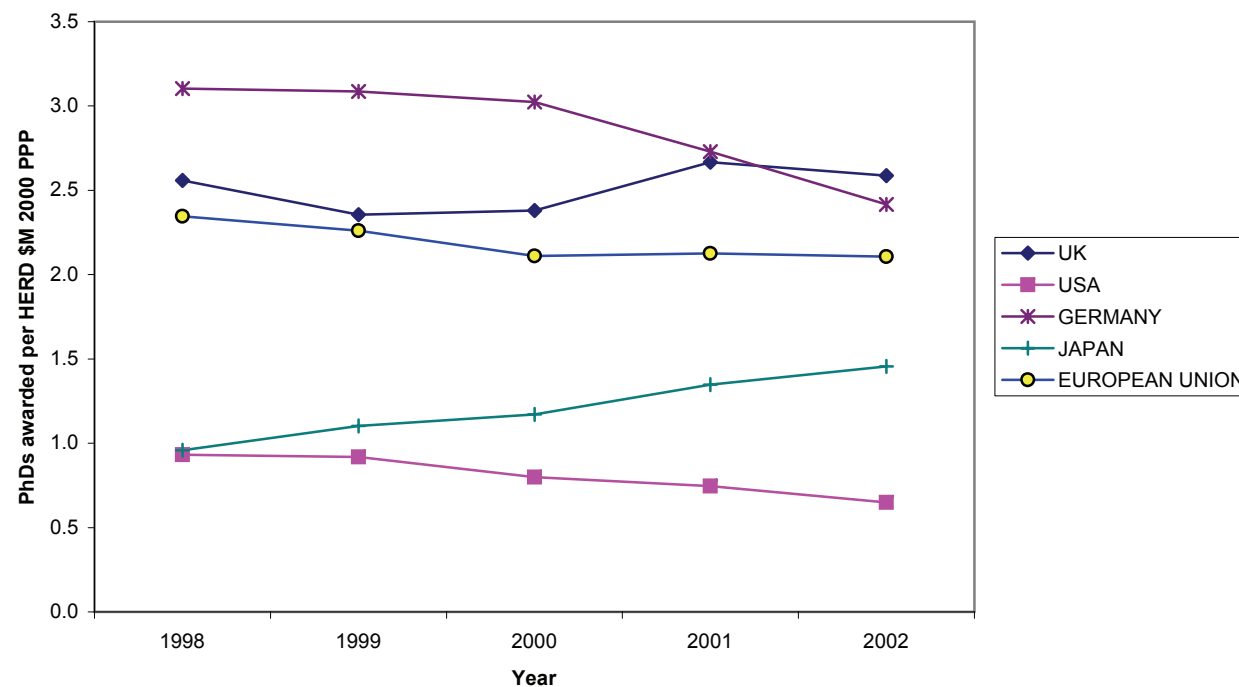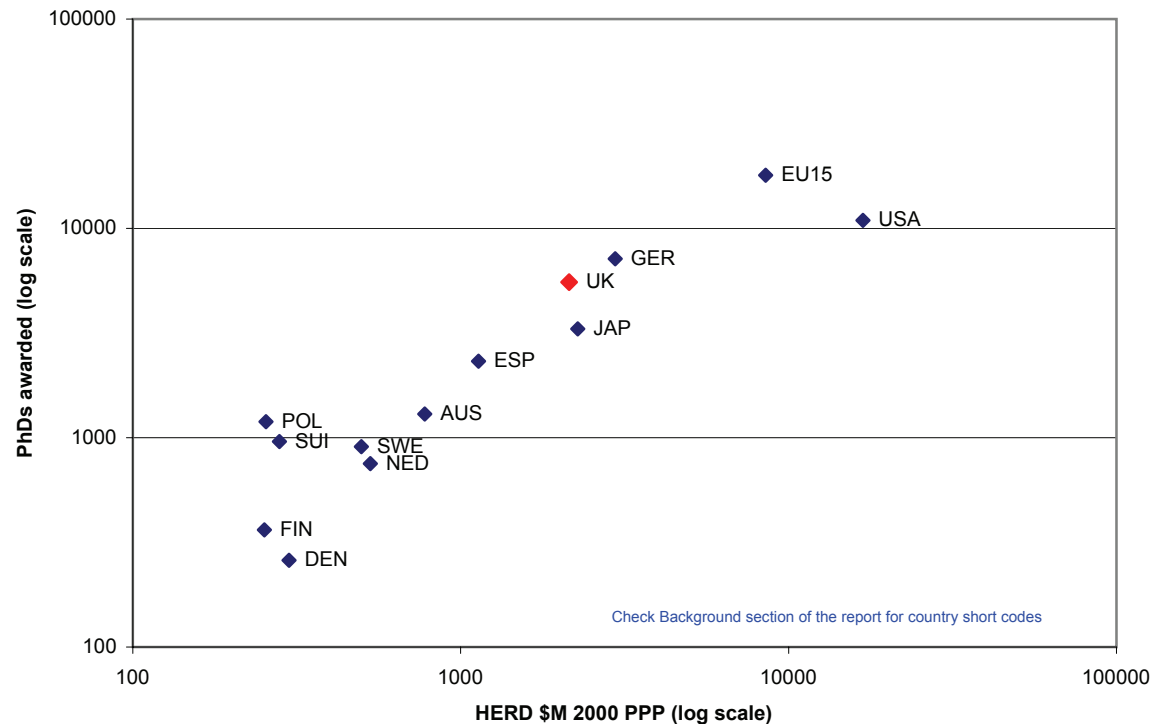

Data: OECD (RDS), OECD Education Database, UK SET statistics and HESA data

Description of performance indicator
Condition signalling improvement

4.02 PhDs awarded relative to HERD in five main research fields
Increased ratio

Natural Sciences - PhDs awarded relative to HERD - OST comparator group nations, 2002

Data: OECD (RDS), OECD Education Database, UK SET statistics and HESA data

Description of performance indicator
Condition signalling improvement

4.02 PhDs awarded relative to HERD in five main research fields
Increased ratio

Engineering and Technology

Indicator Headline

The indicator compares HERD expenditure allocated to Engineering and Technology with the numbers of PhDs awarded in this category.

The UK has around one quarter more PhDs per unit spend than the OST comparator group average (for the 5-year period). This is a similar level of productivity per unit spend to Finland and Sweden and above Germany (who are slightly below the OST comparator group average in this measure). The USA is similar to Germany, whilst Japan is substantially below the OST comparator group average.

The UK is close to the EU average, but its productivity has dropped over the period.

In Engineering and Technology, the UK awards about 2,000 PhDs per year (there has been a drop of about 10% between 2001 and 2002). It is the 4th largest (to USA - 5,400, Japan - 3,100 and Germany 2,400) by volume. There are no available data for France, but its research in this area has historically had good impact.

UK PhD data are subject to a change in HESA data collection from 2001 (see Background).

There is a correlation across countries between funding and PhD output, implying that probably both scale with an underlying size factor such as staff numbers, which affect training and research volumes although other factors may also play a role.

	Average 1998 - 2001	Actual 2002	Ratio or difference
UK PhDs awarded per HERD ($M 2000 PPP) - Actual	1.99	1.69	0.85
OST comparator group average - PhDs awarded per unit HERD ($M 2000 PPP)	1.56	1.35	1
UK PhDs awarded per unit HERD ($M 2000 PPP) - Rank	2	5	-3

Engineering and Technology - PhDs per HERD, G8 nations (no data for Canada, France, Italy or Russia)
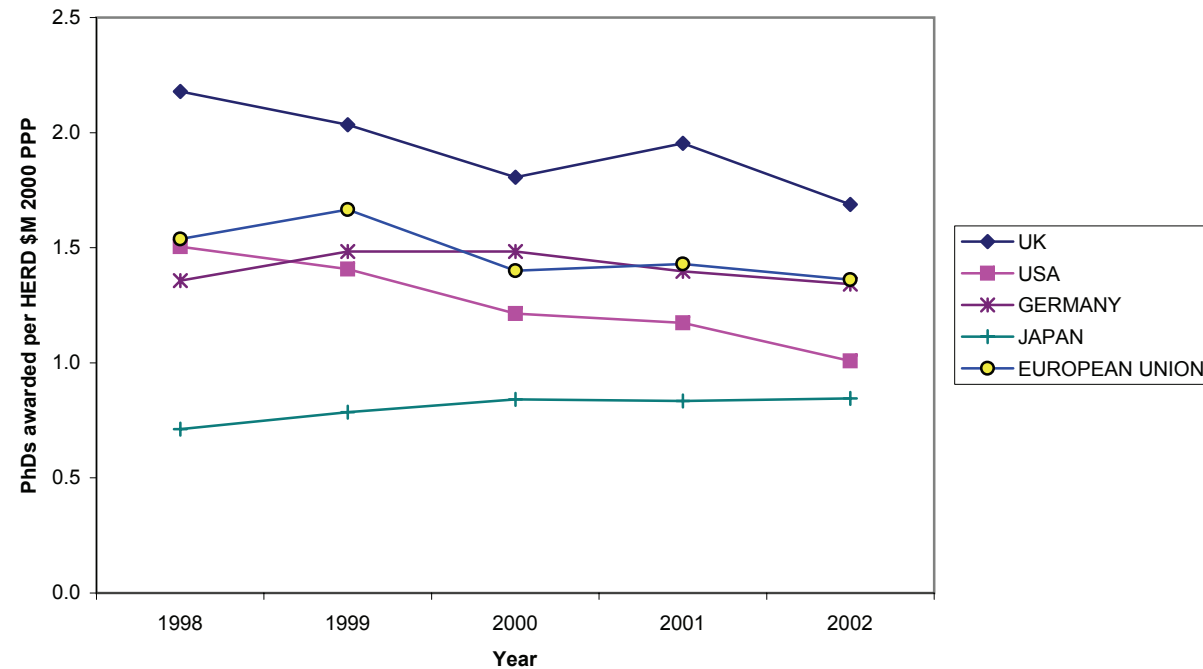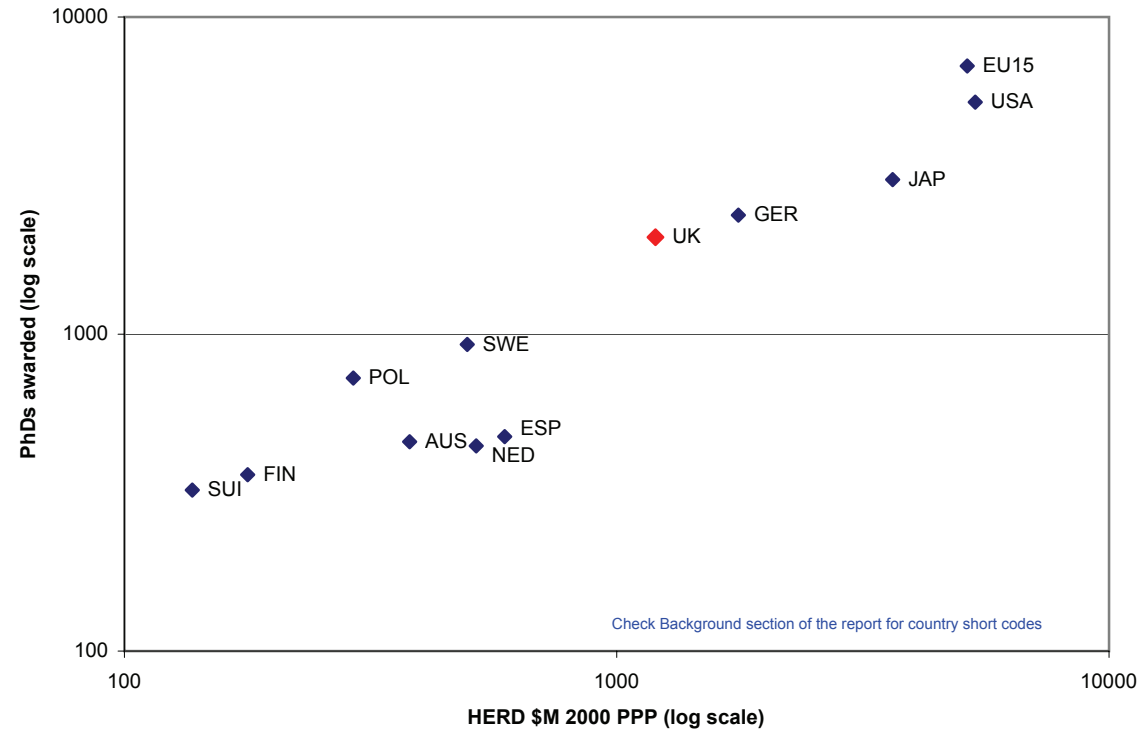

Data: OECD (RDS), OECD Education Database, UK SET statistics and HESA data

Description of performance indicator
Condition signalling improvement

4.02 PhDs awarded relative to HERD in five main research fields
Increased ratio

Engineering and Technology - PhDs awarded relative to HERD - OST comparator nations, 2002

Data: OECD (RDS), OECD Education Database, UK SET statistics and HESA data

Description of performance indicator
Condition signalling improvement

4.02 PhDs awarded relative to HERD in five main research fields
Increased ratio

Social Sciences

Indicator Headline

The indicator compares HERD expenditure allocated to Social Sciences with the numbers of PhDs awarded in this category. Social Sciences includes business and management fields.

The UK produces rather fewer PhDs per unit spend than the OST comparator group average. The range is much wider in this field than the science-technology-based categories and other analyses have thrown doubt on data consistency for some countries.

The UK's average level of productivity per unit spend is roughly half that of Germany, and one third that of the USA. In this field, the UK awards more than 2,000 PhDs per year and is the 3rd largest (to the USA - 17,000 and Germany - 4,000) by volume.

UK PhD data are subject to a change in HESA data collection from 2001 (see Background).

There is a correlation across countries between funding and PhD output, implying that probably both scale with an underlying size factor such as staff numbers, which affect training and research volumes although other factors may play a role.

There are no data available for Japan HERD in Social Sciences.

	Average 1998 - 2001	Actual 2002	Ratio or difference
UK PhDs awarded per HERD ($M 2000 PPP) - Actual	3.01	2.78	0.92
OST comparator group average - PhDs awarded per unit HERD ($M 2000 PPP)	3.69	3.31	1
UK PhDs awarded per unit HERD ($M 2000 PPP) - Rank	5	5	0

Social Sciences - PhDs per HERD, G8 nations (no data for Canada, France, Italy or Russia)
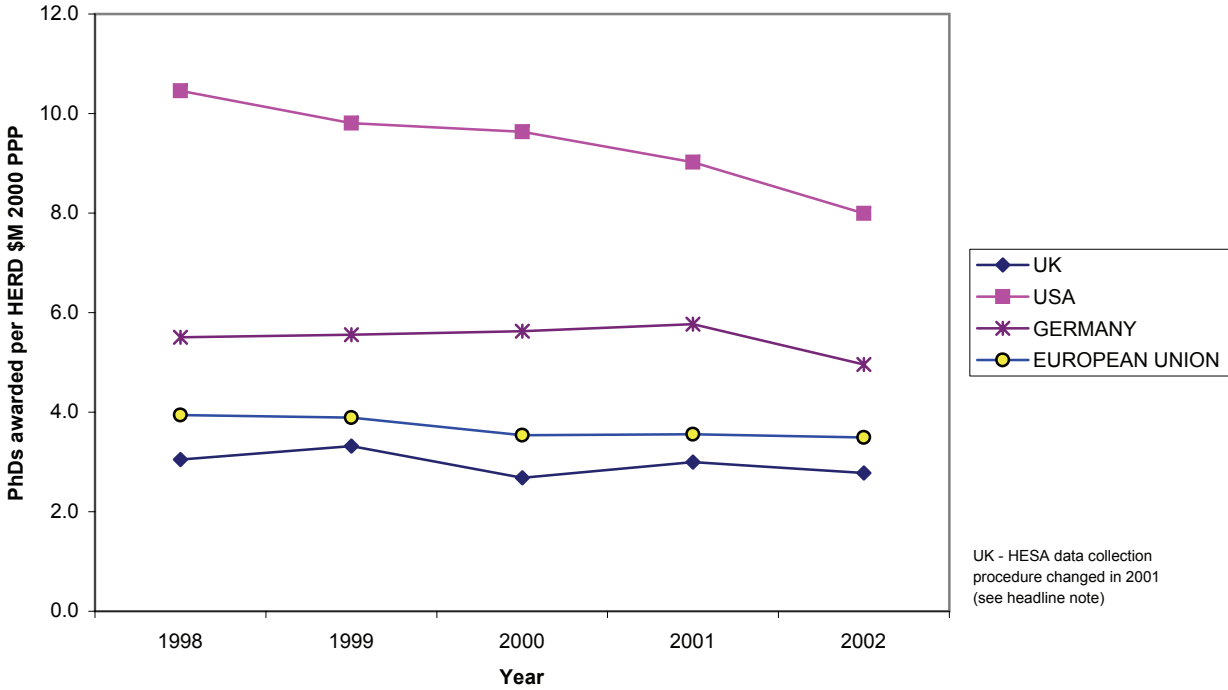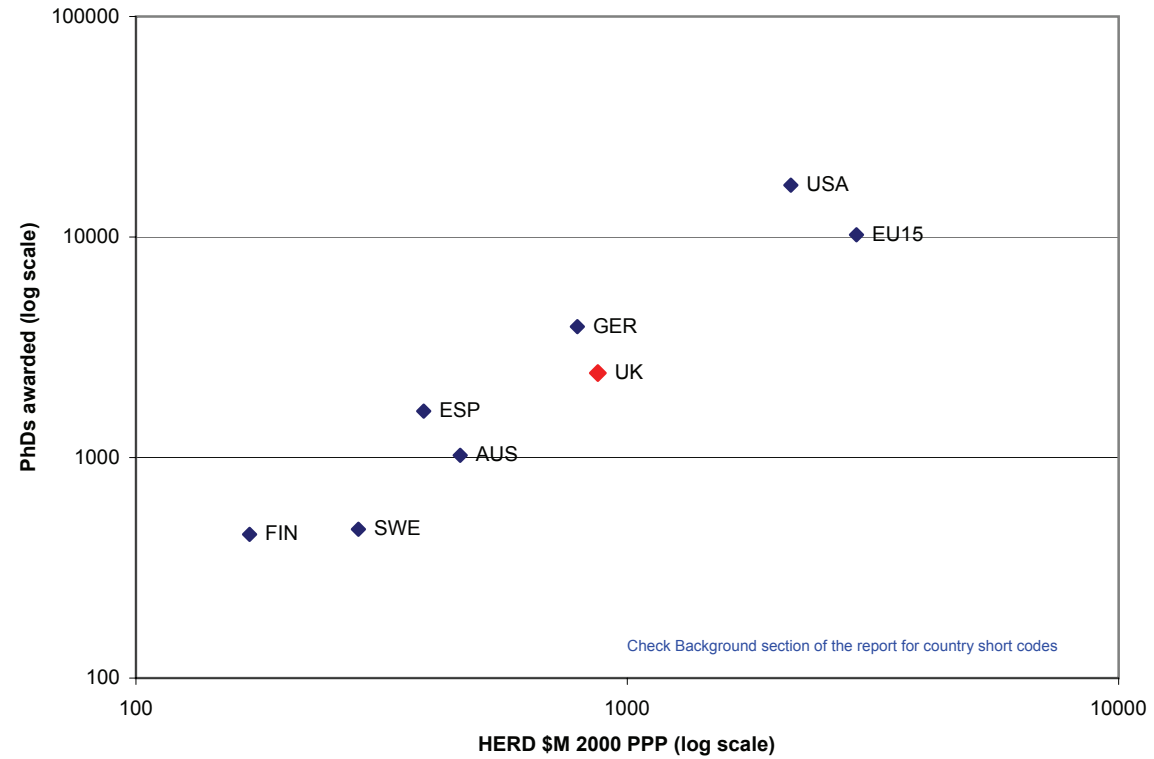

UK - HESA data collection procedure changed in 2001 (see headline note)

Data: OECD (RDS), OECD Education Database, UK SET statistics and HESA data

Description of performance indicator   **4.02 PhDs awarded relative to HERD in five main research fields**
Condition signalling improvement   **Increased ratio**

Social Sciences - PhDs awarded relative to HERD - OST comparator nations, 2002

Data: OECD (RDS), OECD Education Database, UK SET statistics and HESA data

Description of performance indicator
Condition signalling improvement

4.02 PhDs awarded relative to HERD in five main research fields
Increased ratio

Humanities

Indicator Headline

The indicator compares HERD expenditure allocated to Humanities with the numbers of PhDs awarded in this category. This is the first time that Humanities data have been analysed in this indicator. The data coverage is sparse, reducing the feasibility of interpretation

The UK produces a much larger number of PhDs per unit spend than the OST comparator group. This is a similar average level of productivity per unit spend to Finland and approximately twice that of Germany, which itself is below the OST comparator group average.

In this field, the UK awards close to 2,000 PhDs per year and is the 3rd largest (after the USA - 6,000 and just behind Germany also with 2,000) by volume. The UK recently started producing more humanities PhDs than France.

UK PhD data are subject to a change in HESA data collection from 2001 (see Background).

There are no data available for the USA HERD in Humanities.

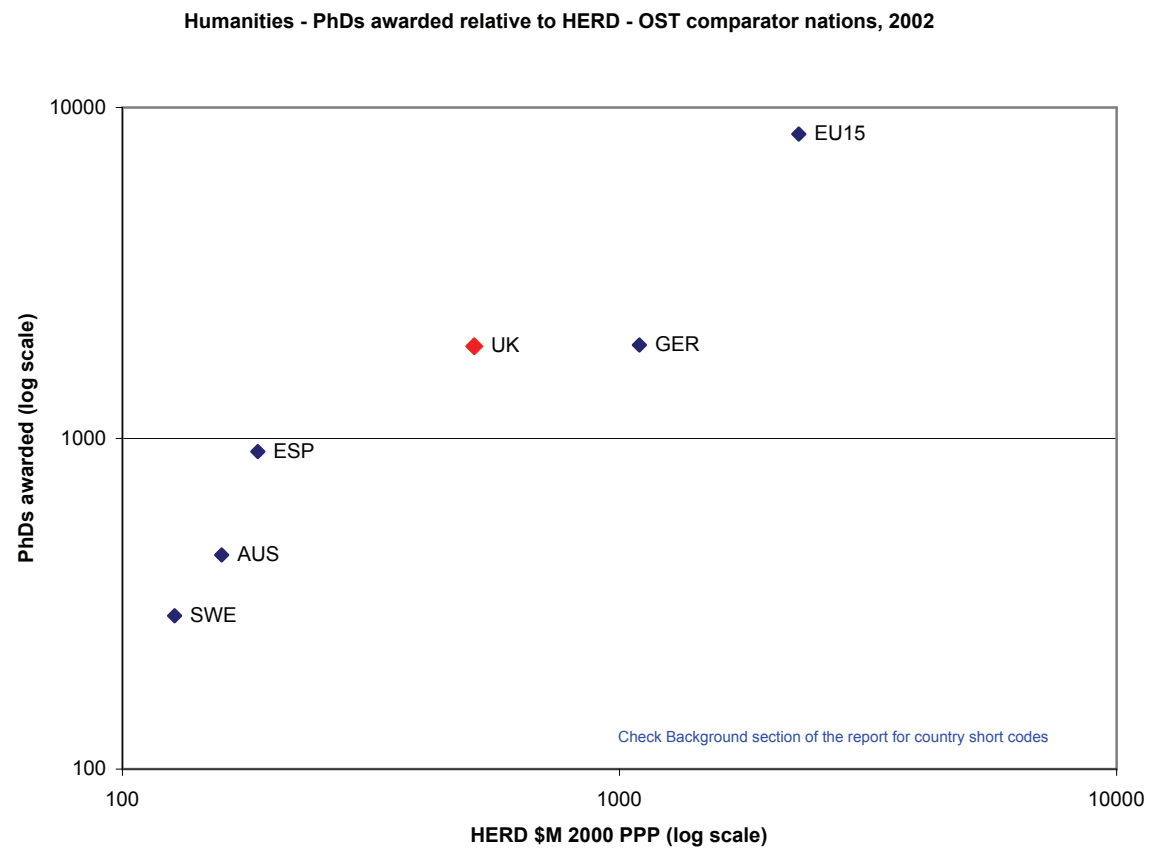|	Average 1998 - 2001	Actual 2002	Ratio or difference
UK PhDs awarded per HERD ($M 2000 PPP) - Actual	3.96	3.72	0.94
OST comparator group average - PhDs awarded per unit HERD ($M 2000 PPP)	2.49	2.35	1
UK PhDs awarded per unit HERD ($M 2000 PPP) - Rank	3	3	0

Humanities - PhDs per HERD, G8 nations (no data for USA, Canada, France, Italy or Russia)
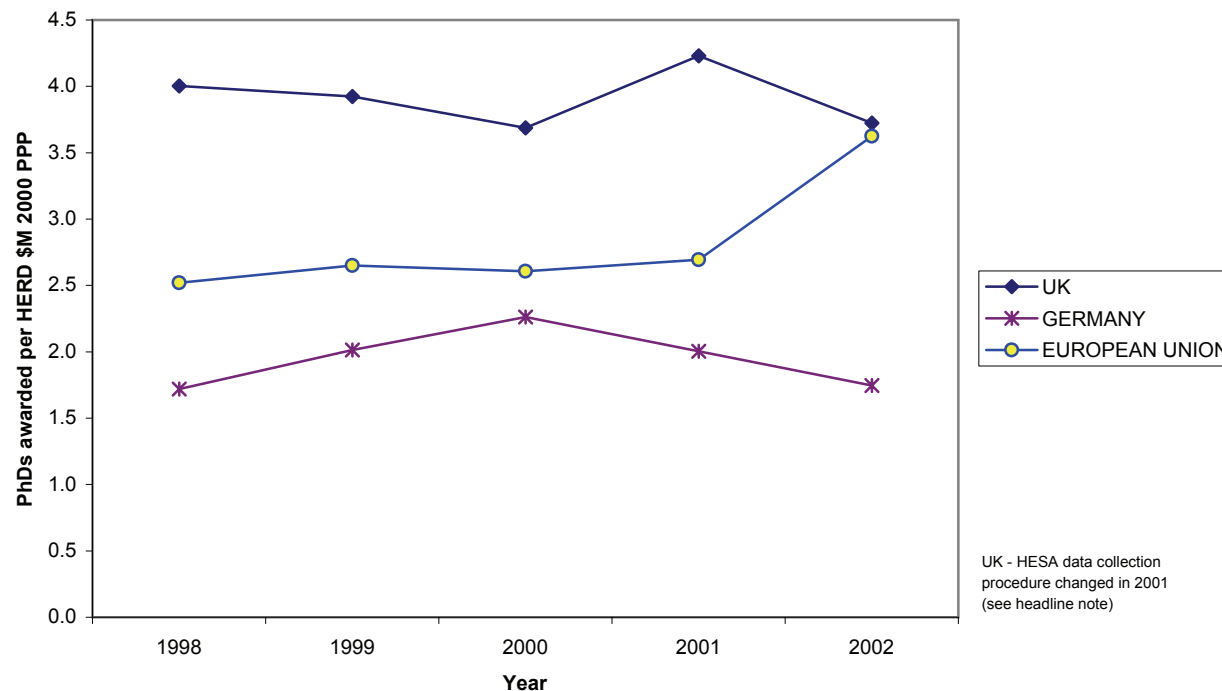
UK - HESA data collection procedure changed in 2001 (see headline note)

Data: OECD (RDS), OECD Education Database, UK SET statistics and HESA data

Description of performance indicator   **4.02 PhDs awarded relative to HERD in five main research fields**
Condition signalling improvement   **Increased ratio**

Humanities - PhDs awarded relative to HERD - OST comparator nations, 2002

Data: OECD (RDS), OECD Education Database, UK SET statistics and HESA data

Description of performance indicator
Condition signalling improvement

4.03 PhDs awarded relative to PUBERD
Increased ratio

	Average 1998 - 2001	Actual 2002	Ratio or difference
UK PhDs awarded per PUBERD (2000 $M PPP) - Actual	1.36	1.54	1.14
OST comparator group average - PhDs awarded per PUBERD (2000 $M PPP)	1.17	1.15	0.99
UK PhDs awarded per PUBERD (2000 $M PPP) - Rank	6	4	2
UK PhDs awarded per PUBERD (2000 $M PPP) / OST comparator group average - PhDs awarded per PUBERD (2000 $M PPP)	1.16	1.34	

Indicator Headline

The indicator compares the output of people gaining research degrees with the total public research spend (PUBERD, the sum of GOVERD and HERD).

The UK is ranked 1st within the G8 nations in terms of PhD awards per PUBERD, and 4th amongst the OST comparator group (behind Poland, Switzerland and Spain).   The UK remains significantly above the OST comparator group average throughout the period 1998-2001.

Over the 5-year period only one other G8 nation has improved the PhD/PUBERD ratio - Japan by 30%. The ratios for the USA and France have continued to decline. A UK decline in 2000 is obscured by the change in data collection in 2001.
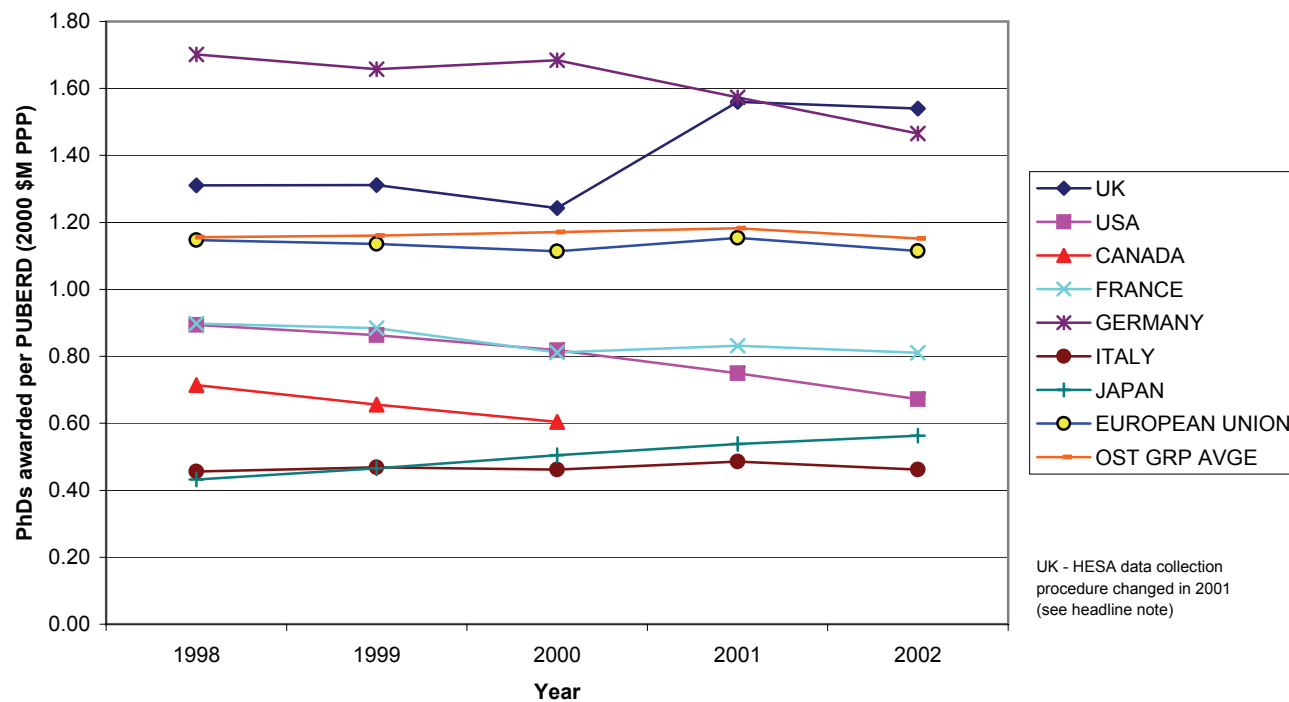
Outside the G8, the PhD/PUBERD ratio of South Korea has levelled off after an increase in the previous 4 years of more than 13%. The EU15 average is fairly level.

UK PhD data are subject to a change in HESA data collection from 2001 (see Background).

PhDs per PUBERD (2000 $M PPP), G8 nations (no data for Russia)
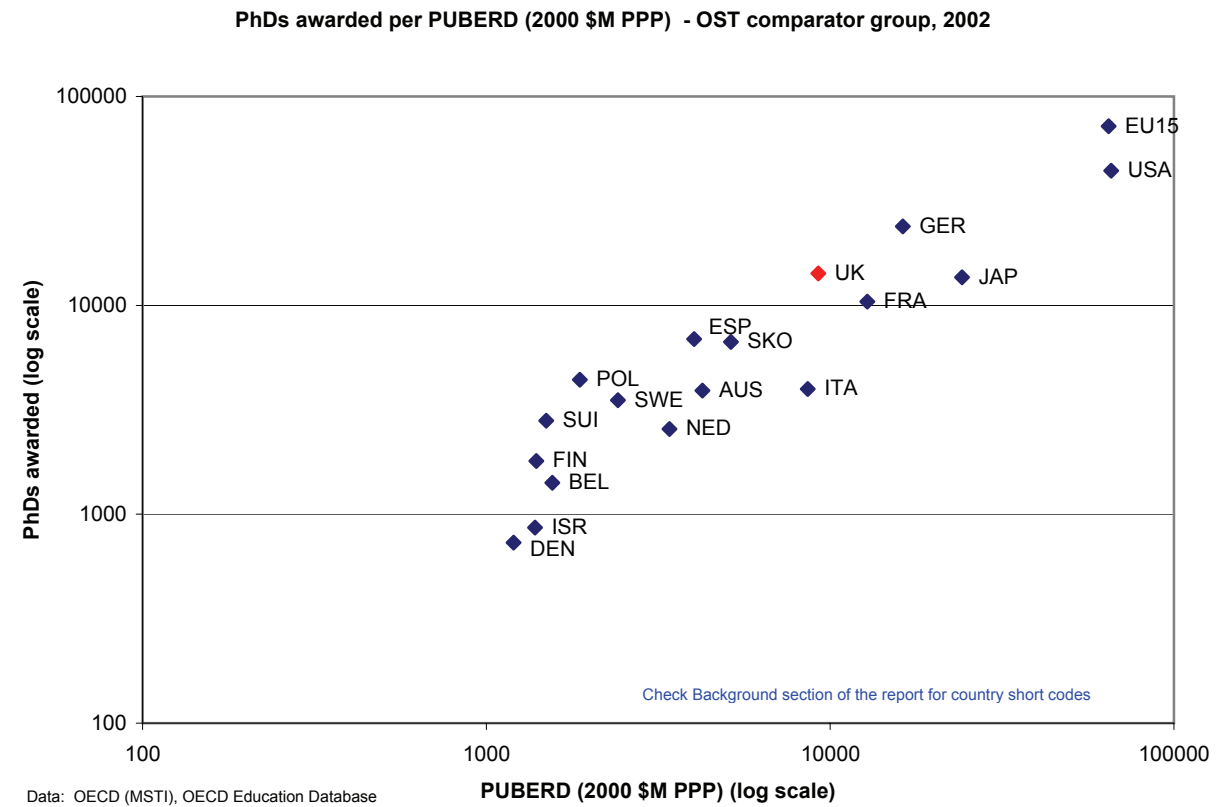

UK - HESA data collection procedure changed in 2001 (see headline note)

Data: OECD (MSTI), OECD Education Database

Description of performance indicator **4.03 PhDs awarded relative to PUBERD**
Condition signalling improvement **Increased ratio**

PhDs awarded per PUBERD (2000 $M PPP) - OST comparator group, 2002

Data: OECD (MSTI), OECD Education Database

4.04 Citations relative to GDP
Improved ratio of citations per GDP compared to recent past

Indicator Headline

This is the first of a series of indicators that measure citation accumulation (hence research esteem) in relation to the components of investment.

This indicator measures the association between total GDP and national citation count.

The UK is the leading country among the G8 group. The UK is well ahead of the USA which is ranked 11th in the OST group overall (the UK holds the 7th position). Several countries, including the UK, Canada and the USA have declined in performance relative to the OST average. Germany's performance has recently levelled, having improved slightly since 1995 throughout the time period.

UK relative international performance remains well ahead of the average for the OST comparator group, although it declined slightly in 2001 and again in 2003 compared to the OST group average.

The UK is ranked 7th overall for recognition compared to general expenditure, behind Israel, Switzerland, the Netherlands and the Scandinavian countries.

The EU15 combined overall performance is increasingly similar to that of the USA, especially since the late 1990s.

Data for Russia are anomalous, because of the rapid fall in the OECD figures for Russian GDP.

	Average 1998 - 2002	Actual 2003	Ratio or difference
UK citations per GDP (2000 $M PPP) - Actual	0.49	0.12	0.24
OST comparator group average citations per GDP (2000 $M PPP)	0.35	0.09	0.26
UK citations per GDP - Rank	7	7	0
UK cites per GDP / OST comparator group average cites per GDP	1.38	1.27	0.92

Citations relative to GDP rebased to OST comparator group average - G8 nations
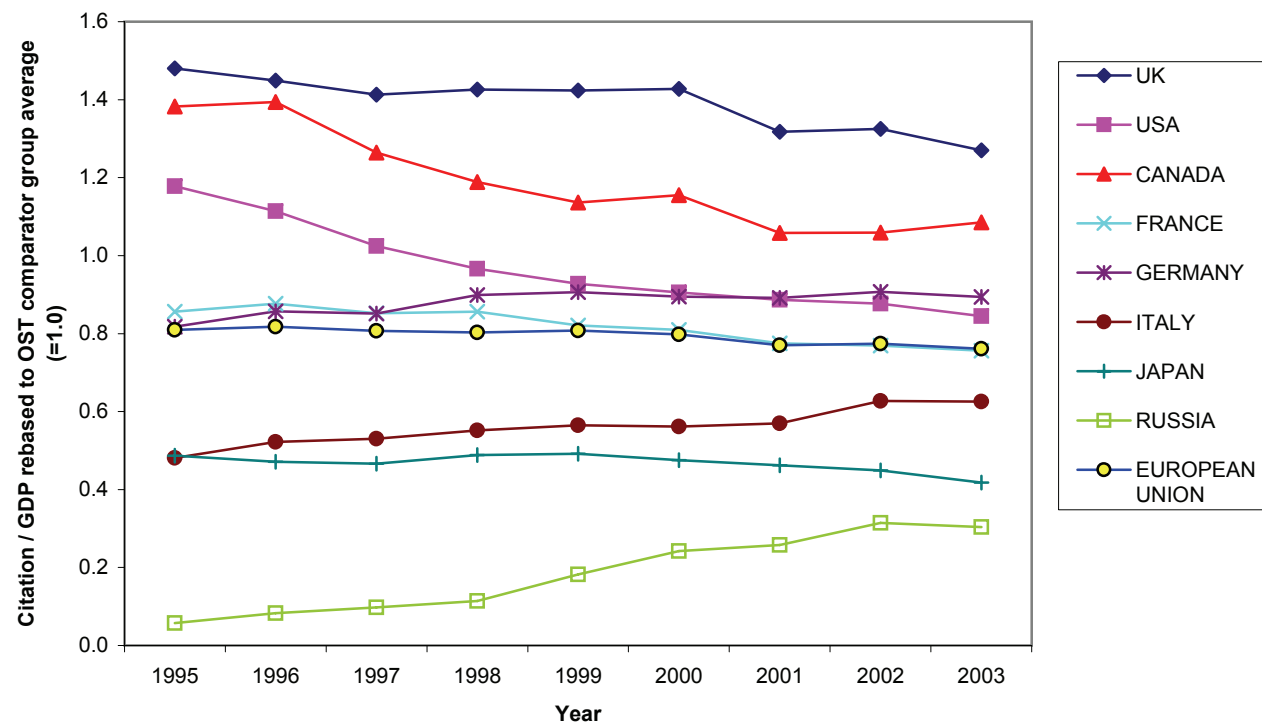
Data: Thomson ISI® National Science Indicators, OECD (MSTI)

evidence

Description of performance indicator
Condition signalling improvement

4.04 Citations relative to GDP
Improved ratio of citations per GDP compared to recent past
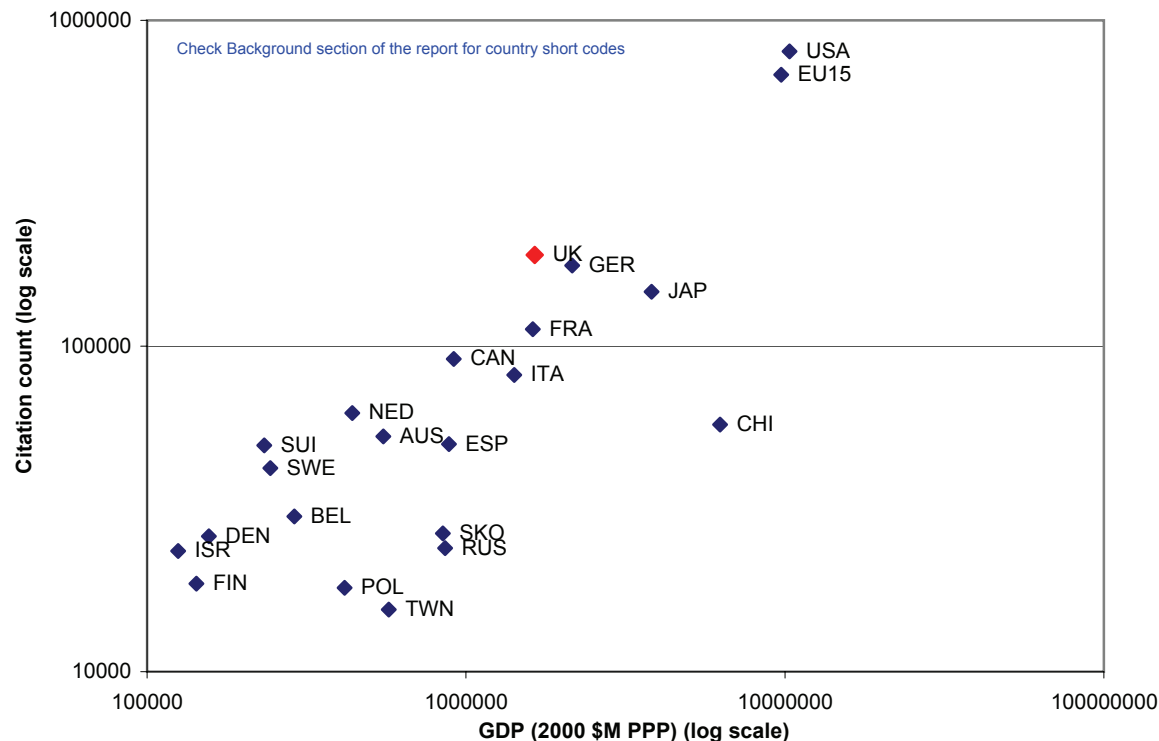
Indicator Headline cont.

At a gross level, it is not clear that all research performance should be attributed solely to specific investment in R&D. There are other reasons why some economies may tend to support a greater level of innovation and inventiveness and these may be linked more loosely to the overall level of economic activity. Conversely, some nations may have rather a low level of research performance compared to the size of the economy.

Citations accumulate with time, so citation count for earlier years is greater than for the more recent years. Direct comparison between countries is therefore informative but data need to be rebased for comparison between years.

Citations relative to GDP - OST comparator group nations, 2003

Data: Thomson ISI® National Science Indicators, OECD (MSTI)

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Description of performance indicator
Condition signalling improvement

4.05 Number and share of citations relative to GERD
Increased citations per unit expenditure

Indicator Headline

This indicator compares national citation counts to Gross Expenditure on R&D (GERD) including both public and private sector spend. The private sector generally publishes far less than the public sector and its expenditure is therefore less likely to generate citations. As a consequence, national economies that have a balance towards the private sector will generate fewer citations per unit GERD.

Within the OST comparator group the UK has a strong performance in terms of relative share of citations compared to relative expenditure.

The UK continues to lead among the G8 nations although its position is perhaps not as strong as it has been previously.

UK GERD has increased in real terms over the last ten years and again was greater in 2003 than the average for the recent past. The OST comparator group average rate of increase is dominated by USA figures: USA GERD increased by over one third in the last decade.

Citations accumulate with time and are always fewer in more recent years. The UK has dipped very slightly in its relative international performance on this indicator (an average change in citations per GERD - ratio between 2003 and recent average is UK = 0.240, OST comparator group average = 0.255).

Switzerland still leads in this indicator (32.2 cites/$M GERD average in recent 5 years) but in the last 3 years Poland has risen through the ranks from around 12th to 2nd or 3rd. The UK is ranked 5th behind Switzerland, Poland, the Netherlands and Denmark.

cont./

	Average 1998 - 2002	Actual 2003	Ratio or difference
UK GERD (2000 $M PPP)	27792	30203	1.09
UK citations / GERD (2000 $M PPP) - Actual	26.24	6.31	0.24
OST comparator group average citations / GERD (2000 $M PPP)	16.04	4.10	0.26
UK citations / GERD (2000 $M PPP) - Rank	3	5	2
UK share of OST comparator group citations / UK share of OST comparator group GERD (2000 $M PPP)	2.09	2.08	0.99
UK share of OST comparator group citations/spend - Rank	3	5	2

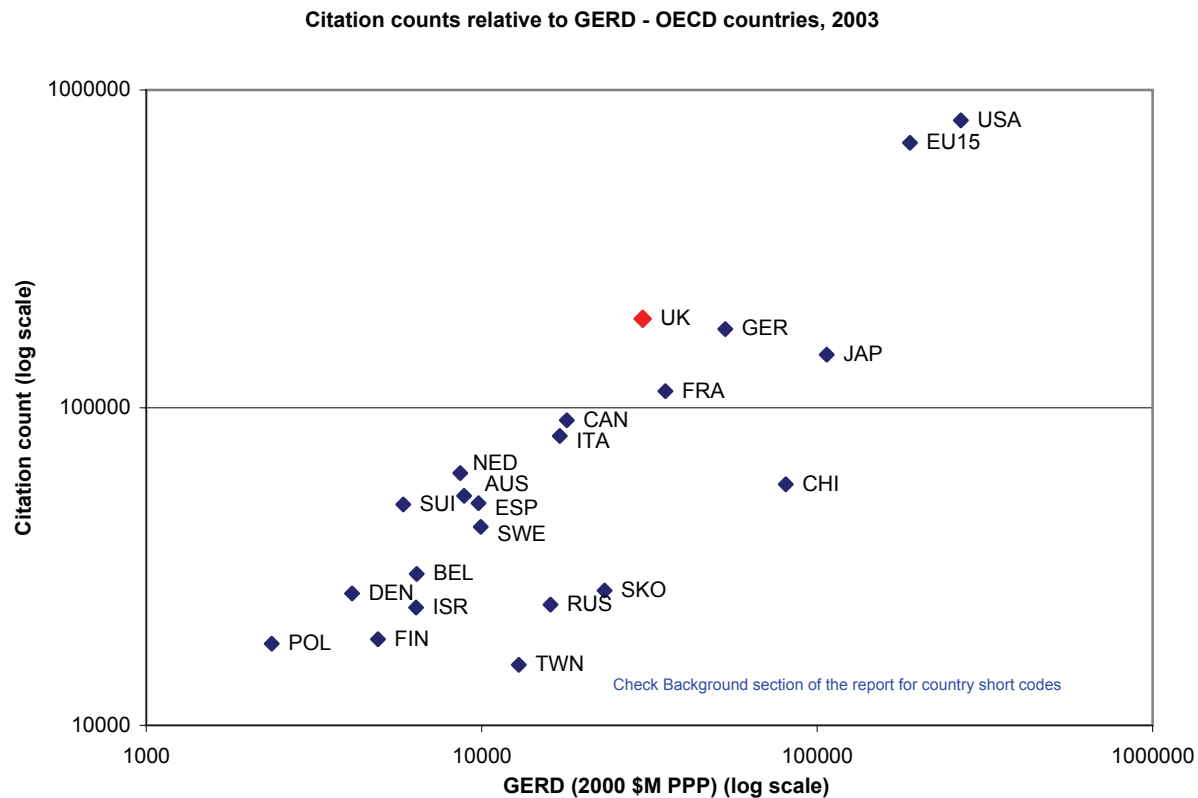**OST comparator group citation share / OST comparator group GERD share for G8 nations**
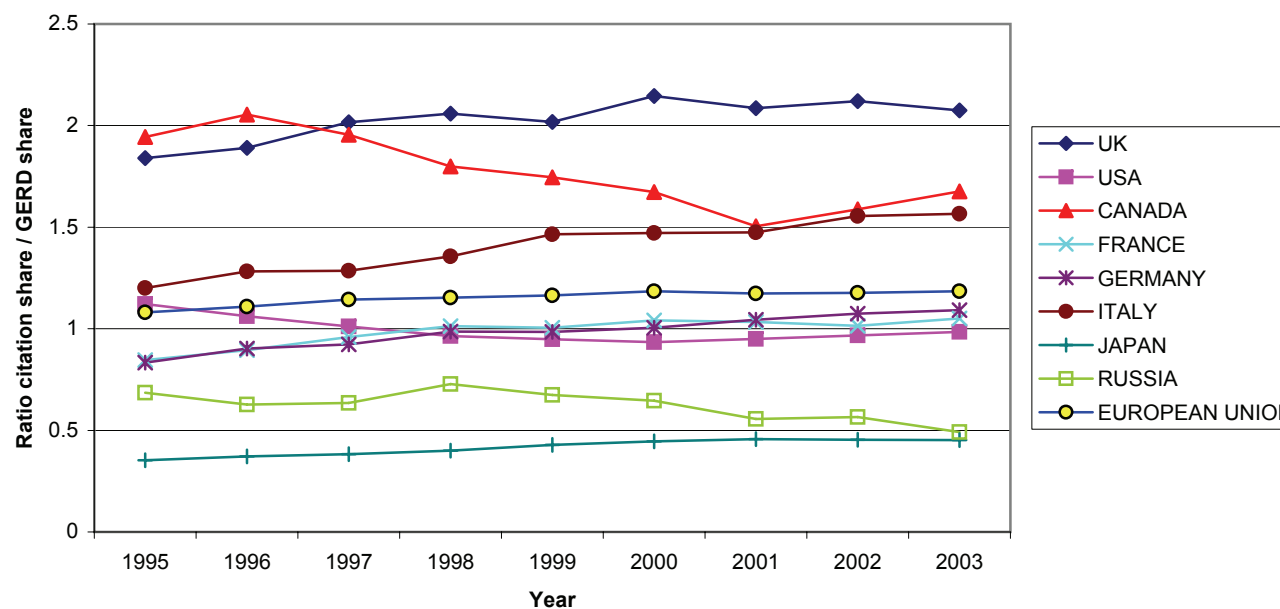
Data: Thomson ISI® National Science Indicators, OECD (MSTI)

Description of performance indicator
Condition signalling improvement

4.05 Number and share of citations relative to GERD
Increased citations per unit expenditure

Indicator Headline cont.

The EU15 combined overall performance appears to have stabilised against that of the USA. The USA has about 0.80 cites/GERD compared to the EU15 total. The USA remains larger in absolute terms of GERD (USA = $M268k in 2003; EU15 = $M189k) and total citations (USA = 800,000 in 2003; EU15 = 680,000).

Citation counts relative to GERD - OECD countries, 2003

Check Background section of the report for country short codes

Data: Thomson ISI® National Science Indicators, OECD (MSTI)

Description of performance indicator
Condition signalling improvement

4.06 Citations relative to PUBERD (GOVERD + HERD)
Increased citations per unit expenditure

	Average 1998 - 2002	Actual 2003	Ratio or difference
UK GOVERD + HERD (2000 $M PPP)	8930	9379	1.05
UK citations / GOVERD + HERD (2000 $M PPP) - Actual	81.08	20.31	0.25
OST comparator group average citations / GOVERD + HERD (2000 $M PPP)	48.05	12.12	0.25
UK citations per GOVERD + HERD (2000 $M PPP) - Rank	2	3	1

Indicator Headline

It is useful to know about national research performance in relation to levels of public spending on the research base. While GERD indicates total national expenditure on R&D, and it is reasonable to anticipate some interaction and gearing between public and private sectors, private R&D investment is not generally aimed at producing papers or people.

Indicator 1.02 shows that UK expenditure on R&D performed in the public sector has risen in real terms compared to the recent past. This increase is less, however, over the last ten years than for the OST group average.

The UK has maintained its strong relative international performance in the G8 and the wider OST comparator group.

Most countries have experienced a reduction in the absolute number of citations/$M PUBERD but the relative positions are unchanged. Thus, the UK (81.1 citations/$M PUBERD on average for recent years) is ranked 2nd recently and 3rd in 2003 to Switzerland (129.3 cites/$M) and just behind Denmark. The USA (55.2 cites/$M) is ranked 9th.

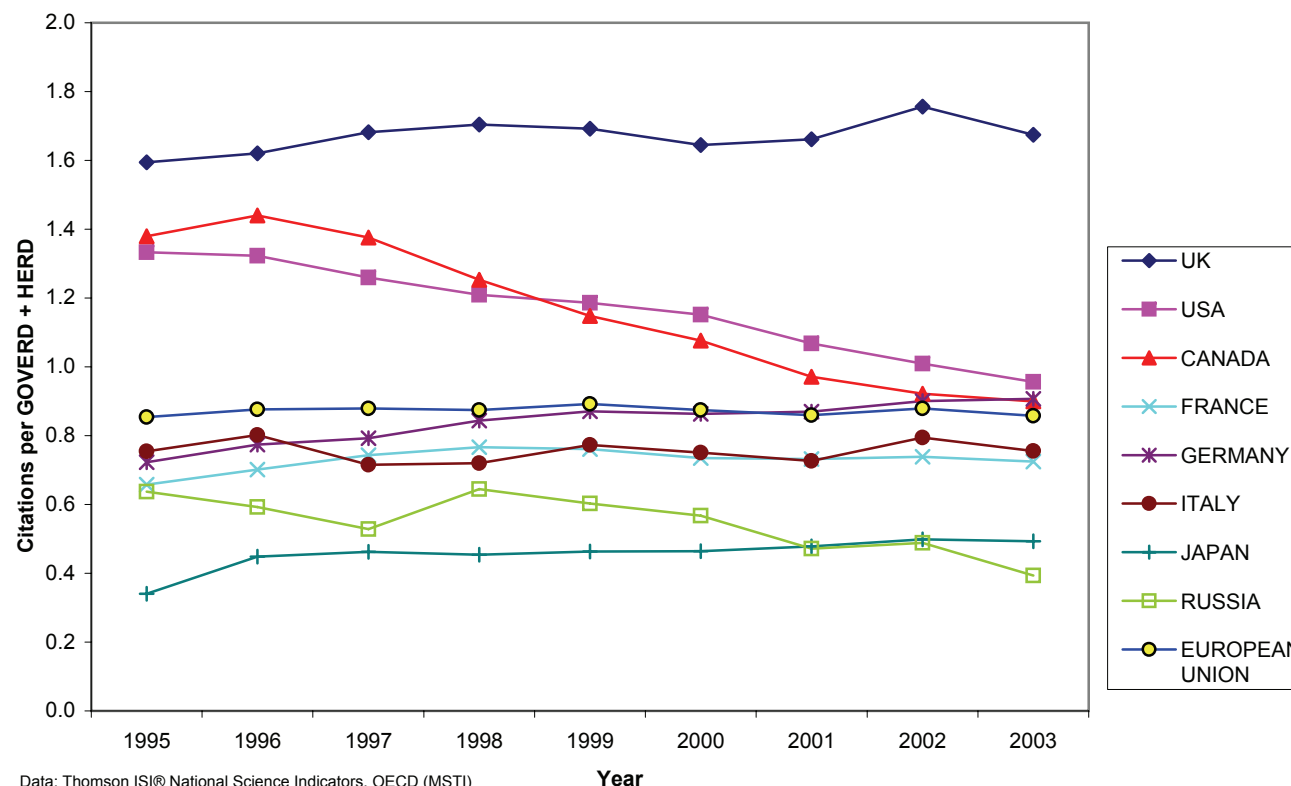Of the G8, Germany (41.5 cites/$M) has maintained its upward trend and Japan, though not increasing as in previous years has remained stable whilst other countries are experiencing declines in this measure.

cont./

Citations per GOVERD + HERD rebased to OST comparator group average (= 1.0) - G8

Data: Thomson ISI® National Science Indicators, OECD (MSTI)

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Description of performance indicator
Condition signalling improvement

4.06 Citations relative to PUBERD (GOVERD + HERD)
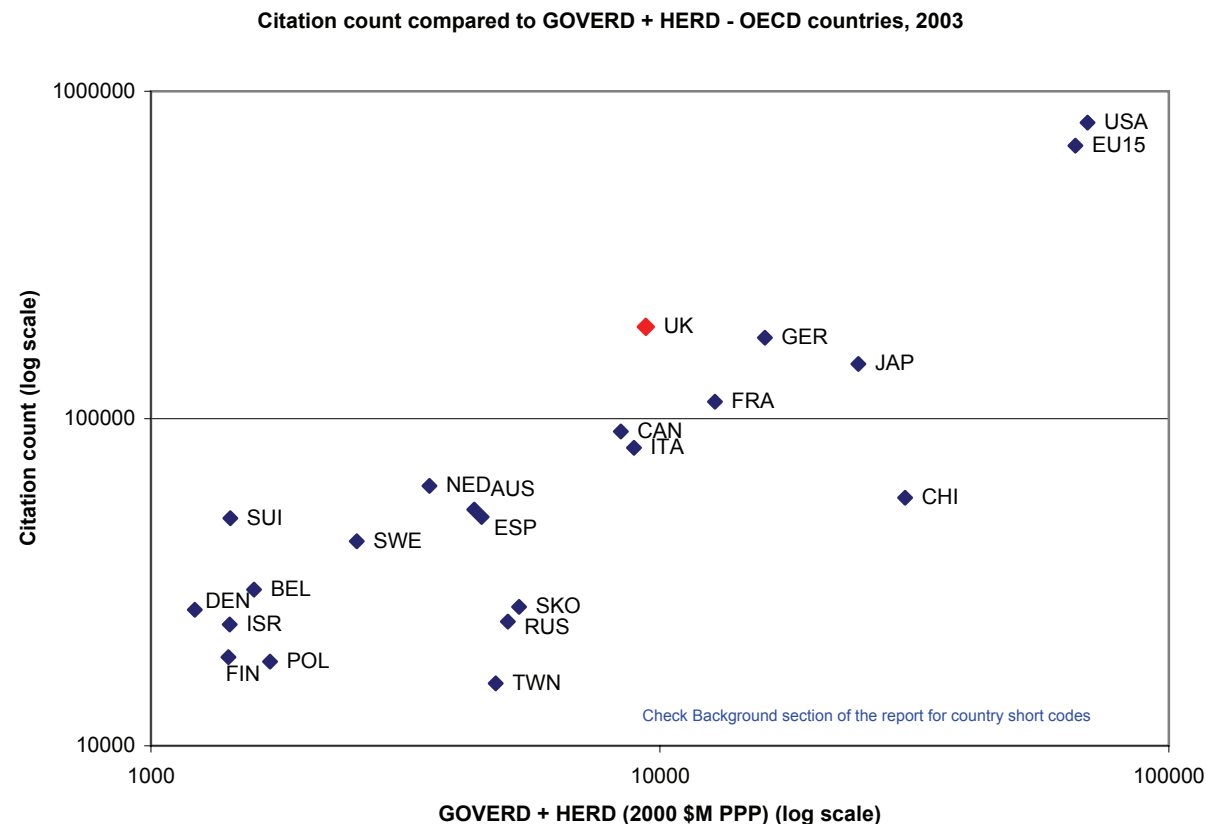**Increased citations per unit expenditure**

Indicator Headline cont.

Relative positions within the OST comparator group average using this indicator show little change over the ten year period. The exceptions to this are Denmark and Sweden who have risen by 4 places (from 6th to 2nd) and fallen by 4 places (from 2nd to 6th) respectively.

In this indicator, research recognition as citation count is compared with R&D carried out specifically in the Government (GOVERD) and Higher Education (HERD) sectors (together designated as PUBERD). These are the bulk of public sector R&D. It is feasible but challenging and costly to separate the citations attributable to papers published by different sectors in each country. The indicator therefore currently reflects the relationship between national research performance and public sector spend.

Citations accumulate over time and are always fewer in more recent years. Compared to other countries, UK performance indexed as citations per unit PUBERD has remained broadly similar to the OST comparator group average.

Citation count compared to GOVERD + HERD - OECD countries, 2003

Data: Thomson ISI® National Science Indicators, OECD (MSTI)

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Description of performance indicator
Condition signalling improvement

4.07 Citations relative to HERD
Increased citations per unit expenditure

Indicator Headline

HERD is Expenditure on R&D performed in the Higher Education sector. Here, citation counts are compared with HERD.

UK HERD has increased markedly, over one third in real terms over the last ten years and by nearly a quarter between 1999 and 2002 alone. OST comparator group average has increased by a similar amount over ten years.

Citations accumulate over time and are always fewer in more recent years. UK actual citations per HERD naturally decrease since expenditure is greater and older papers have had more time to accumulate citations. By comparison to the average for the OST comparator group, the UK has about 1.6 times as many citations per unit expenditure.

The UK's position in 2003 is 2nd (29.5 cites/$M), it has apparently lost some ground to Switzerland (36.0 cites/$M) and is now only slightly ahead of Denmark (27.7 cites/$M). The UK is ranked 4th with regard to average recent performance in this indicator behind Switzerland, Denmark and Russia. However, the UK is still a clear leader amongst the G8 nations.
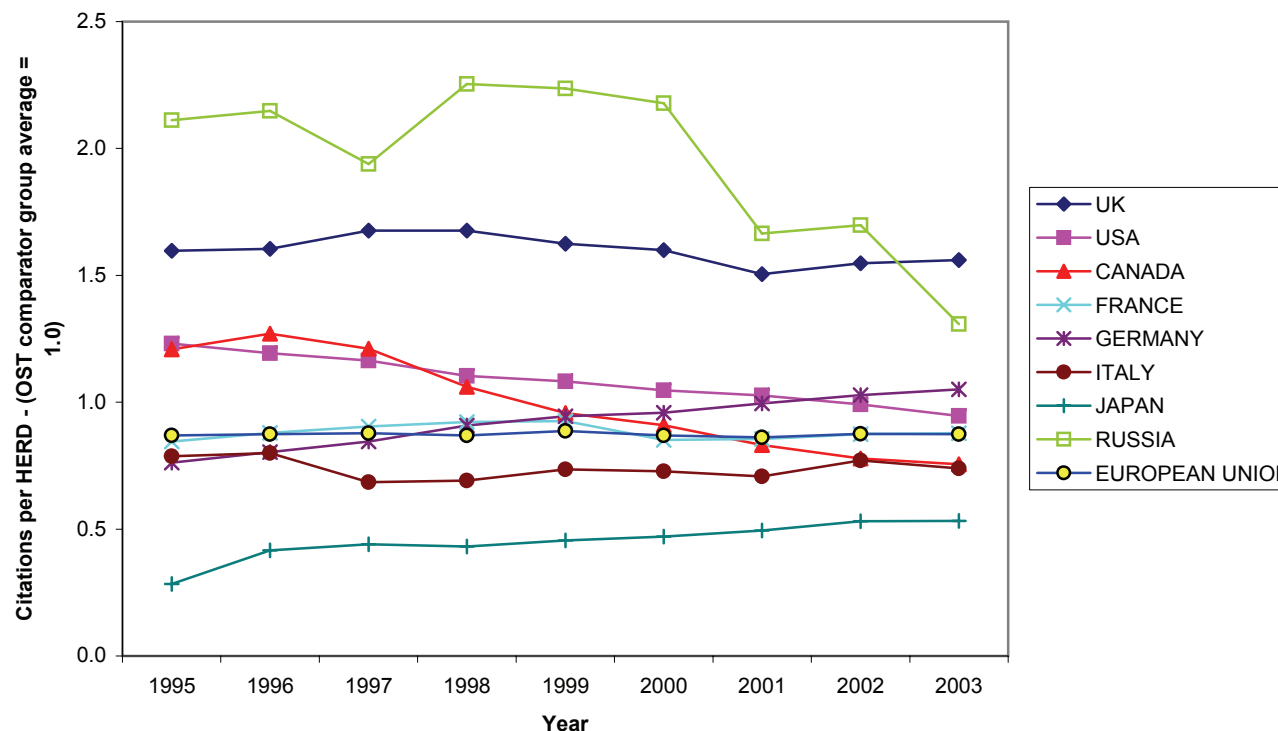
The EU15 has continued to improve its overall performance relative to the USA. The ratio of USA cites/$M HERD in 1995 to that of the EU15 in the same year was 1.41 and for the most recent year, 2003, this ratio had dropped to 1.08. Average HERD for the most recent five year period for the USA and the EU15 is close to $40BN.

cont./

	Average 1998 - 2002	Actual 2003	Ratio or difference
UK HERD (2000 $M PPP)	5786	6462	1.12
UK citations per HERD (2000 $M PPP) - Actual	128.85	29.48	0.23
OST comparator group average citations per HERD (2000 $M PPP)	80.07	18.87	0.24
UK citations per HERD (2000 $M PPP) - Rank	4	2	-2

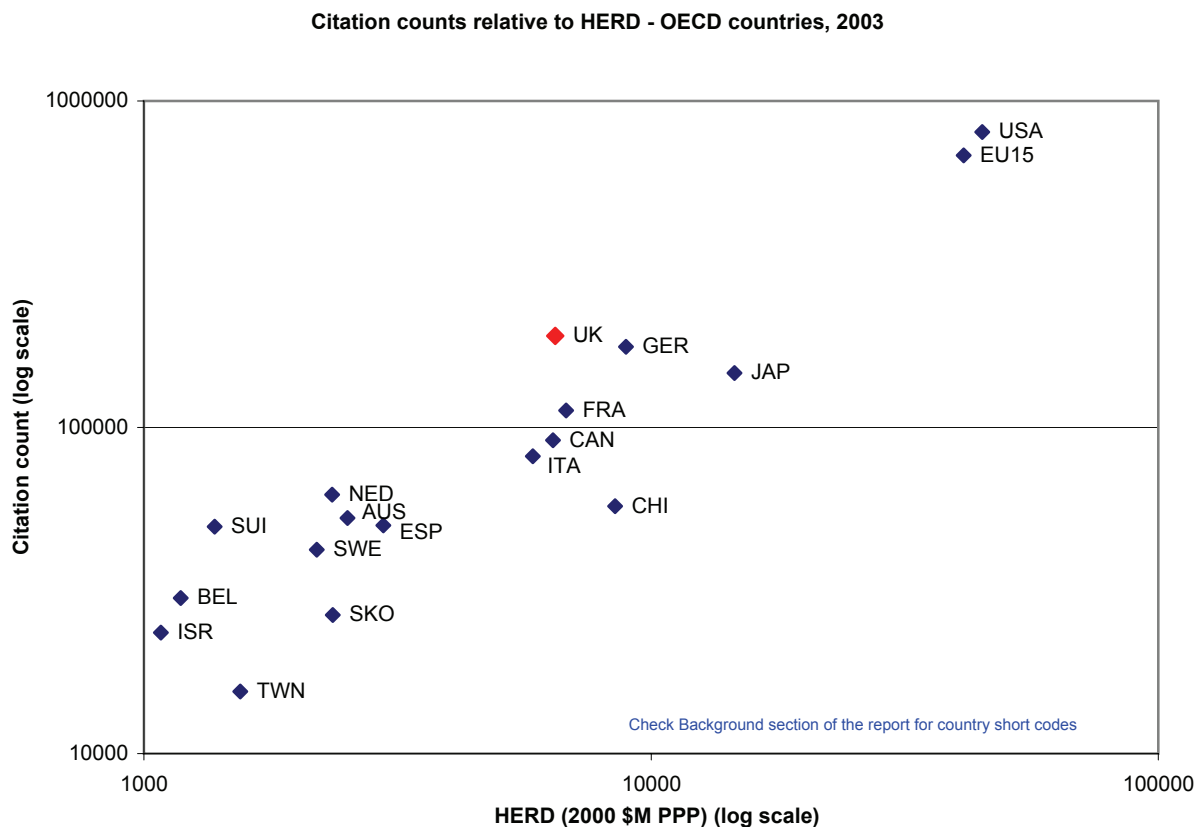**Citations per unit HERD rebased to OST comparator group average (= 1.0) for G8 nations**

Data: Thomson ISI® National Science Indicators, OECD (MSTI)

Description of performance indicator
Condition signalling improvement

4.07 Citations relative to HERD
Increase in cites per unit spend at the OECD field level

Indicator Headline cont.

Russia's performance is affected by volatile changes in GERD and its components.

The OECD definition of what can be included in HERD is relatively broad and may include activity outside universities and colleges in some countries. There is no implication here that HE is the only agent acquiring citations. In many research economies the major driver of innovative and original research is the higher education sector. However, the research institute sector is also an important part of the research base in the UK and even more so in France, Germany and Japan. The OECD HERD definition is flexible enough to permit broad comparability.

Citation counts relative to HERD - OECD countries, 2003

Data: Thomson ISI® National Science Indicators, OECD (MSTI)

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Description of performance indicator
Condition signalling improvement

4.08 Citations relative to HERD in five main research fields
Increase in cites per unit spend at the OECD field level

Medical Sciences

Indicator Headline

For some countries, both HERD and citation counts can be disaggregated by OECD field for analysis in this indicator.

For the Medical Sciences, the UK acquires more cites per unit HERD than the OST comparator group average and is ranked 3rd behind Denmark (on its own at over twice OST average, but with a somewhat anomalous blip in 2002) and Finland in recent years. Ranked 1st among G8 nations, UK performance is broadly constant over the period. From 2001 Spain replaces Finland in second place, and in 2003, the Netherlands edges the UK into 4th position.

The USA is ranked 7th, at 0.85 OST comparator group average.

The data for Denmark show a general level of performance that is exceptional and where the profile departs substantially from that of other countries. This is due to relatively low amounts of HERD expenditure until a marked rise in 2002 which accounts for the drop in 2002.
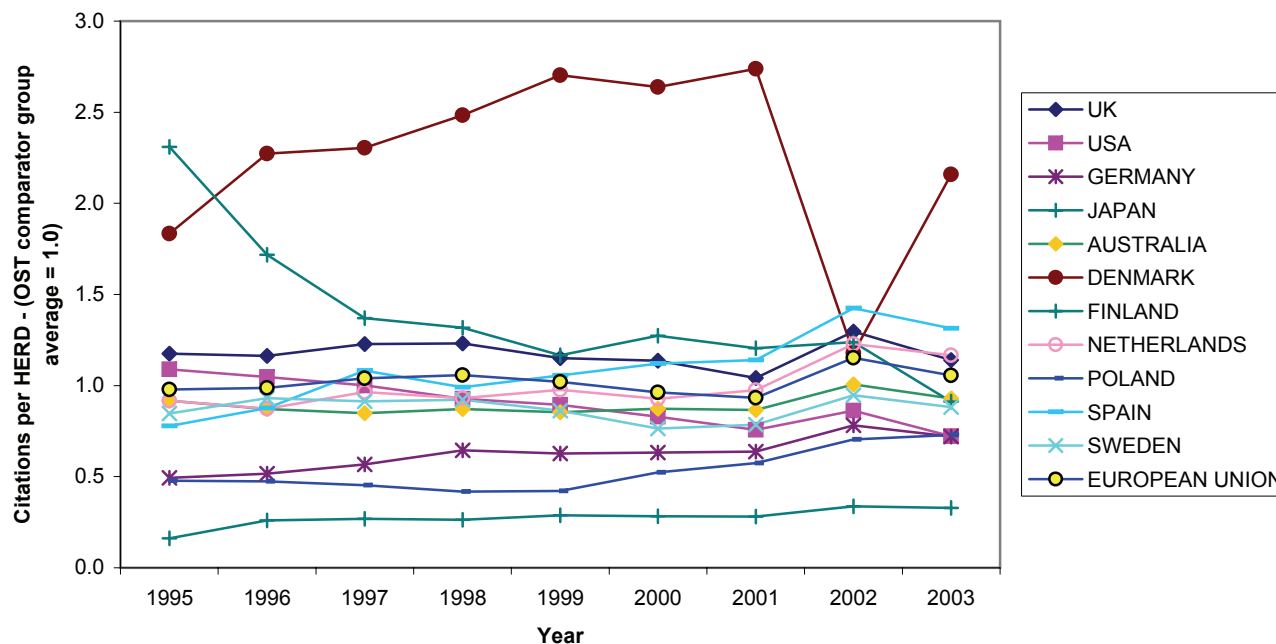
The EU15 line should be regarded with caution. The OECD data do not accurately reflect a true sum and the index is therefore over-inflated.

HERD is Expenditure on R&D performed in the Higher Education sector. Here, citation counts are compared with HERD. It is not implied that HE is the only agent acquiring citations, but in many research economies it is the major player.

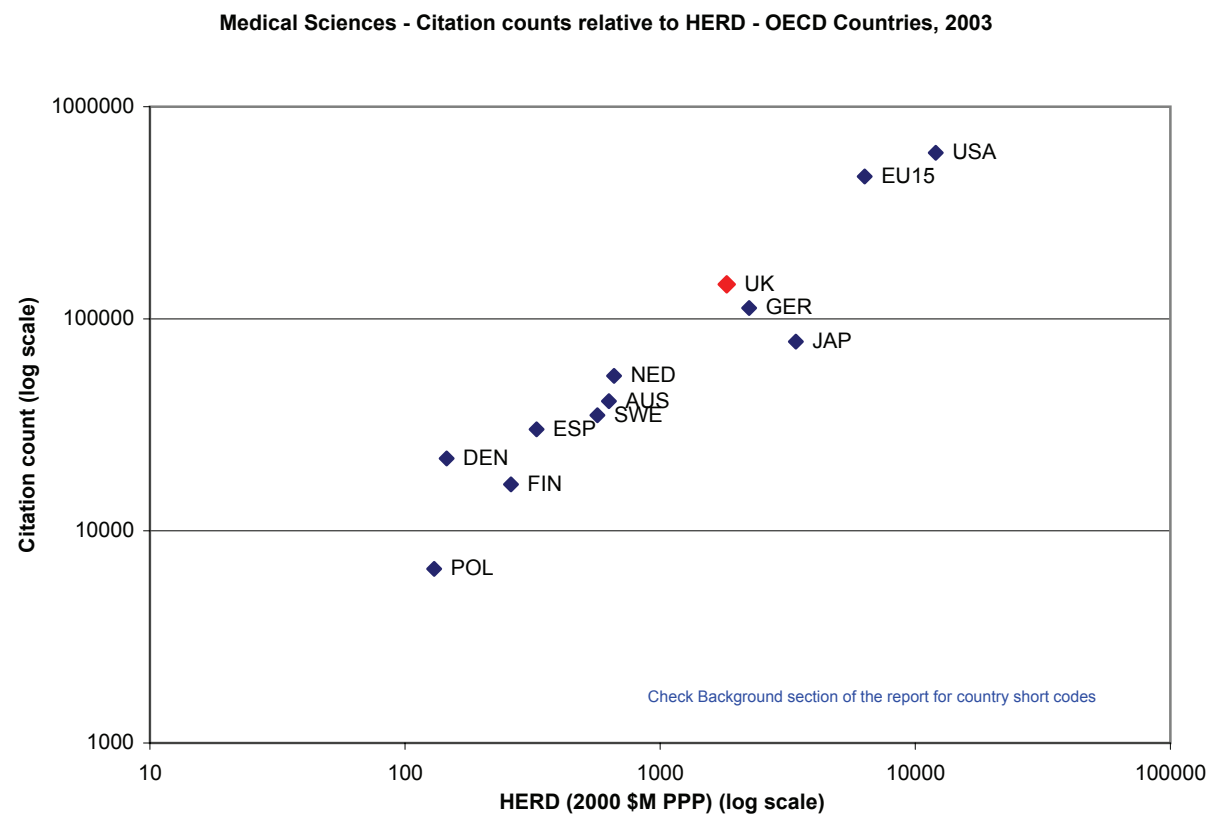|	Average 1998 - 2002	Actual 2003	Ratio or difference
UK HERD (2000 $M PPP)	1607	1821	1.13
UK citations per HERD (2000 $M PPP) - Actual	357.79	79.77	0.22
OST comparator group average citations per HERD (2000 $M PPP)	306.98	69.95	0.23
UK citations per HERD (2000 $M PPP) - Rank	3	4	-1
UK cites per HERD / OST comparator group average	1.17	1.14	

Medical Sciences - Citations per unit HERD rebased to OST comparator group average (= 1.0) for OECD nations

Data: Thomson ISI® National Science Indicators, OECD (RDS), UK SET statistics and HESA data

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Description of performance indicator
Condition signalling improvement

4.08 Citations relative to HERD in five main research fields
Increase in cites per unit spend at the OECD field level

Medical Sciences - Citation counts relative to HERD - OECD Countries, 2003

Check Background section of the report for country short codes

Data: Thomson ISI® National Science Indicators, OECD (RDS), UK SET statistics and HESA data

Description of performance indicator
Condition signalling improvement

4.08 Citations relative to HERD in five main research fields
Increase in cites per unit spend at the OECD field level

Natural Sciences

Indicator Headline

For some countries, both HERD and citation counts can be disaggregated by OECD field for analysis in this indicator.

For the Natural Sciences, the UK acquires more cites per unit HERD than the OST comparator group average and is ranked 1st among G8 nations, and 2nd behind the Netherlands overall. Recent UK performance is steady after a period of decline.
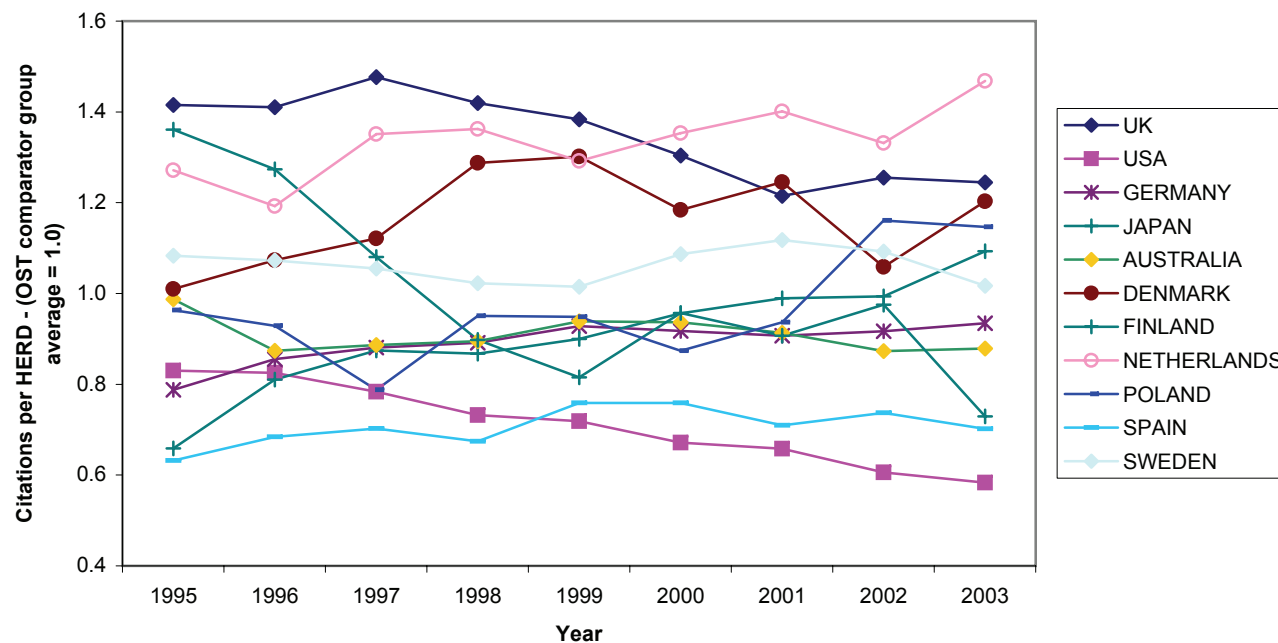
The USA is placed bottom of the OST nations in this indicator, and its performance continues to decline.

HERD is Expenditure on R&D performed in the Higher Education sector. Here, citation counts are compared with HERD. It is not implied that HE is the only agent acquiring citations, but in many research economies it is the major player.

	Average 1998 - 2002	Actual 2002	Ratio or difference
UK HERD (2000 $M PPP)	1918	2080	1.08
UK citations per HERD (2000 $M PPP) - Actual	254.94	61.66	0.24
OST comparator group average citations per HERD (2000 $M PPP)	190.60	49.53	0.26
UK citations per HERD (2000 $M PPP) - Rank	2	2	0
UK cites per HERD / OST comparator group average	1.34	1.24	

Natural Sciences - Citations per unit HERD rebased to OST comparator group average (= 1.0) for OECD nations

Data: Thomson ISI® National Science Indicators, OECD (RDS), UK SET statistics and HESA data

Description of performance indicator

4.08 Citations relative to HERD in five main research fields

Condition signalling improvement

Increase in cites per unit spend at the OECD field level

Natural Sciences - Citation counts relative to HERD - OECD Countries, 2003
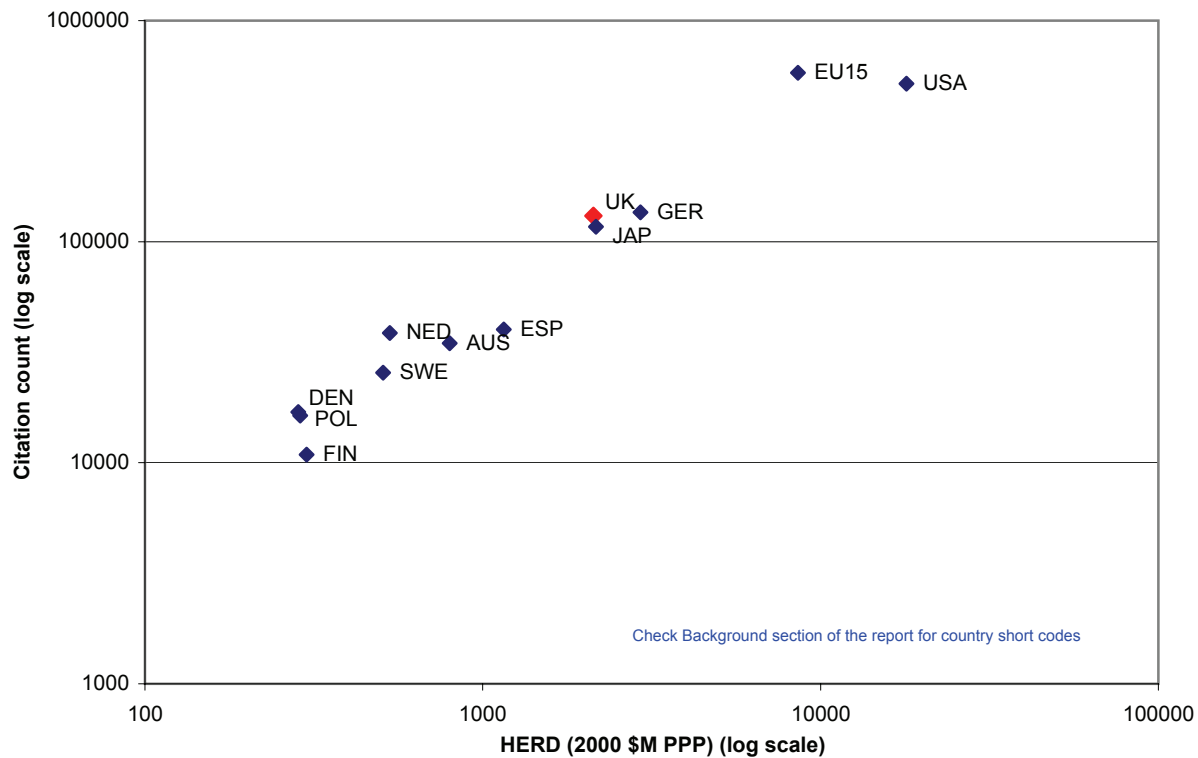

Data: Thomson ISI® National Science Indicators, OECD (RDS), UK SET statistics and HESA data

Description of performance indicator
Condition signalling improvement

4.08 Citations relative to HERD in five main research fields
Increase in cites per unit spend at the OECD field level

Engineering and Technology

Indicator Headline

For some countries, both HERD and citation counts can be disaggregated by OECD field for analysis in this indicator.

For Engineering and Technology, the UK acquires more cites per unit HERD than the OST comparator group average and is ranked 1st among G8 nations, and 2nd behind Denmark overall. Its recent performance shows a steady decline, however.

The USA is ranked 3rd, with Germany in 4th place, showing improvement over the period.

HERD is Expenditure on R&D performed in the Higher Education sector. Here, citation counts are compared with HERD. It is not implied that HE is the only agent acquiring citations, but in many research economies it is the major player.

	Average 1998 - 2002	Actual 2003	Ratio or difference
UK HERD (2000 $M PPP)	1045	1202	1.15
UK citations per HERD (2000 $M PPP) - Actual	58.17	12.25	0.21
OST comparator group average citations per HERD (2000 $M PPP)	45.35	11.38	0.25
UK citations per HERD (2000 $M PPP) - Rank	2	2	0
UK cites per HERD / OST comparator group average	1.28	1.08	

Engineering and Technology - Citations per unit HERD rebased to OST comparator group average (= 1.0) for OECD nations
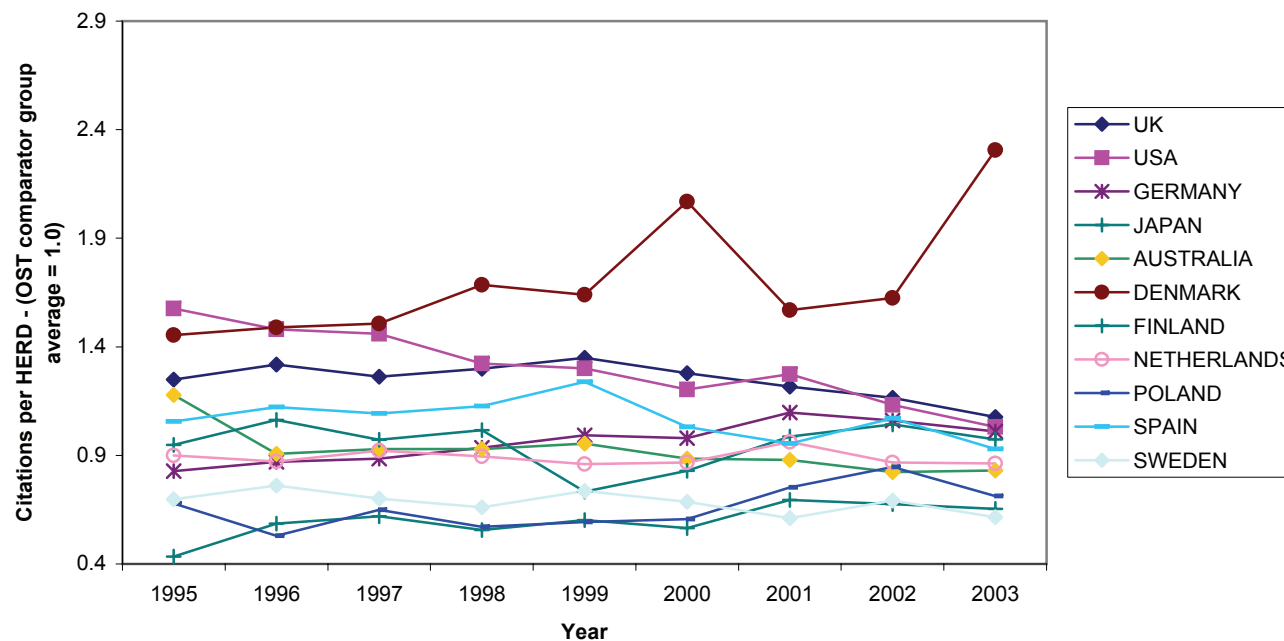
Data: Thomson ISI® National Science Indicators, OECD (RDS), UK SET statistics and HESA data

Description of performance indicator
Condition signalling improvement

4.08 Citations relative to HERD in five main research fields
Increase in cites per unit spend at the OECD field level

Engineering and Technology - Citation counts relative to HERD - OECD Countries, 2003
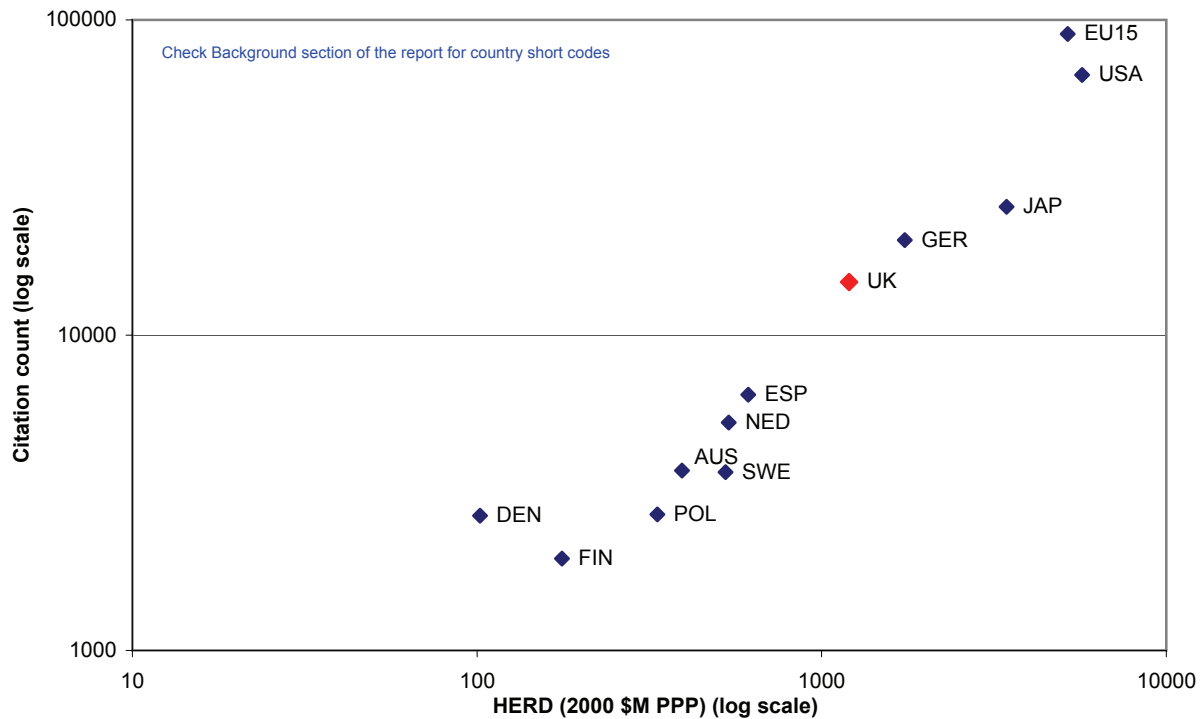

Data: Thomson ISI® National Science Indicators, OECD (RDS), UK SET statistics and HESA data

Description of performance indicator
Condition signalling improvement

4.08 Citations relative to HERD in five main research fields
Increase in cites per unit spend at the OECD field level

Social Sciences

Indicator Headline

For some countries, both HERD and citation counts can be disaggregated by OECD field for analysis in this indicator.

Bibliometric data for the Social Sciences cannot be compared directly with other disciplines. Recent work has shown that European comparisons must be made with caution.

For the Social Sciences, the UK acquires more cites per unit HERD than the OST comparator group average and is ranked 2nd behind the USA overall. Its recent profile shows a steady performance, while the USA is declining.

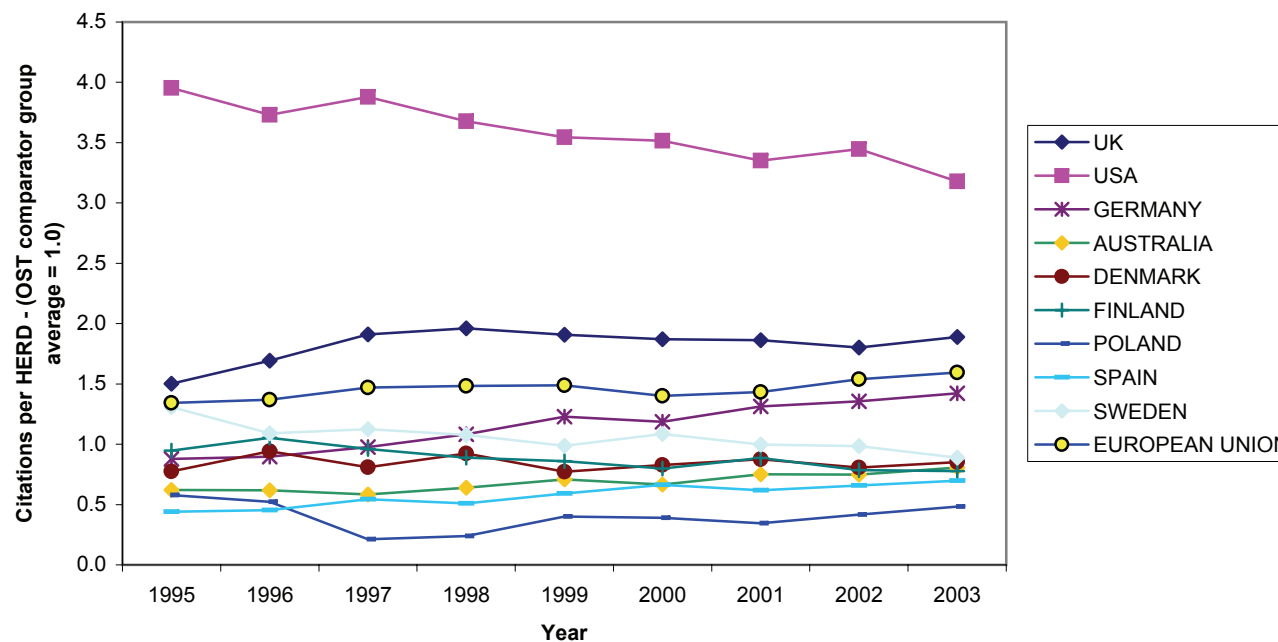Germany is ranked 3rd, showing improvement over the period.

The EU15 line should be regarded with caution. The OECD data do not accurately reflect a true sum and the index is therefore over-inflated.

HERD is Expenditure on R&D performed in the Higher Education sector. Here, citation counts are compared with HERD. It is not implied that HE is the only agent acquiring citations, but in many research economies it is the major player.

	Average 1998 - 2002	Actual 2003	Ratio or difference
UK HERD (2000 $M PPP)	738	860	1.16
UK citations per HERD (2000 $M PPP) - Actual	119.93	22.47	0.19
OST comparator group average citations per HERD (2000 $M PPP)	63.05	11.89	0.19
UK citations per HERD (2000 $M PPP) - Rank	2	2	0
UK cites per HERD / OST comparator group average	1.90	1.89	

Social Sciences - Citations per unit HERD rebased to OST comparator group average (= 1.0) for OECD nations

Data: Thomson ISI® National Science Indicators, OECD (RDS), UK SET statistics and HESA data

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Description of performance indicator
Condition signalling improvement

4.08 Citations relative to HERD in five main research fields
Increase in cites per unit spend at the OECD field level

Social Sciences - Citation counts relative to HERD - OECD Countries, 2003

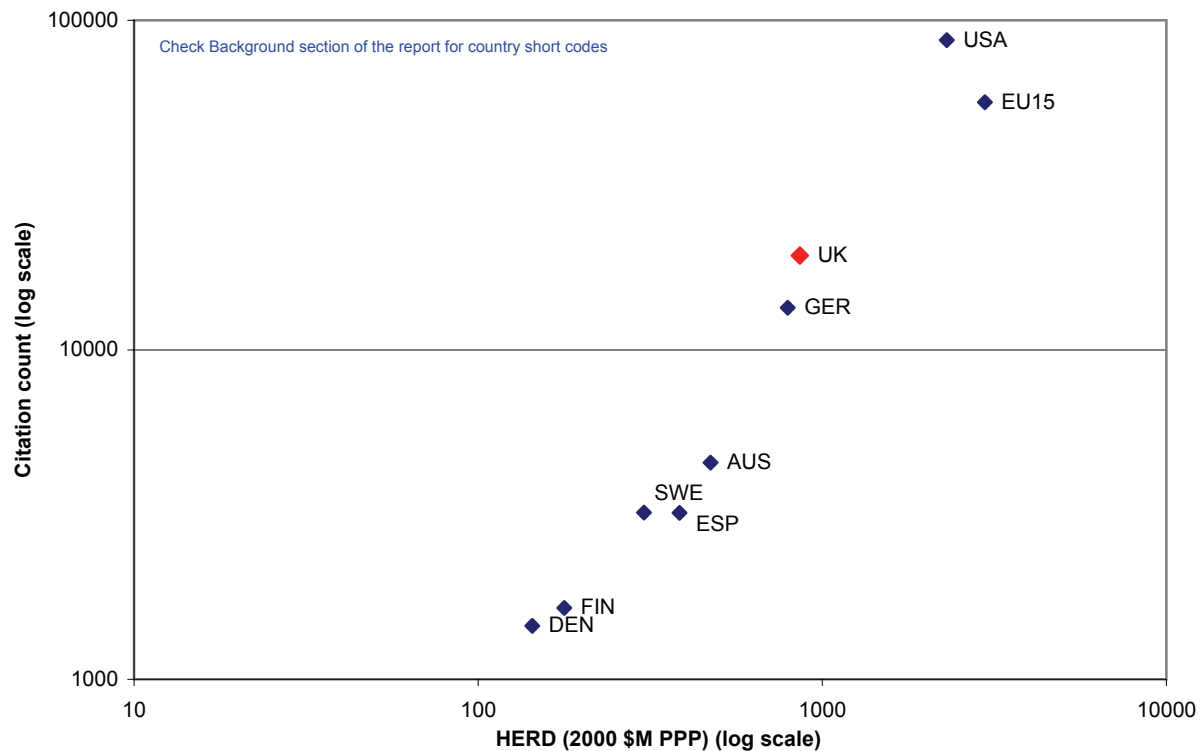Check Background section of the report for country short codes

Data: Thomson ISI® National Science Indicators, OECD (RDS), UK SET statistics and HESA data

Description of performance indicator
Condition signalling improvement

4.08 Citations relative to HERD in five main research fields
Increase in cites per unit spend at the OECD field level

Humanities

Indicator Headline

This is the first time that data on the Humanities have been analysed for this indicator.

For some countries, both HERD and citation counts can be disaggregated by OECD field for analysis in this indicator.

For the Humanities, the UK acquires roughly three times more cites per unit HERD than the OST comparator group average and is ranked 1st. Its recent performance shows a modest decline, but no other nation's performance is close.

As is widely understood, citations in this field are extremely low compared with other fields.

HERD is Expenditure on R&D performed in the Higher Education sector. Here, citation counts are compared with HERD. It is not implied that HE is the only agent acquiring citations, but in many research economies it is the major player.

	Average 1998 - 2002	Actual 2003	Ratio or difference
UK HERD (2000 $M PPP)	405	498	1.23
UK citations per HERD (2000 $M PPP) - Actual	5.24	1.14	0.22
OST comparator group average citations per HERD (2000 $M PPP)	1.09	0.27	0.25
UK citations per HERD (2000 $M PPP) - Rank	1	1	0
UK cites per HERD / OST comparator group average	4.82	4.18	

Humanities - Citations per unit HERD rebased to OST comparator group average (= 1.0) for OECD nations
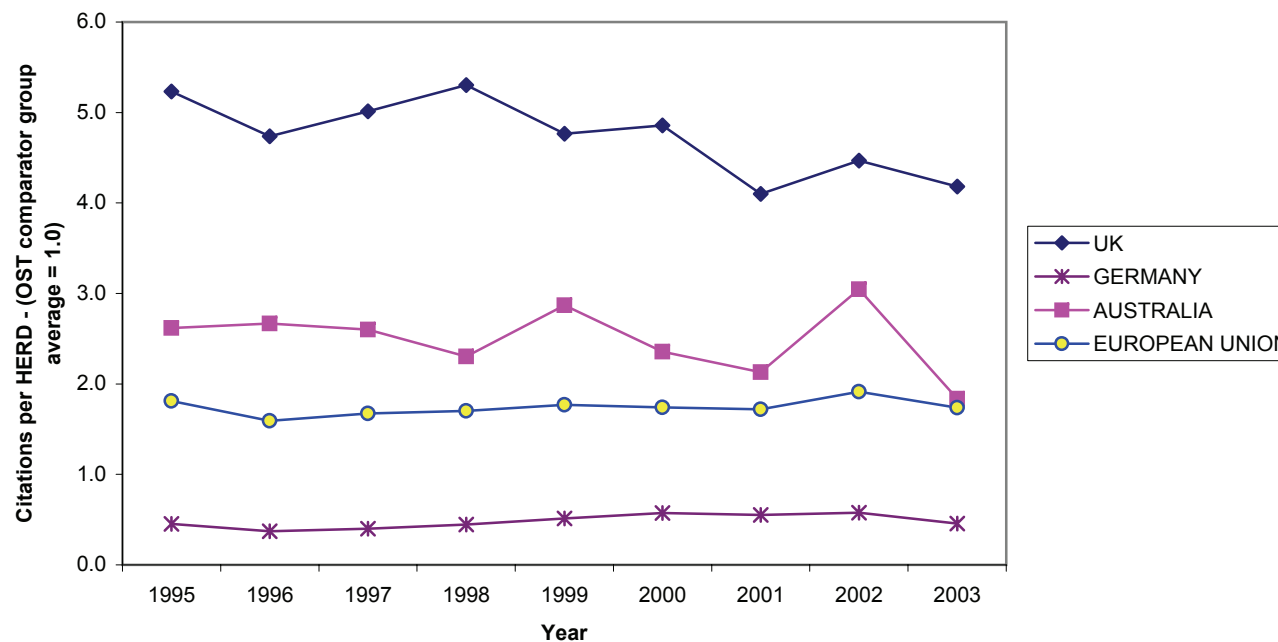
Data: Thomson ISI® National Science Indicators, OECD (RDS), UK SET statistics and HESA data

Description of performance indicator
Condition signalling improvement

4.08 Citations relative to HERD in five main research fields
Increase in cites per unit spend at the OECD field level

Humanities - Citation counts relative to HERD - OECD Countries, 2003
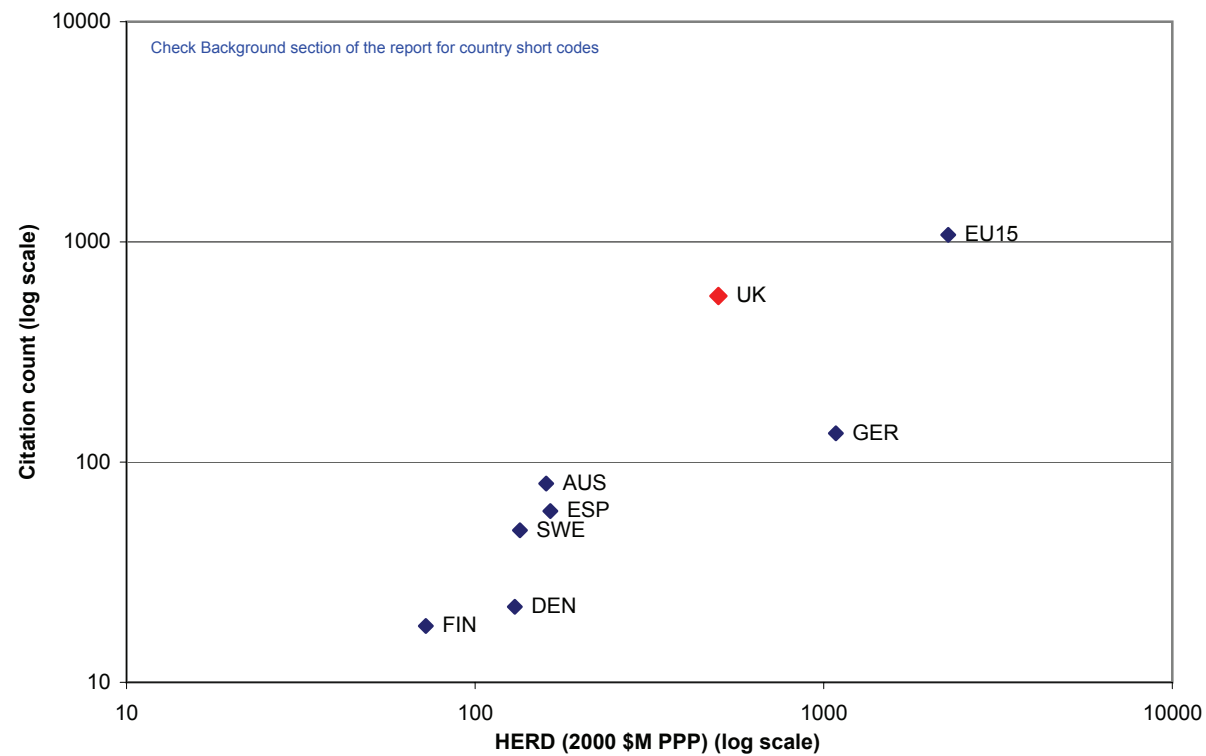

Data: Thomson ISI® National Science Indicators, OECD (RDS), UK SET statistics and HESA data

Description of performance indicator
Condition signalling improvement

5.01 PhDs awarded per researcher
Increased ratio

Indicator Headline

The labour productivity of the research base is measured by the volume of outputs compared to the numbers of highly skilled people contributing to research.

This indicator is also one of sustainability. It measures the relationship between the volume of 'researchers' (see definition in Glossary) already in the research base and the output of highly skilled people gaining research degrees.

The UK is ranked 2nd behind Germany within the G8 in terms of PhD awards per researcher, and 4th within the OST comparator group (behind Switzerland and Spain). The UK has remained well ahead of the OST comparator group average throughout the period.

The number of PhD awards per researcher in the UK has declined in the most recent year. Over the 4-year period it has shown apparent growth of 15%, but this is largely due to data adjustment. UK data for 2001 are affected by a change in HESA data collection.

Both Japan and Belgium have seen increases in this indicator of nearly 30% and more than 40% respectively. Japan trails the G8, however, by a significant margin.

Both the EU average and the USA average are falling over the period. This may have implications for planning as it will affect the availability of highly skilled people.

There are no data for China.

	Average 1999 - 2001	Actual 2002	Ratio or difference
UK PhDs awarded per researcher - Actual	0.07	0.08	1.11
OST comparator group average - PhDs awarded per researcher	0.06	0.06	0.99
UK PhDs awarded per researcher - Rank	5	4	1
UK PhDs awarded per researcher / OST comparator group average PhDs awarded per researcher	1.21	1.36	1.12

PhDs per FTE researcher, G8 nations (no data for Russia)
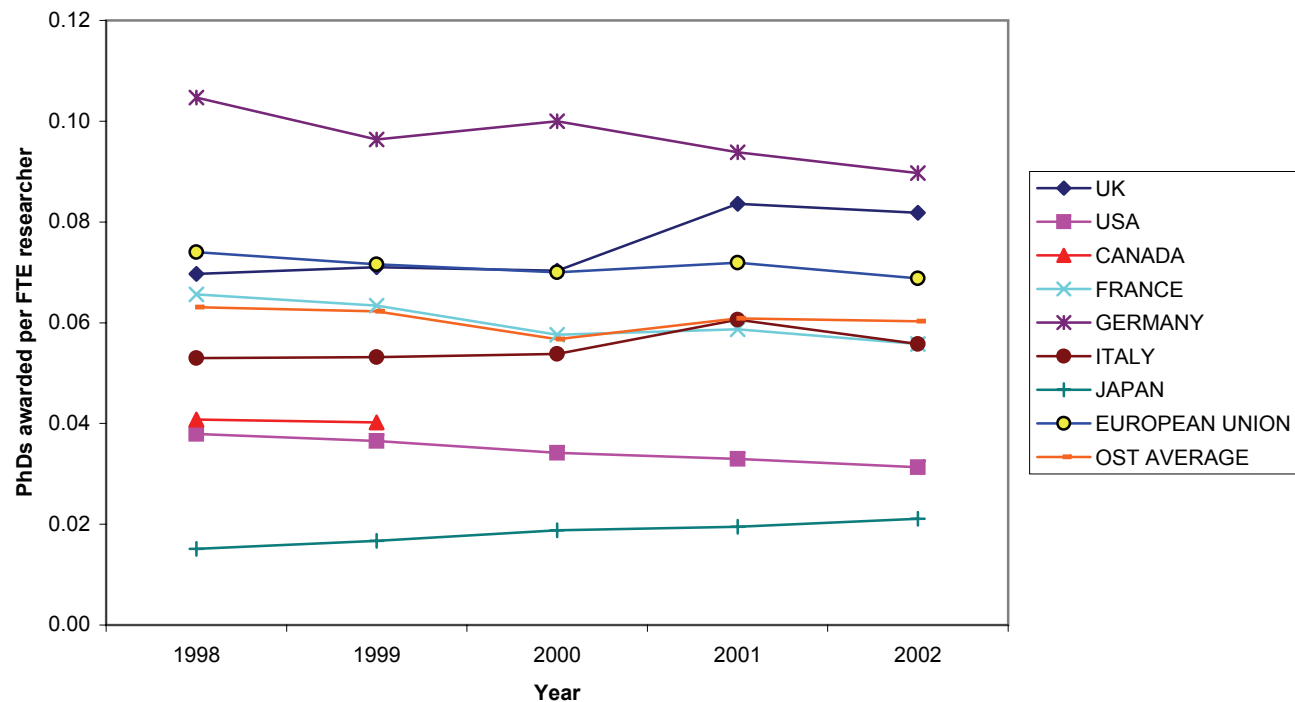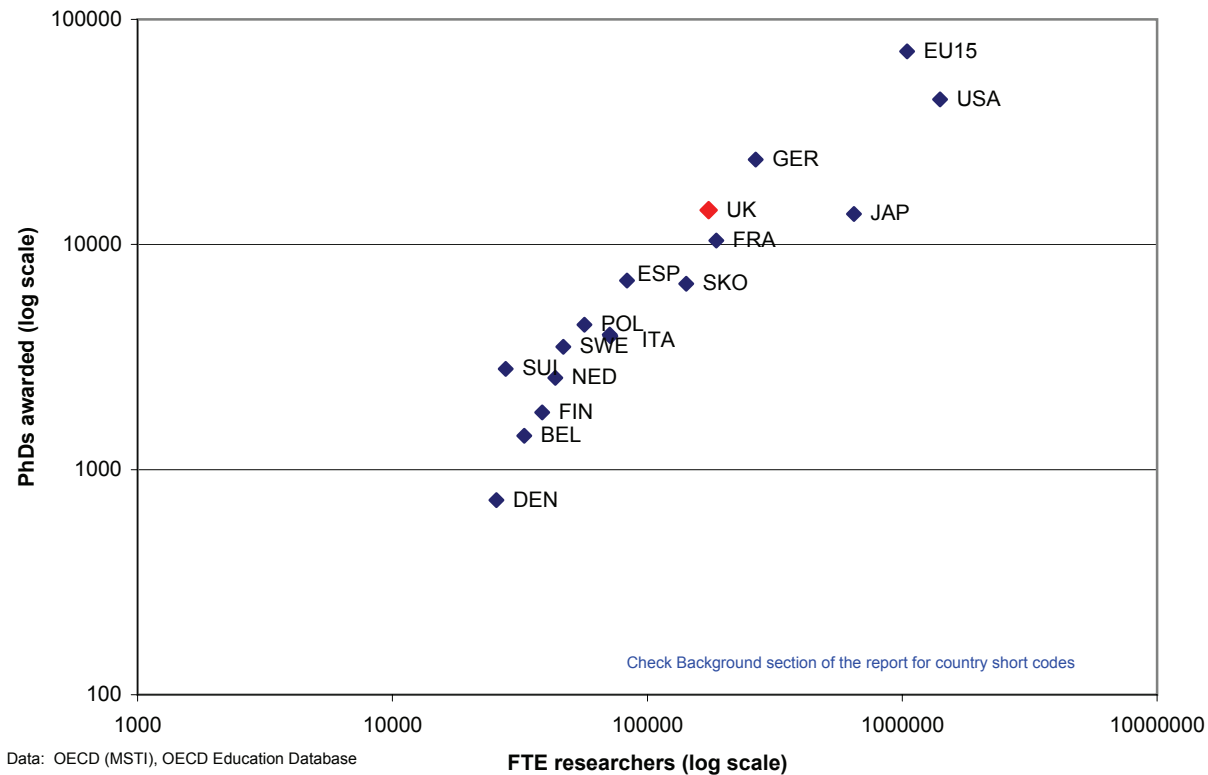

Data: OECD (MSTI), OECD Education Database

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Description of performance indicator
Condition signalling improvement

5.01 PhDs awarded per researcher
Increased ratio

PhDs awarded per researcher - OST comparator group nations, 2002

Data: OECD (MSTI), OECD Education Database

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Description of performance indicator
Condition signalling improvement

5.02 Publications per researcher
Increased relative output

Indicator Headline

Research culture is reflected in the numbers of publications in international journals that are produced by each researcher active within the research base.

The UK's recent (2.17 papers/FTE) and current (2.08 papers/FTE) performance is 3rd to Switzerland (2.69, 2.61) and the Netherlands (2.32, 2.22) as an average for the recent period (1998-2002) and for 2003. [Italy - see below].

The UK's ratio of papers per researcher has fallen between the recent period and 2003. For the OST comparator group, the average number of papers per researcher also fell slightly during this period.

UK output per researcher remains much higher than the OST comparator group average. In absolute terms the UK relative output has improved to more than twice that of the USA.

The UK ranks first in the G8 for the average recent period whereas several of the G8 are below the OST comparator group average. The performance of the EU15 has been fairly stable over the 10-year period at around 1.4 to 1.5 papers per researcher whilst the USA output has declined from 1.2 down to 0.95 papers/FTE.

China's productivity has doubled over the ten years, but is only one-tenth that of the UK.

Italy's indexed papers/FTE researcher has increased. This may be an artefact, however, because of a diminishing researcher base. That decline has stabilised, so a continuing upward trend would indicate genuine improvement.

	Average 1998 - 2002	Actual 2003	Ratio or difference
UK papers per researcher - Actual	2.17	2.08	0.96
OST comparator group average papers per researcher	1.38	1.35	0.97
UK papers per researcher - Rank	3	4	-1
OST comparator group average compared to UK (UK=1)	0.62	0.63	1.02

Ratio of publications to FTE researchers for G8 nations
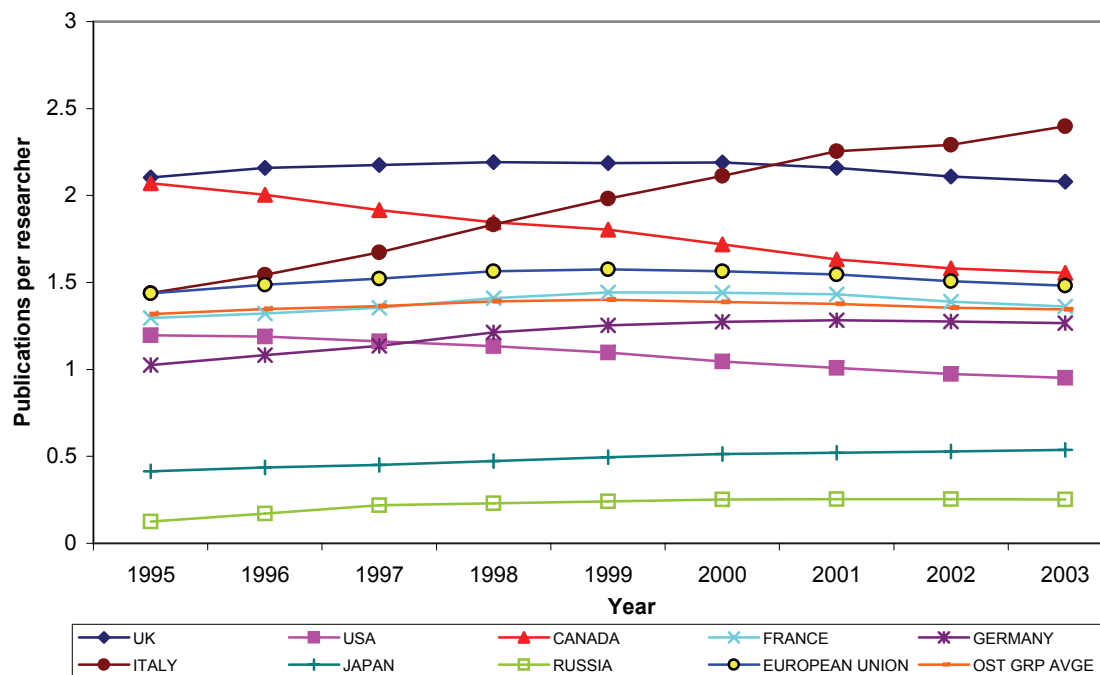
Data: Thomson ISI® National Science Indicators, OECD (MSTI)

Description of performance indicator
Condition signalling improvement

5.02 Publications per researcher
**Increased relative output**

Indicator Headline cont.

This is a simple indicator that compares the number of national publications in journals recorded on Thomson Scientific® database with the numbers of 'researchers' recorded on OECD databases. Productivity increases with the number of publications per capita, by definition. In fact, because publications here are indexed only from international databases, this is also a reflection of quality since there will be other publications for each country that appear only in more specialist, local and national-quality journals.

Unfortunately, these data cannot be disaggregated below national level. 'Researcher' information held by OECD is only available at the level of the major research fields within the HE sector, and even here, UK data is not supplied to OECD in this form as HESA does not collect data about managers and technicians in HE. This index is calculated only for the research base as a whole.

Publications on ISI databases and numbers of researchers
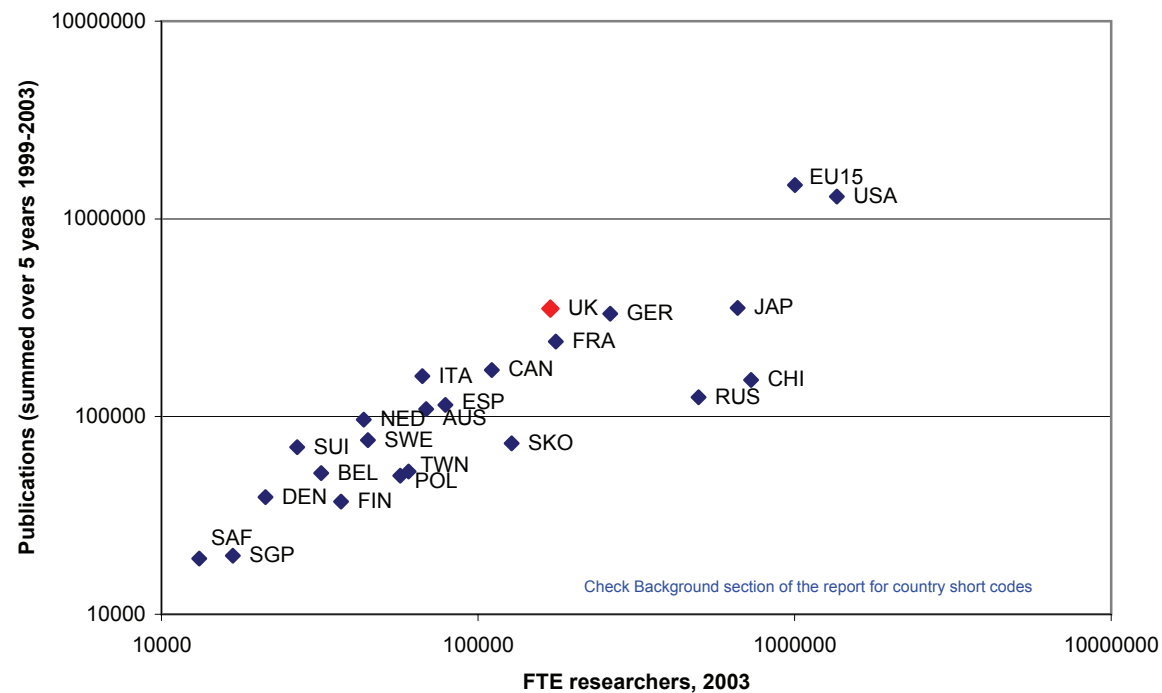
Check Background section of the report for country short codes

Data: Thomson ISI® National Science Indicators, OECD (MSTI)

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Description of performance indicator
Condition signalling improvement

5.03 Citations per researcher
Increase in citation ratio

Indicator Headline

As with indicator 5.02, this is a simple and readily understood index calculated at the level of the research base as a whole.

Gross output per capita in international journals is a good measure of volume of research activity. It is also important to consider the effectiveness of that output by measuring the citations they generate: in other words, we need a measure of quality as well as quantity.

For the UK, there has been a clear and substantial trend of improvement in citations per researcher throughout the 10-year time period, indicating a relative improvement in research quality as measured by peer esteem.

The UK's relative international position has improved in line with that of Switzerland and the Netherlands. Along with Denmark, these nations have an average of more than 10 citations per researcher per year over the 10-year period.

China's rapidly increasing output (see 2.03) is generated by a huge researcher population. Its impact still lags (see 3.01) and its effectiveness by this indicator is less than 0.5 citations per FTE researcher at present.

Italy has nominally overtaken the UK this year, but reservations about the apparent Italian performance (see Indicator 5.02) apply here also.

cont./

	Average 1998 - 2002	Actual 2003	Ratio or difference
UK citations per researcher - Actual	10.29	11.09	1.08
OST comparator group average citations per researcher	5.96	6.45	1.08
UK citations per researcher - Rank	3	4	-1
OST comparator group average compared to UK (UK=1)	0.56	0.56	1.00

Numbers of citations per researcher for G8 nations
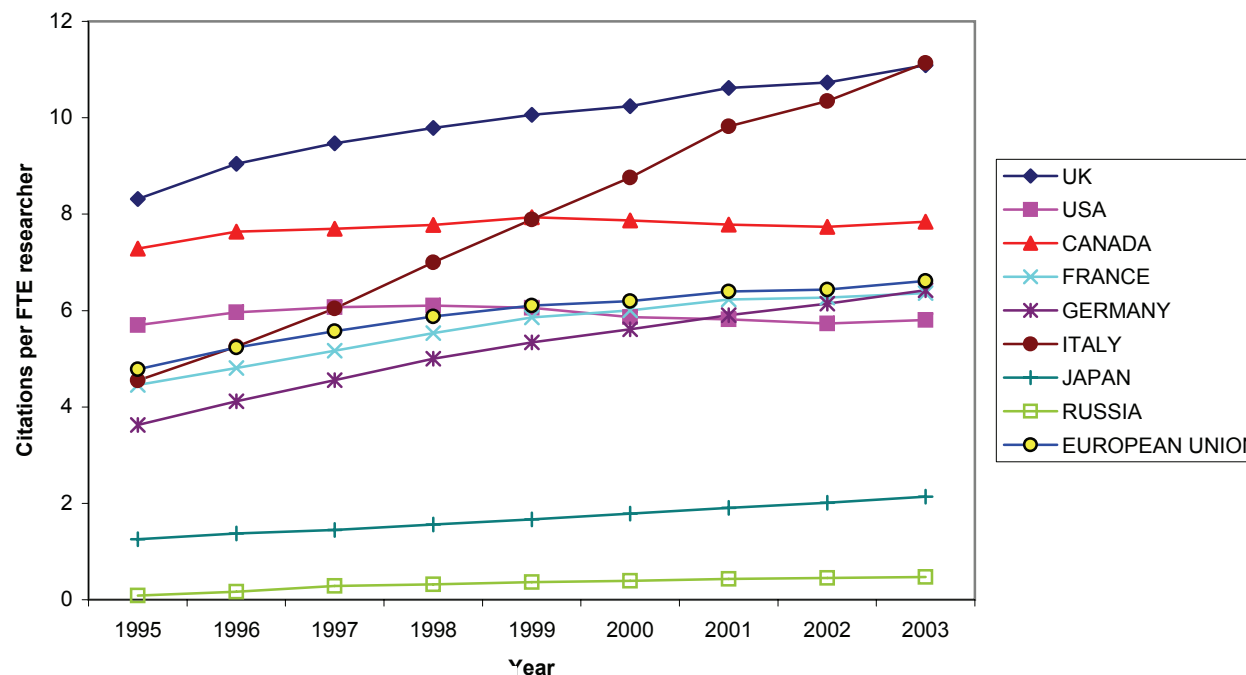
Data: Thomson ISI® National Science Indicators, OECD (MSTI)

Description of performance indicator
Condition signalling improvement

5.03 Citations per researcher
Increase in citation ratio

Indicator Headline cont.

The UK output of citations per FTE researcher has consistently increased by around 6% per annum. This is similar to the improvement shown by Germany. However, the UK accrues almost twice as many citations per researcher as either Germany or the USA, and performs better in this indicator than the G8 nations and compared to OST comparator group average.

The EU15 citations/researcher have increased over the 10-year time period (from 4.8 to 6.6) whilst the USA index has not (remaining steady at around 5.7 to 5.8).

Citations accumulate over time and on average are usually fewer in more recent years. Constant 5-year windows for citation counts are used in this indicator to adjust for appropriate comparisons between periods.
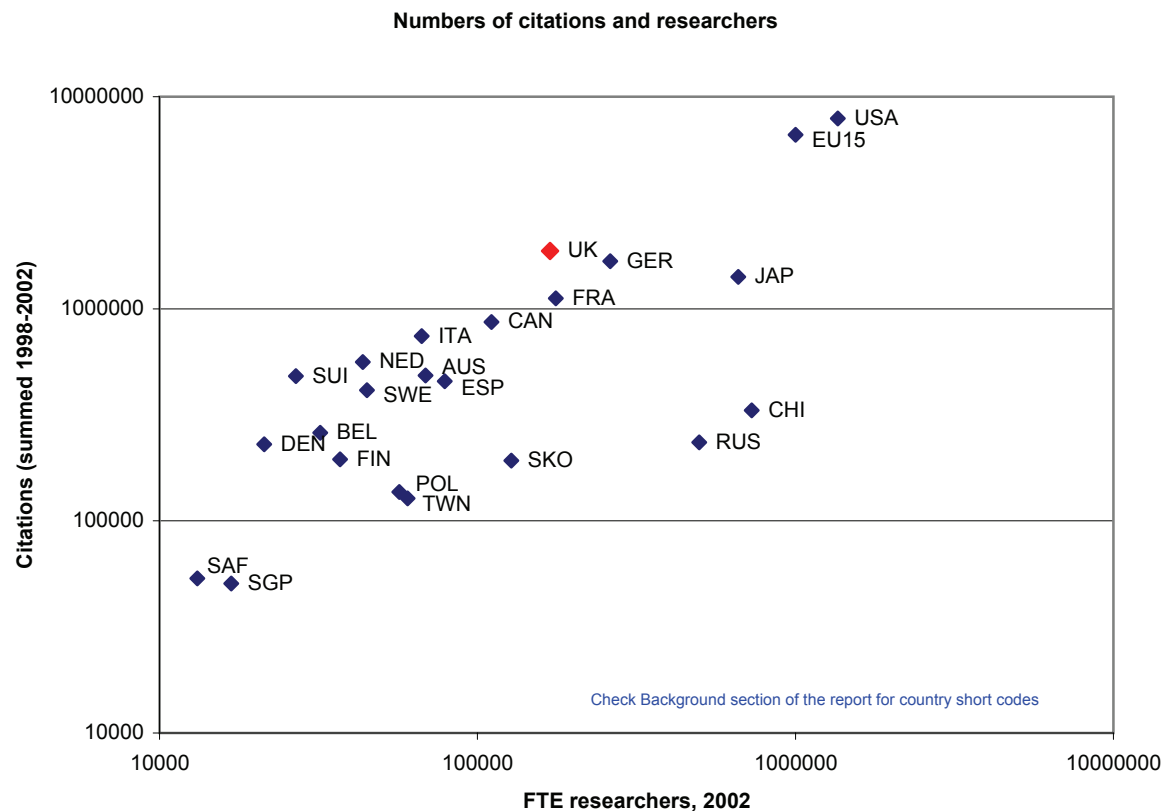
Numbers of citations and researchers

Check Background section of the report for country short codes

Data: Thomson ISI® National Science Indicators, OECD (MSTI)

Description of performance indicator
Condition signalling improvement

6.01 Researchers per thousand population
Increased ratio

Indicator Headline

The numbers of researchers in the population as a whole provides a measure of the resource capacity of each country in regard to research innovation, and an indication of the technological orientation of the country.

Researchers (see Glossary definition) constitute less than 0.5% of the population in those countries in the OST comparator group for which data are available (22 countries).

For the UK, researchers as a percentage of the total population has again risen slightly in 2003 compared to the average for the recent past. This is part of a gradual longer term trend and is similar to but slightly lower than the average rise for the OST comparator group as a whole.

The UK proportion of researchers in the population is much lower than for most of the G8 nations and below that of the OST comparator group average. The UK rank amongst the OST comparator group in this indicator has remained steady at around 14.

Many research economies elsewhere in Europe have increased their relative researcher population by a greater percentage than the UK and other G8 nations.

China has a much smaller relative researcher population but this has risen from 0.04% in 1995 to 0.07% in 2003. The total is about half that of the USA.

	Average 1998 - 2002	Actual 2003	Ratio or difference
UK researchers as a percentage of total population - Actual	0.28	0.30	1.07
OST comparator group average - researchers as a percentage of total population	0.31	0.34	1.11
UK researchers as a percentage of total population - Rank	14	15	1
UK researchers as a percentage of total population / OST comparator group average researchers as a percentage of total population	0.91	0.88	

Researchers compared with total population, G8 nations
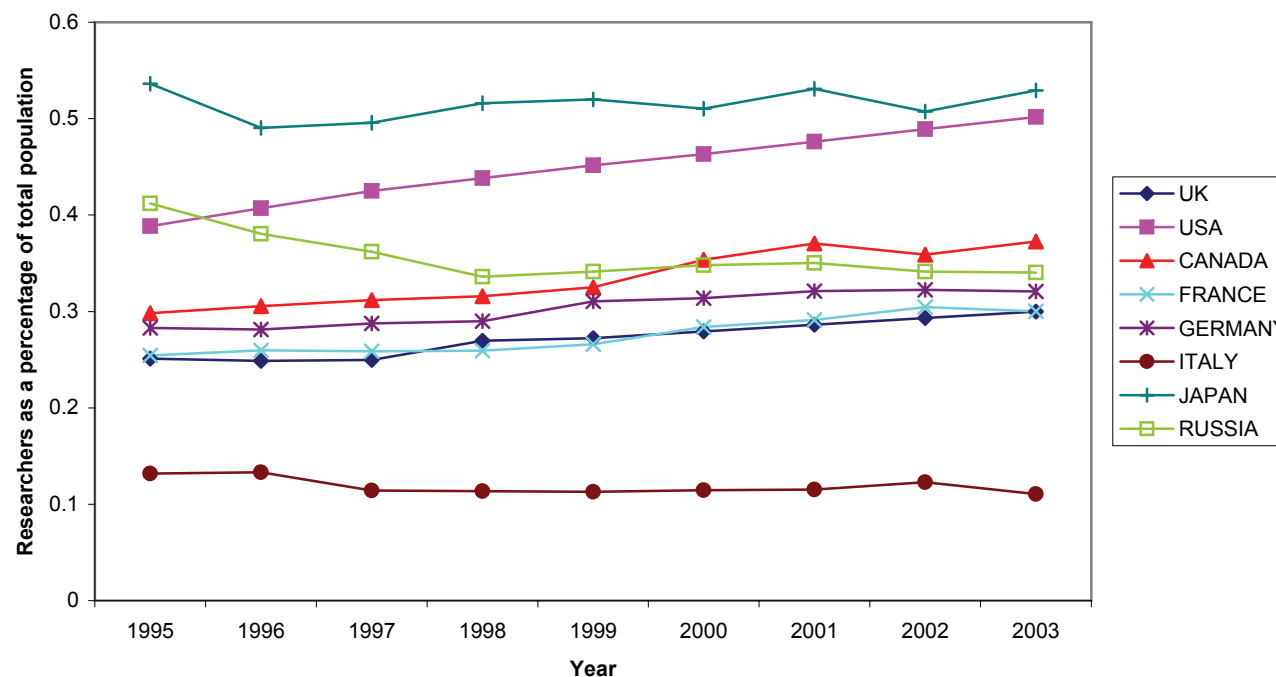
Data: OECD (MSTI)

Description of performance indicator
Condition signalling improvement

6.01 Researchers per thousand population
Increased ratio

Numbers of researchers compared with total population - OST comparator nations, 2003

Check Background section of the report for country short codes

- Researchers (log scale) [y-axis]
- Population in thousands (log scale) [x-axis]

USA
EU15
CHI
JAP
RUS
FRA GER
UK
SKO
CAN
ESP
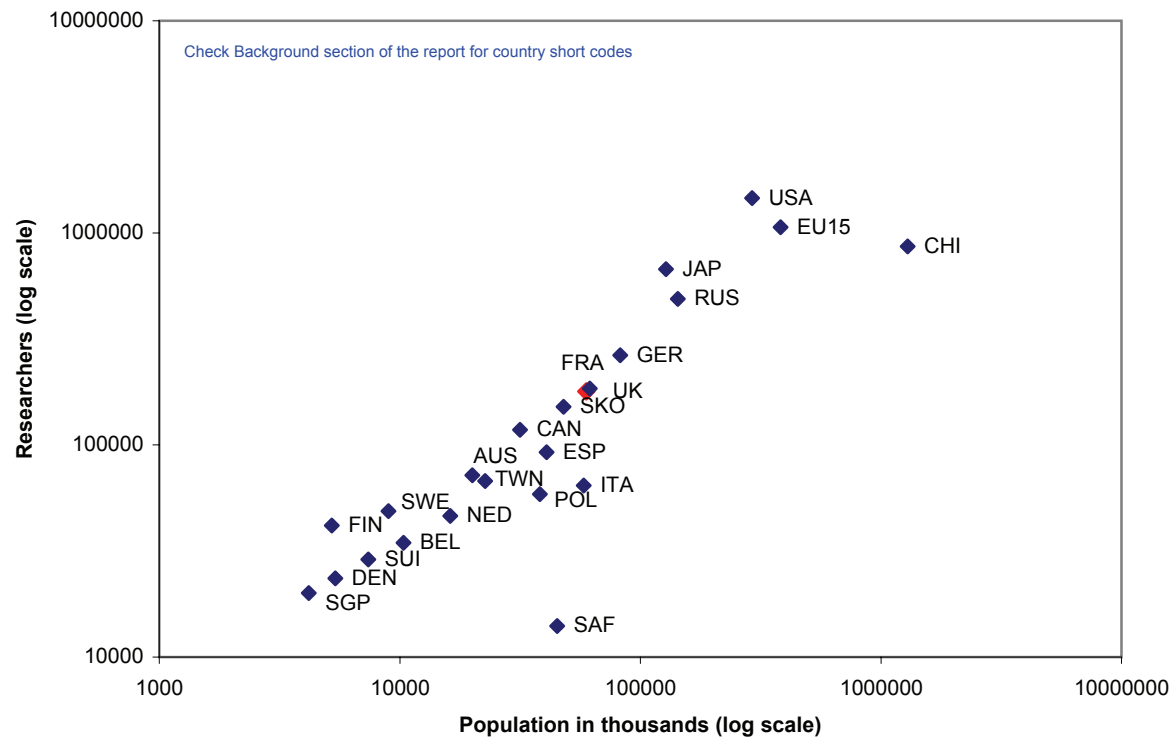AUS
TWN
ITA
SWE
POL
NED
FIN
BEL
SUI
DEN
SGP
SAF

Data: OECD (MSTI)

Description of performance indicator
Condition signalling improvement

6.02 Researchers per thousand workforce
Increased ratio

Indicator Headline

The numbers of researchers in the workforce provides a measure of the resource capacity of each country in regard to research innovation.

The UK continues to perform poorly compared to the other G8 nations in this indicator. The USA proportion of researchers in the workforce continues to rise (9.1 per 1000 workforce, recent average) and is well ahead of the UK (5.6 per 1000 workforce). Finland remains the leader for this indicator with 13.4 researchers per 1000 workforce. Japan and Sweden are both around the same recent average proportion as the USA (9.7 per 1000 workforce in both countries).

The UK's volume of researchers as a proportion of the workforce has increased from 5.1 per 1000 workforce in 1995 to 5.9 per 1000 workforce in 2003. The ratio between the latest year and the recent past is in line with this trend.

The UK has been consistently ranked around 15th over the longer period. Since 2001, however, both South Korea and Taiwan have moved ahead of the UK. Recent change for the UK is similar to but less than the OST comparator group average. The UK remains more than 10% below average for the OST comparator group of 22 countries for which data were available.

Researchers (see Glossary definition) make up a specific subcategory of R&D personnel, and provide a particular measure of research capacity. Both these terms are somewhat broadly defined and there may be inconsistency between national figures.

	Average 1998 - 2002	Actual 2003	Ratio or difference
UK researchers per 1000 workforce - Actual	5.61	5.92	1.05
OST comparator group average - researchers per 1000 workforce	6.21	6.85	1.10
UK researchers per 1000 workforce - Rank	15	17	-2
UK researchers per 1000 workforce / OST comparator group average researchers per 1000 workforce	0.90	0.86	

Researchers per 1000 workforce, G8 nations
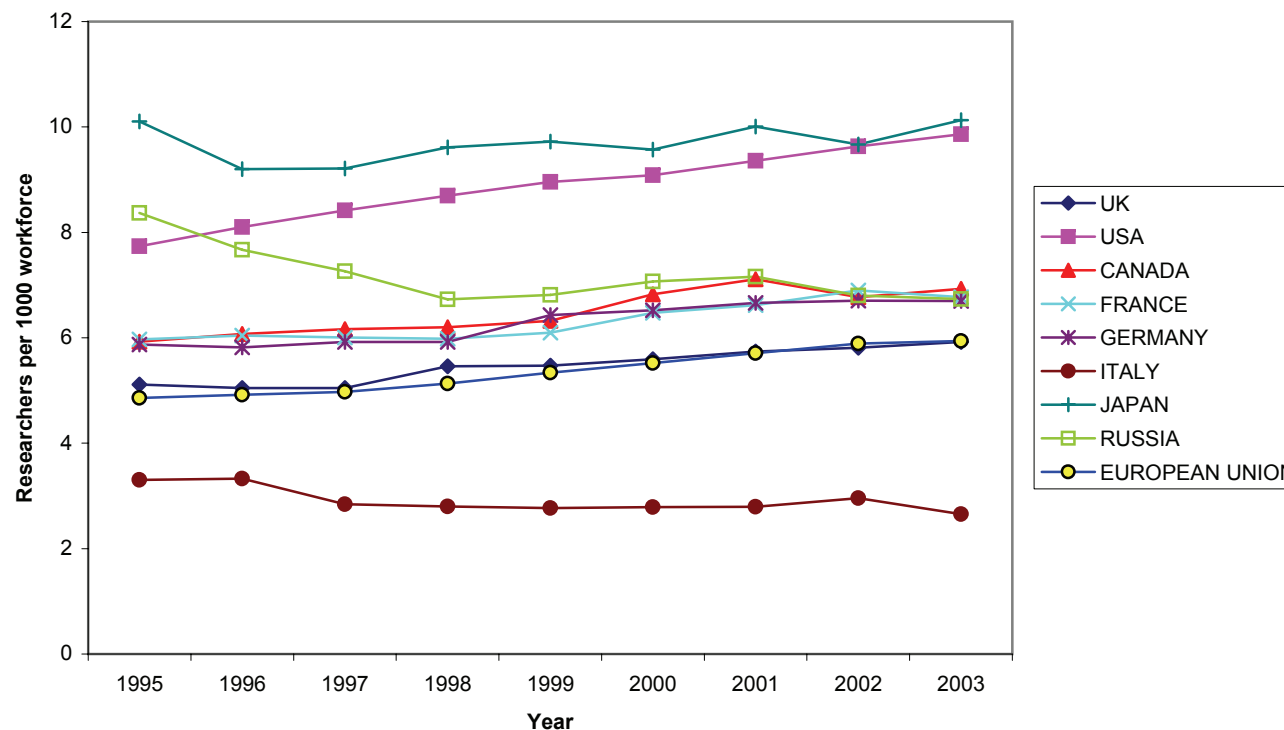
Data: OECD (MSTI)

6.02 Researchers per thousand workforce
Increased ratio

Comparison between numbers of researchers and size of total workforce - OST comparator nations, 2003
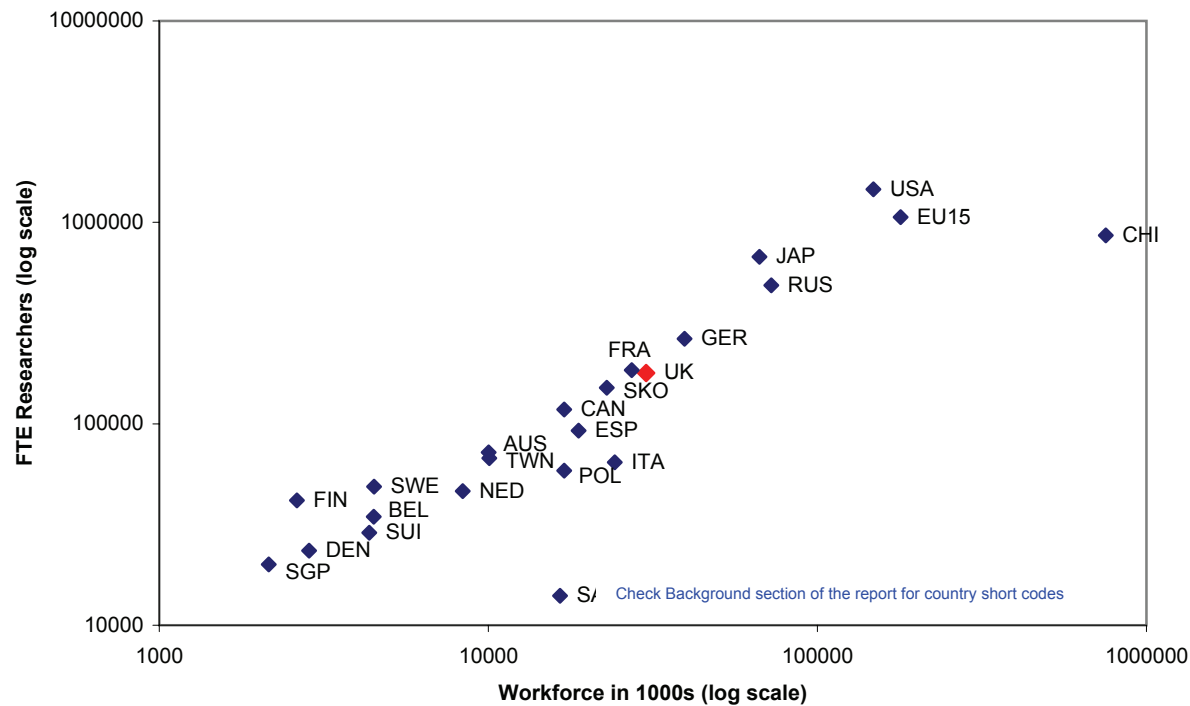
Check Background section of the report for country short codes

Data: OECD (MSTI)

Description of performance indicator
Condition signalling improvement

6.03 R&D personnel per hundred population
Increased ratio

Indicator Headline

The numbers of R&D personnel in the population as a whole provides a measure of the highly-qualified human knowledge base of each country in regard to research and development, and an indication of the technological orientation of the country.

The UK proportion of R&D personnel has remained at around 0.45%. Amongst the G8 nations (the USA is not included in this indicator), the UK has a lower proportion of R&D personnel in the population than every member, except Italy. Within the OST comparator group as a whole the UK is ranked 15th, a decline of 3 positions since 1995. The UK has also dropped below EU15 average.

R&D personnel account for just over 0.5% of the workforce, on average, in the 21 OST comparator group countries for which data are available (there is no data available for the USA).

The OST comparator group average has improved steadily from 0.45% in 1995 to 0.53% in 2003.

R&D personnel (see Glossary definition) provide a general measure of research capacity, of which researchers (see Glossary definition) are a particular set. Both these terms are somewhat broadly defined and there may be inconsistency between national figures.

	Average 1998 - 2002	Actual 2003	Ratio or difference
UK R&D personnel as a percentage of total population	0.46	0.45	0.98
OST comparator group average - R&D personnel as a percentage of total population	0.50	0.53	1.07
UK R&D personnel as a percentage of total population - Rank	14	15	-1
UK R&D personnel as a percentage of total population / OST comparator group average R&D personnel as a percentage of total population	0.93	0.85	

R&D personnel as a percentage of total population G8 nations (no data for USA)
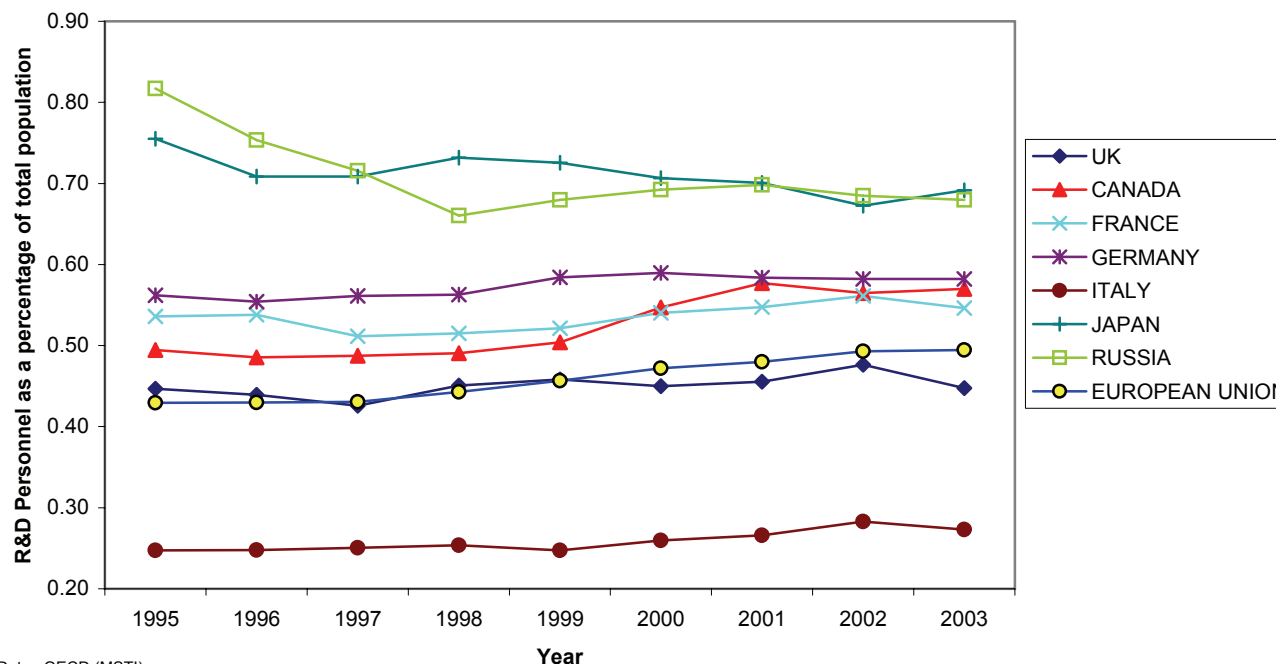
Data: OECD (MSTI)

Description of performance indicator
Condition signalling improvement

Indicator Headline cont.

For some countries in the OST comparator group this index has shown consistent year-on-year growth resulting in substantial overall improvements across the 10-year period for Singapore, the Scandinavian countries and to a lesser extent, Belgium and Spain. In 2003, these countries, with the exception of Spain, all had more R&D personnel per 1000 population than the UK.

6.03 R&D personnel per hundred population
Increased ratio

Numbers of R&D personnel compared with total population - OST comparator nations, 2003
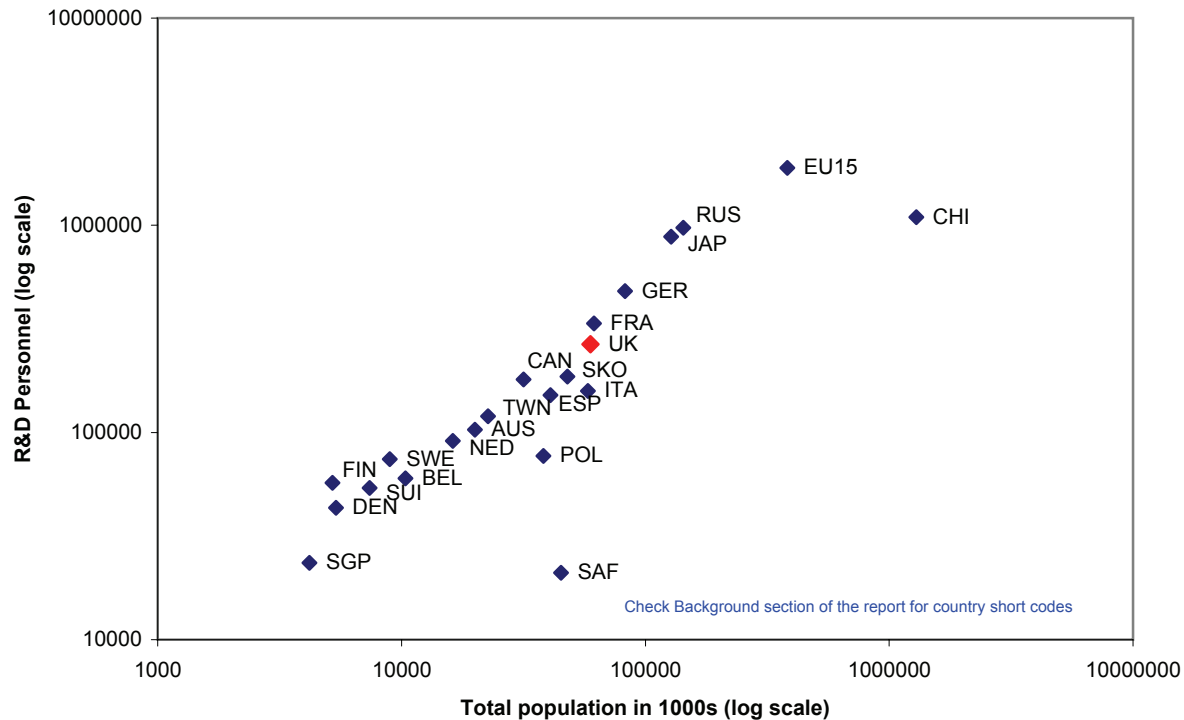
Data: OECD (MSTI)

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Description of performance indicator
Condition signalling improvement

6.04 R&D personnel per hundred workforce
Increased ratio

Indicator Headline

The numbers of R&D personnel in the workforce provides a measure of the highly-qualified human knowledge base of each country in regard to research development.

The UK has less than 1% of its workforce classified as R&D personnel in OECD data and its relative concentration has declined while the average has improved. The UK percentage has fluctuated around 0.9% in the last 10 years but has not changed significantly. The pattern has generally been slightly better for other G8 nations, except Russia.

The UK is below the OST comparator group average, which increased steadily over the last decade. The OST comparator group average (over 1% of workforce) is for a group of 21 countries, excluding the USA, for which data are available. Within this group the UK has been ranked 14th in most years. This index has changed little for the UK whilst the OST comparator group average and the EU15 average have increased, reducing the UK 'share' of the total. Meanwhile smaller countries including Singapore, the Scandinavian countries and Belgium have moved ahead of the average.

It might be expected that R&D personnel should increase as a proportion of workforce in a knowledge-based economy, but issues of classification may affect data reporting.

R&D personnel (see Glossary definition) provide a general measure of research capacity, of which researchers (see Glossary definition) are a specific part. Both these terms are somewhat broadly defined and there may be inconsistency between national figures.

	Average 1998 - 2002	Actual 2003	Ratio or difference
UK R&D personnel as a percentage of workforce - Actual	0.92	0.88	0.96
OST comparator group average - R&D personnel as a percentage of workforce	1.01	1.07	1.06
UK R&D personnel as a percentage of workforce - Rank	14	15	-1
UK R&D personnel as a percentage of workforce / OST comparator group average R&D personnel as a percentage of workforce	0.91	0.83	

R&D personnel as a percentage of workforce, G8 nations (no data for USA)
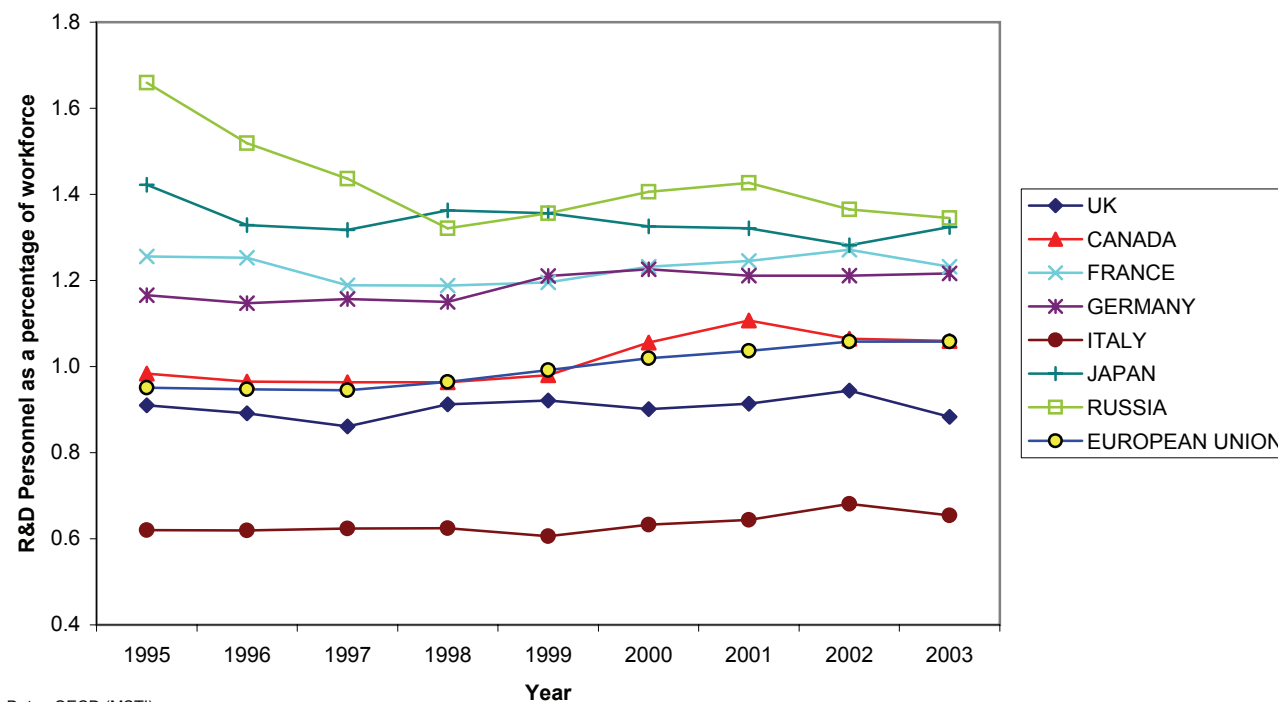
Data: OECD (MSTI)

Description of performance indicator
Condition signalling improvement

6.04 R&D personnel per hundred workforce
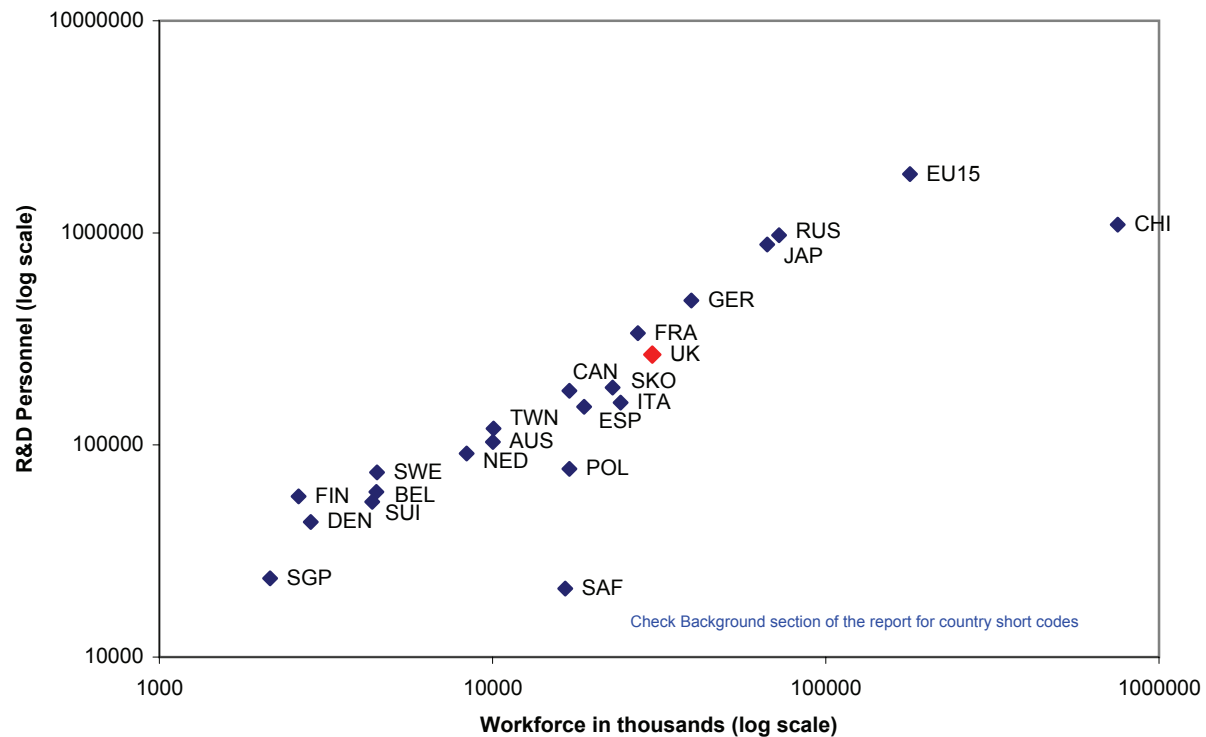**Increased ratio**

Numbers of R&D personnel compared with workforce - OST comparator nations, 2003

Data: OECD (MSTI)

6.05 Researchers as a proportion of R&D Personnel
Increased ratio

Indicator Headline

Although numbers of both researchers and R&D personnel have appeared somewhat static for the UK as a proportion of workforce, the data in this indicator suggest that a shift has taken place. This shift was in line with other G8 nations but may have accelerated.

What these data show is that researchers are increasing as a proportion of R&D personnel. There is no overall decrease in R&D personnel; for the UK these numbers increased slightly although they have now plateaued. This outcome therefore seems to reflect the growing professionalisation of the research workforce in a knowledge-based economy, as traditional technical roles become more complex and sophisticated.

The UK researchers/R&D personnel ratio has improved in the last few years both in absolute and relative terms. There was an increase last year and an increase of 10% between the recent and current year figures. In addition, the UK has improved its ranking from 12th to 8th in the most recent year.

The researcher proportion is highest for Singapore and South Korea, both countries with more than three quarters of their researchers as a proportion of R&D personnel. China also performs strongly in this regard and ranks 3rd. Italy, the Netherlands and Switzerland have the lowest researcher proportions, all with less than half. There are no USA data.

Researchers (see Glossary definition) make up a specific subcategory of R&D personnel, and provide a particular measure of research capacity. Both these terms are somewhat broadly defined and there may be inconsistency between national figures.

	Average 1998 - 2002	Actual 2003	Ratio or difference
UK researchers as a proportion of R&D Personnel - Actual	0.61	0.67	1.10
OST comparator group average - researchers as a proportion of R&D Personnel	0.58	0.61	1.04
UK researchers as a proportion of R&D Personnel - Rank	12	8	4
UK researchers as a proportion of R&D Personnel / OST comparator group average researchers as a proportion of R&D Personnel	1.05	1.10	

Researchers compared with R&D personnel, G8 nations (no data for USA)
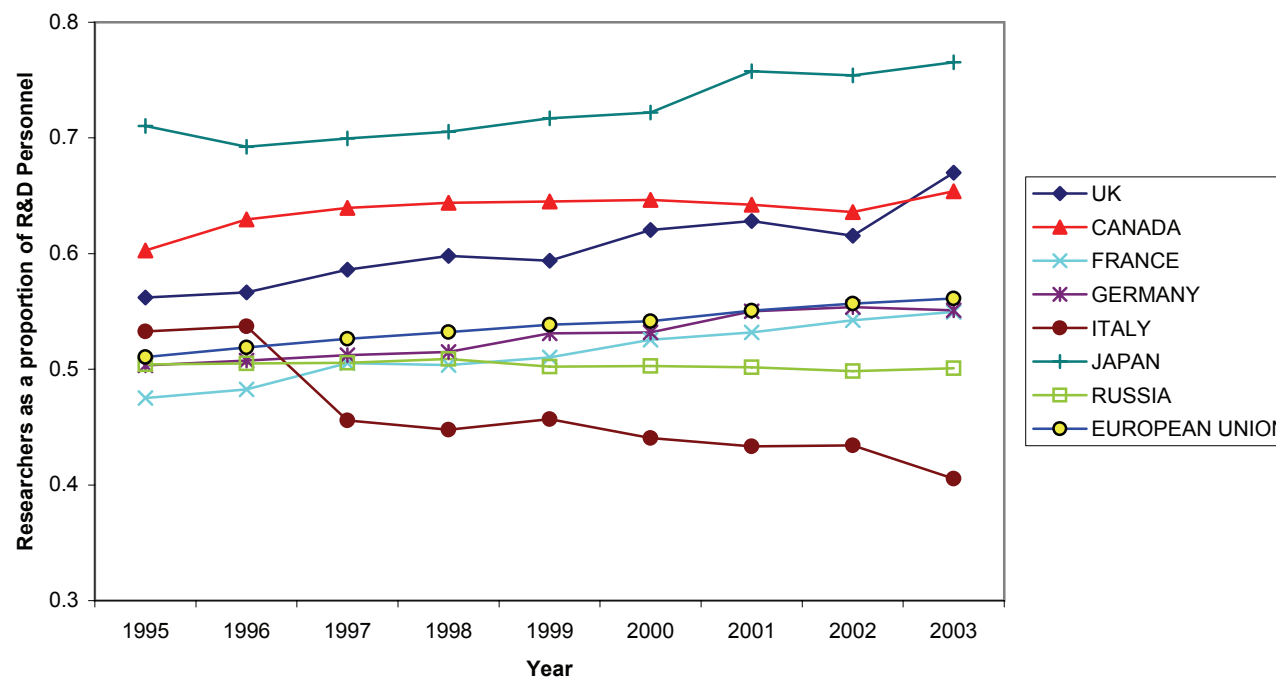
Data: OECD (MSTI)

Description of performance indicator
Condition signalling improvement

6.05 Researchers as a proportion of R&D Personnel
Increased ratio

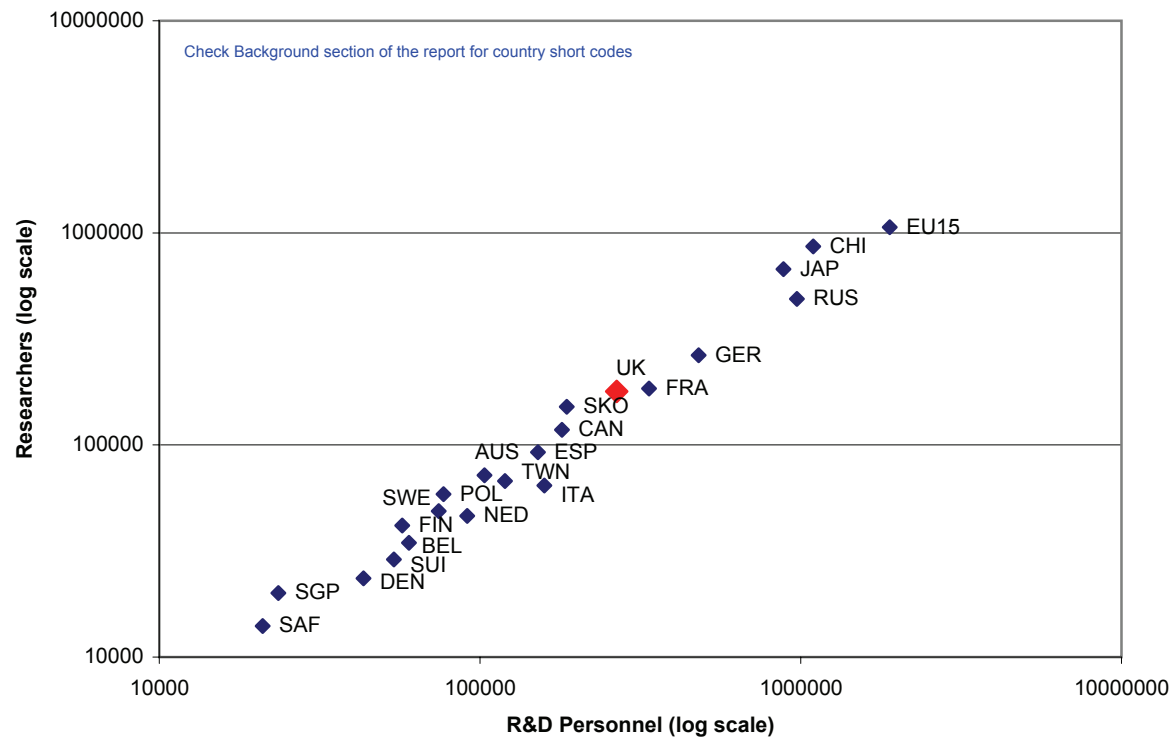**Numbers of researchers compared with R&D personnel - OST comparator nations, 2003**

Check Background section of the report for country short codes

Data: OECD (MSTI)

7.01 Business R&D investment in publicly performed R&D (BE-PUBERD as a proportion of PUBERD
Increased ratio

Indicator Headline

BE-PUBERD is R&D performed in the publicly funded sector (Government plus Higher Education) that is funded by the Business Enterprise sector. Business expenditure via investment in other sectors may reflect confidence in the research and relevance to business objectives.

The UK had ranked ahead of other G8 nations but has dropped behind Germany and Canada. It is now close to OST comparator group and EU15 average, but has fallen to 8th among OST comparator group nations in terms of business investment in publicly funded R&D. This puts it behind Poland (which bounced back from a 'data' drop last year), the Netherlands, Belgium and Finland.

The biggest increases on the recent 5 year average are Italy (28%), Switzerland and Denmark (17%) and the Netherlands, Finland and Germany (9%) compared with a stable OST comparator group average.

The long term trend for the EU15 seems to be an increase on this indicator. By contrast, the USA lags on Europe and is declining.

China ranks 19th in the OST comparator group.

Some 2003 data are produced by forecasting. Forecasted data are 'sense checked' by comparing forecasts in previous reports with outcomes.

	Average 1998 - 2002	Actual 2003	Ratio or difference
UK - percentage of BE-PUBERD within total PUBERD - Actual	9.16	6.61	0.72
OST comparator group average percentage of BE-PUBERD within total PUBERD	6.82	6.78	0.99
UK - percentage of BE-PUBERD within total PUBERD - Rank	5	8	-3
UK percentage of BE-PUBERD within total PUBERD / OST comparator group average percentage of BE-PUBERD within total PUBERD	1.34	0.98	

BE-PUBERD as a percentage of PUBERD - G8 nations (no data for Russia)
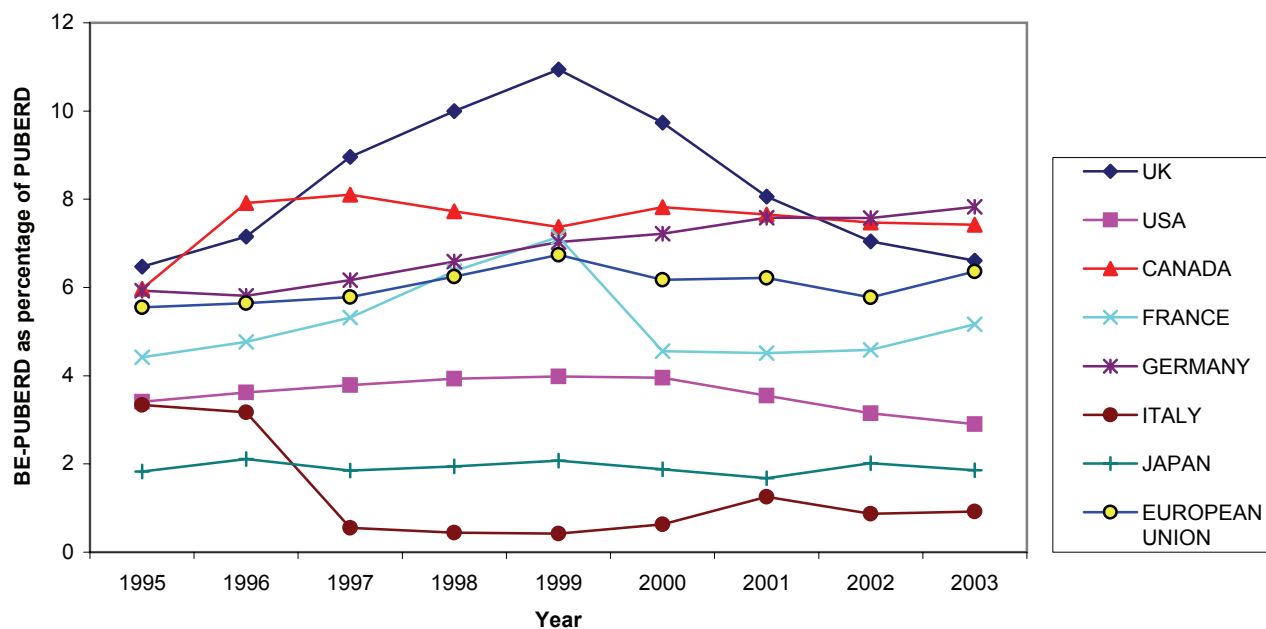
Data: OECD (RDS & MSTI)

Description of performance indicator
Condition signalling improvement

7.01 Business R&D investment in publicly performed R&D (BE-PUBERD as a proportion of PUBERD
Increased ratio

Business Enterprise expenditure in PUBERD - OST comparator nations, 2003

Data: OECD (RDS & MSTI)

Description of performance indicator
Condition signalling improvement

7.02 Business R&D investment in GOVERD (BE-GOVERD as a percentage of GOVERD)
Increased ratio

Indicator Headline

BE-GOVERD is R&D performed in the Government sector that is funded by the Business Enterprise sector.

For the UK, R&D expenditure from business sources as a proportion of GOVERD remains volatile, having dipped to a low-point in the mid-1990s, peaked in 1999 and is now dipping again. Nonetheless, UK BE-GOVERD is still above the OST comparator group average.

The UK remains ahead in the G8 group and ranks 4th to the Netherlands (which is of a similar scale in terms of BE-GOVERD), Finland and Poland overall, declining to 6th in 2003. There have been substantial improvements in both Finland and Poland over the period.
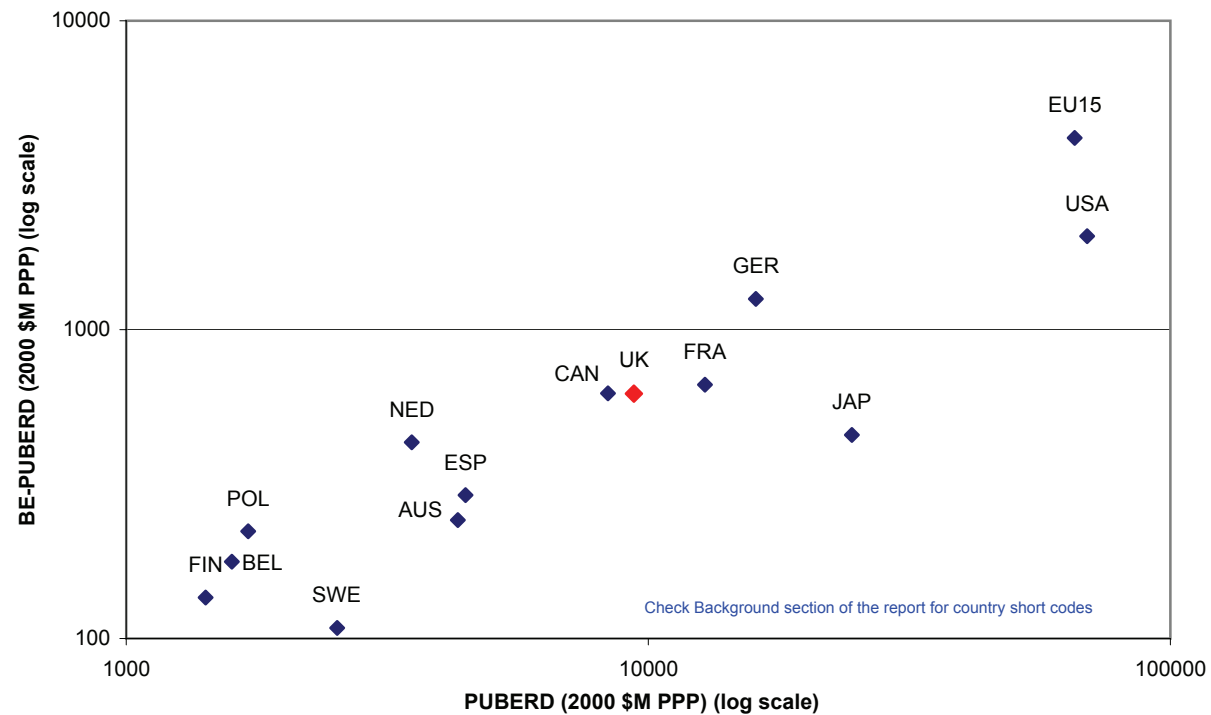
There are no data for the USA or China.

Some 2003 data are produced by forecasting. Forecasted data are 'sense checked' by comparing forecasts in previous reports with outcomes.

	Average 1998 - 2002	Actual 2003	Ratio or difference
UK percentage of BE-GOVERD within total GOVERD - Actual	13.58	8.95	0.66
OST comparator group average percentage of BE-GOVERD within total GOVERD	7.88	7.99	1.01
UK percentage of BE-GOVERD within total GOVERD - Rank	4	6	-2
UK percentage of BE-GOVERD within total GOVERD / OST comparator group average percentage of BE-GOVERD within total GOVERD	1.72	1.12	

BE-GOVERD as a percentage of GOVERD - G8 nations, not USA (no data for Russia)
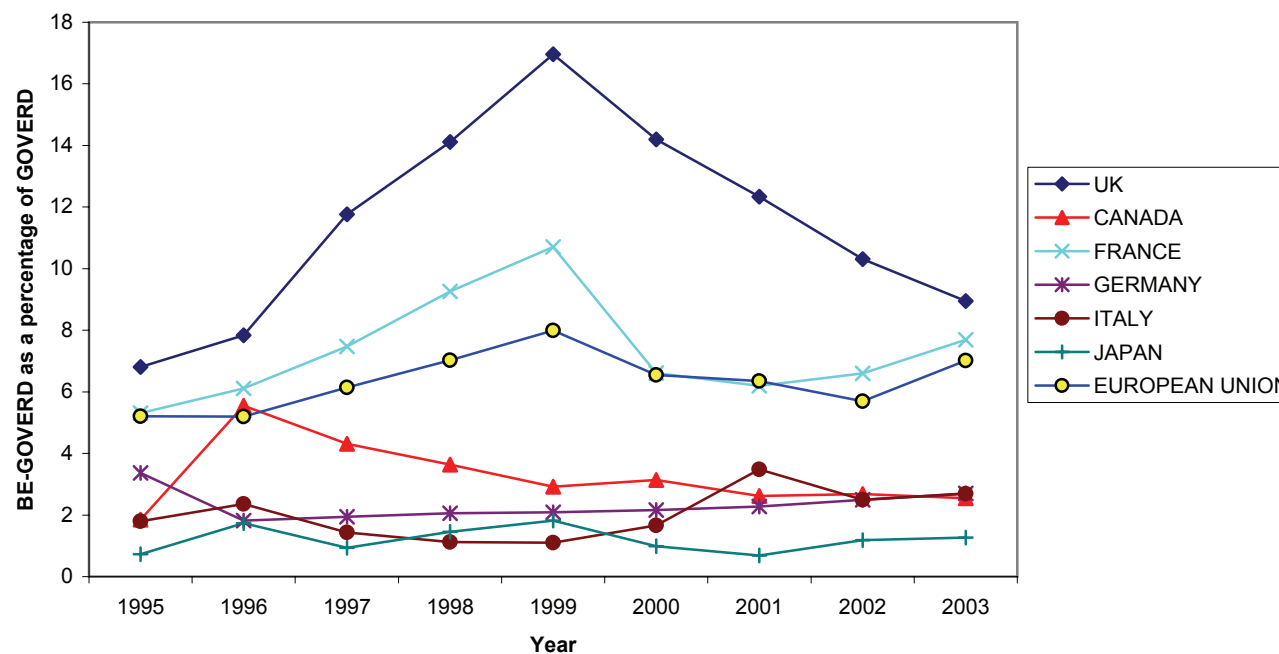
Data: OECD (RDS & MSTI)

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Description of performance indicator
Condition signalling improvement

7.02 Business R&D investment in GOVERD (BE-GOVERD as a percentage of GOVERD)
Increased ratio

BE-GOVERD compared to GOVERD - OST comparator nations, 2003 not USA

Data: OECD (RDS & MSTI)

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**7.03 Business R&D investment in PNPERD (BE-PNPERD as a percentage of PNPERD)
Increased ratio**

Indicator Headline

BE-PNPERD is R&D performed in the Private-Non-Profit sector that is funded by the Business Enterprise sector.

This indicator has seen substantial change since last year due to revision to UK PNPERD data. Total PNPERD has seen a substantial increase, particularly in recent years, leading to an apparent relative decrease in the proportion funded by the Business Enterprise sector.

UK business source expenditure as a proportion of PNPERD dropped by 50% between 1998 and 2002, beginning to show growth again only in 2003.

Among G8 nations, the UK is 4th with Canada and France well behind Japan. Japan is exceptional on this indicator. Among the OST comparator group, the UK's rank position has remained steady at 10.

In terms of absolute scale of BE-PNPERD, apart from Japan and the US, only France and South Korea (another strong performer in this indicator) approach the UK level.

The OST comparator group average has remained almost static, but there are marked variations between countries and greater fluctuations within some such as Sweden. Spain, in particular, has markedly improved its position.
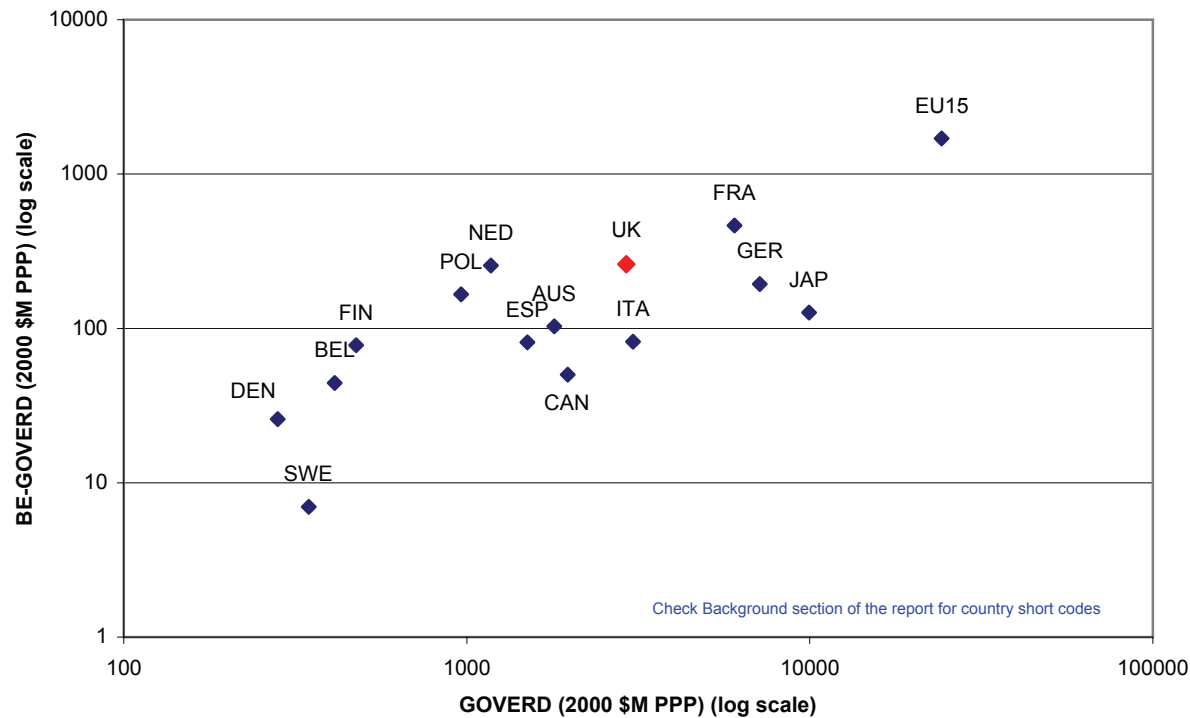
Some 2003 data are produced by forecasting. Forecasted data are 'sense checked' by comparing forecasts in previous reports with outcomes.

	Average 1998 - 2002	Actual 2003	Ratio or difference
UK percentage of BE-PNPERD within total PNPERD - Actual	12.84	10.50	0.82
OST comparator group average percentage of BE-PNPERD within total PNPERD	18.07	18.02	1.00
UK percentage of BE-PNPERD within total PNPERD - Rank	10	10	0
UK percentage of BE-PNPERD within total PNPERD / OST comparator group average percentage of BE-PNPERD within total PNPERD	0.71	0.58	

BE-PNPERD as a percentage of PNPERD - G8 nations (no data for Germany, Italy or Russia)
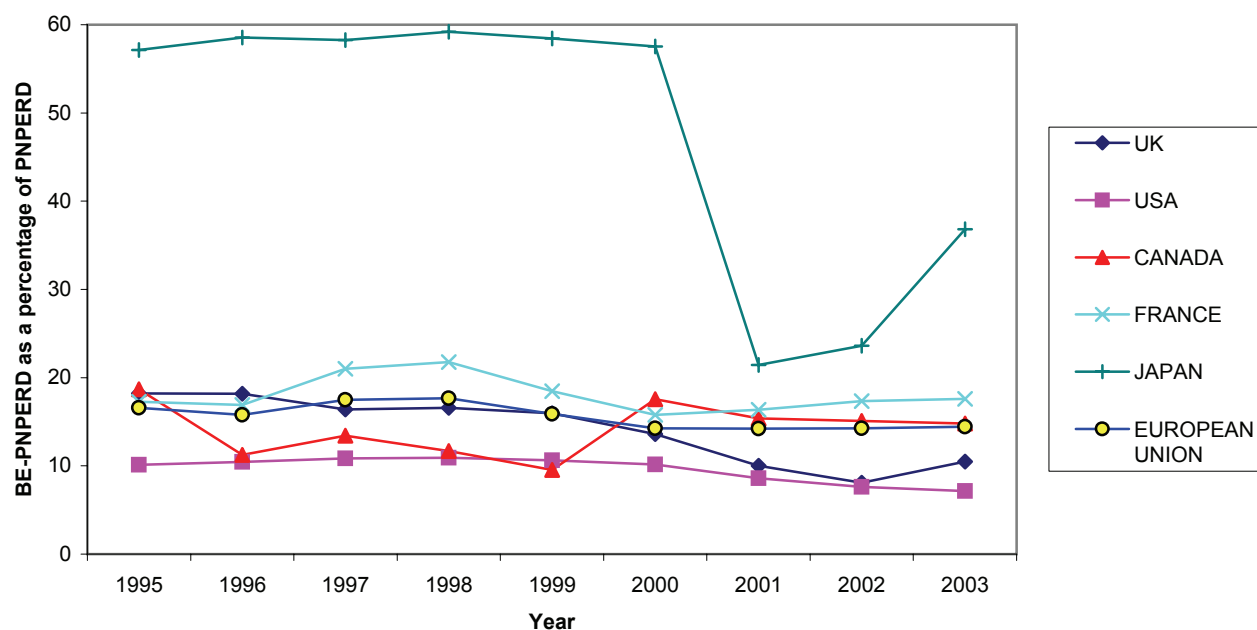
Data: OECD (RDS)

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Description of performance indicator
Condition signalling improvement

7.03 Business R&D investment in PNPERD (BE-PNPERD as a percentage of PNPERD)
Increased ratio

Business Enterprise expenditure in PNPERD - OST comparator nations, 2003

Data: OECD (RDS)

7.04 Business R&D investment in HERD (BE-HERD as a percentage of HERD)
Increased ratio

Indicator Headline

BE-HERD is R&D performed in the Higher Education sector that is funded by the Business Enterprise sector. There is a general but rather weak correlation between volume HERD and the level of BE-HERD (see graph). In other words, BEHERD as a share of HERD is fairly consistent across a range of countries.

For the UK, the overall increase in relative business R&D funding within the HE sector in the mid-1990s plateaued, dipped at the turn of the millennium, and is now below the EU15 average. There has been a very similar dip for the USA which is now well below the EU.

BE-HERD has fallen back in South Korea, where it was high, but is strong and continues to be maintained in Germany. Both Canada and Germany are ahead of the UK in absolute and relative terms. Their data cannot, unfortunately, be disaggregated at the more detailed level of Indicator 7.05. Belgium is a srong performer in this indicator, and Switzerland, Finland and the Netherlands all show strong recent growth.

The OST comparator group average fluctuates from year to year. It generally fell from the early 1990s but picked up in 2001 because of simultaneous increases in a number of European countries. The UK is consequently now below group average and its rank position has fallen from 7th to 10th.

Some 2003 data are produced by forecasting. Forecasted data are 'sense checked' by comparing forecasts in previous reports with outcomes.

	Average 1998 - 2002	Actual 2003	Ratio or difference
UK - percentage of BE-HERD within total HERD - Actual	6.65	5.56	0.84
OST comparator group average percentage of BE-HERD within total HERD	6.82	6.83	1.00
UK - percentage of BE-HERD within total HERD - Rank	7	10	-3
UK percentage of BE-HERD within total HERD / OST comparator group average percentage of BE-HERD within total HERD	0.98	0.81	

Business R&D investment in HERD - G8 nations (no data for Russia or Italy)
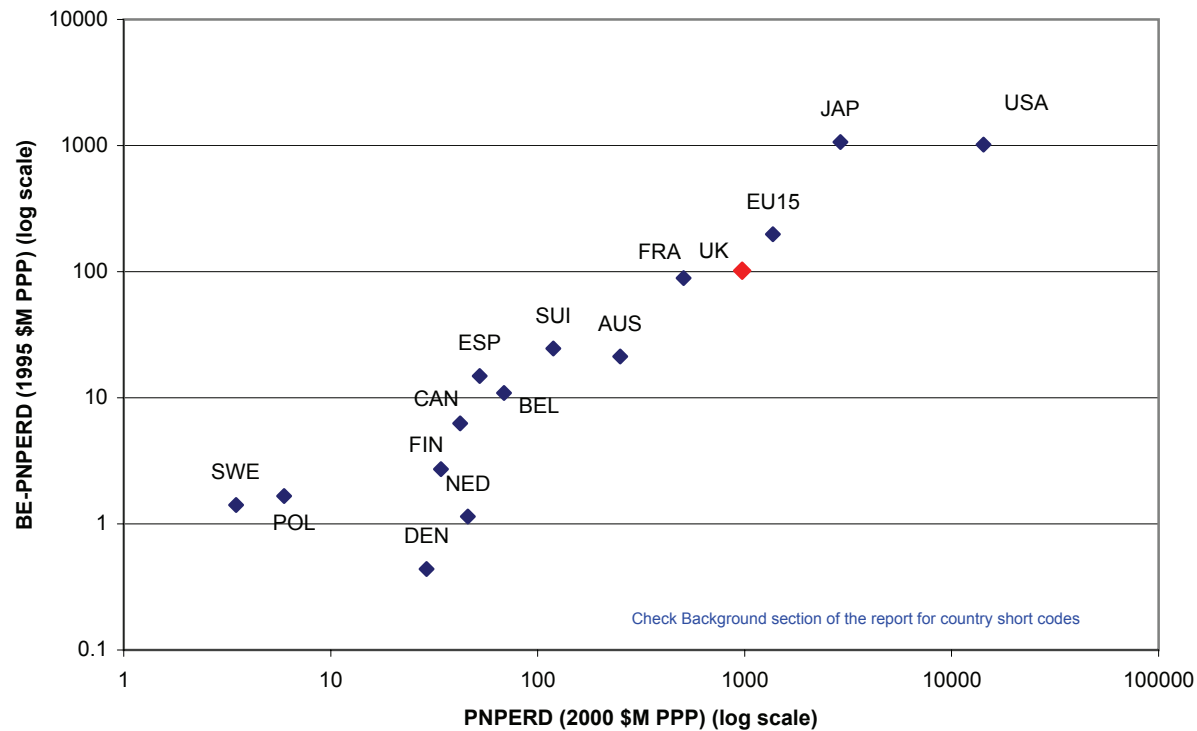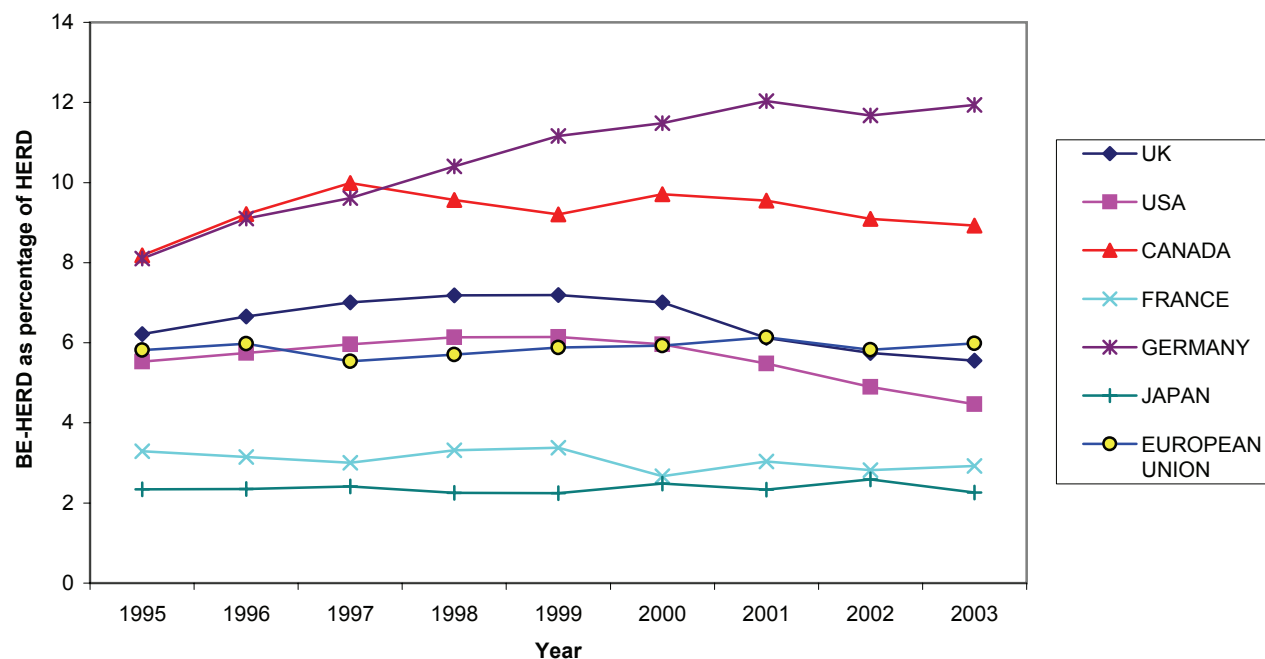

Data: OECD (RDS & MSTI)

Description of performance indicator
Condition signalling improvement

7.04 Business R&D investment in HERD (BE-HERD as a percentage of HERD)
Increased ratio

Business Enterprise expenditure in HERD - OST comparator nations, 2003

Data: OECD (RDS & MSTI)

Description of performance indicator
Condition signalling improvement

7.05 Business R&D investment in HERD (BE-HERD as %ge of HERD) in five main research fields
Increased ratio

Medical Sciences

Indicator Headline

BE-HERD is R&D performed in the Higher Education sector that is funded by the Business Enterprise sector.

Data for OECD field Medical Sciences BE-HERD are available only for 8 countries. These do not include USA, Canada, France and Germany. This explains the somewhat unusual mix of countries shown in the attached graph.

UK Medical Sciences BE-HERD is second highest to Japan in absolute terms and third highest to Poland and Spain as a proportion of HERD among OST comparator group countries.

The UK's steady decline reflects a fall-off in BE-HERD since 2000 in the context of (sometimes rapidly) rising HERD. Both BE-HERD and HERD decreased in 2003.

Denmark has been very volatile and Finland and Poland have seen significant fluctuations although on a smaller volume than the UK. Increases have not always been sustained.

Some 2003 data are produced by forecasting. Forecasted data are 'sense checked' by comparing forecasts in previous reports with outcomes.

The EU15 figure is based on a limited data set.

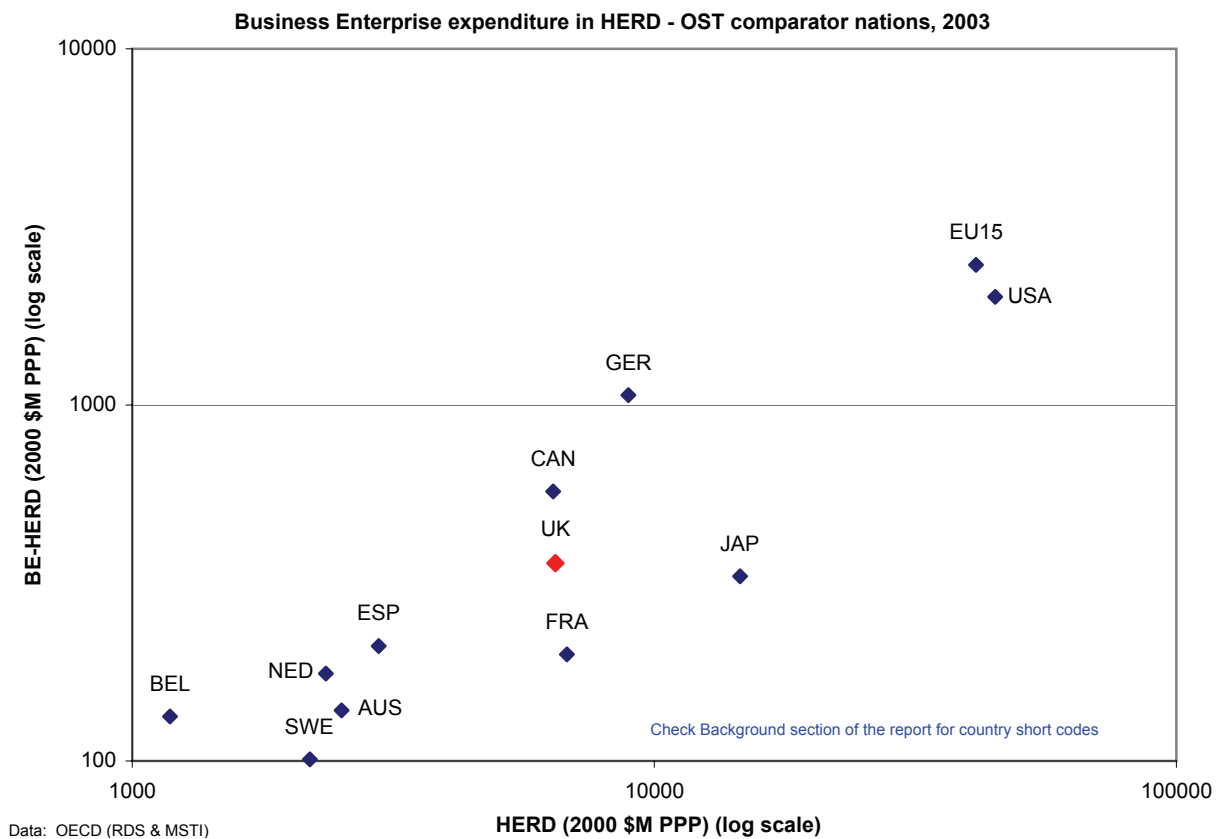|	Average 1998 - 2002	Actual 2003	Ratio or difference
UK - Percentage of BE-HERD within total HERD - Actual	6.51	5.47	0.84
OST comparator group average percentage of BE-HERD within total HERD	5.85	6.00	1.03
UK - Percentage of BE-HERD within total HERD - Rank	3	5	-2
UK - Percentage of BE-HERD within total HERD / OST comparator group average percentage of BE-HERD within total HERD	1.11	0.91	

Medical Sciences - BE-HERD as a percentage of HERD
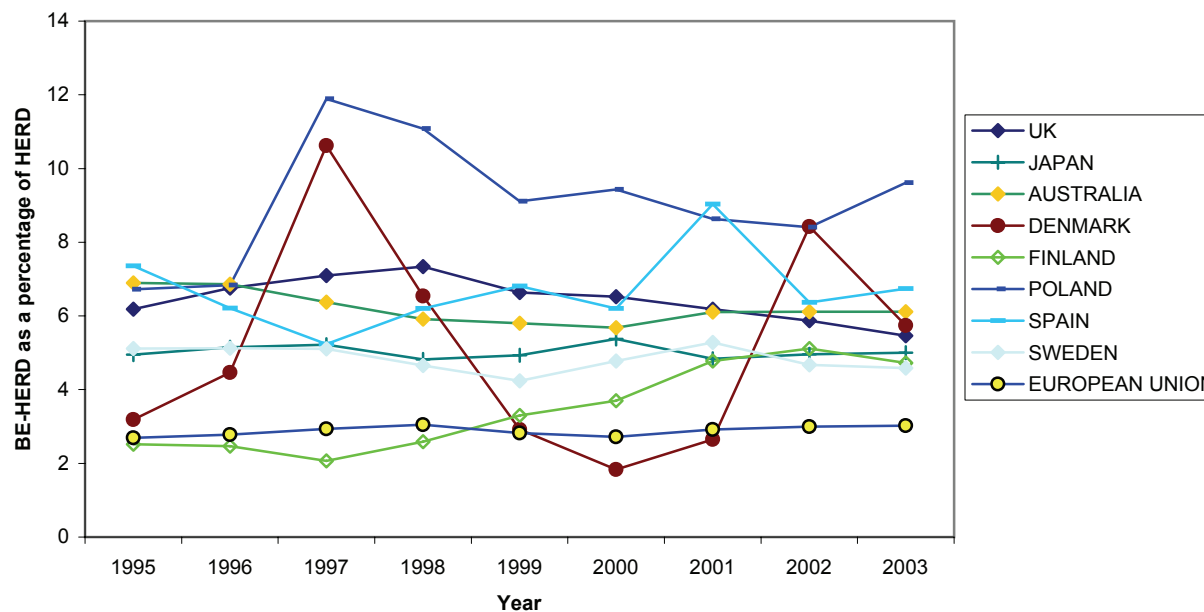
Data: OECD (RDS & MSTI), UK SET statistics and HESA

Description of performance indicator   **7.05 Business R&D investment in HERD (BE-HERD as %ge of HERD) in five main research fields**
Condition signalling improvement   **Increased ratio**

Medical Sciences - Business Enterprise expenditure in HERD - OST comparator nations, 2003

Data: OECD (RDS & MSTI), UK SET statistics and HESA data

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Description of performance indicator
Condition signalling improvement

7.05 Business R&D investment in HERD (BE-HERD as %ge of HERD) in five main research fields
Increased ratio

Natural Sciences

Indicator Headline

BE-HERD is R&D performed in the Higher Education sector that is funded by the Business Enterprise sector.

Data are available only for 8 countries at the OECD field level. These do not include USA, Canada, France and Germany. This explains the somewhat unusual mix of countries shown in the attached graph.

UK Natural Sciences BE-HERD is still highest in absolute terms (by 1/3rd over Spain) but is now 3rd as a proportion of HERD among the group of comparator countries. This element of UK business funding declined in 2001 after substantial growth in the last decade.

UK research impact is also strong in this area and research volume is high in Life Sciences. Relatively high levels of business investment may reflect confidence in UK research.

Spain, Finland and - to a lesser extent - Australia have seen significant relative increases.

The average OST comparator group figure for this indicator is fairly stable.

Some 2003 data are produced by forecasting. Forecasted data are 'sense checked' by comparing forecasts in previous reports with outcomes.

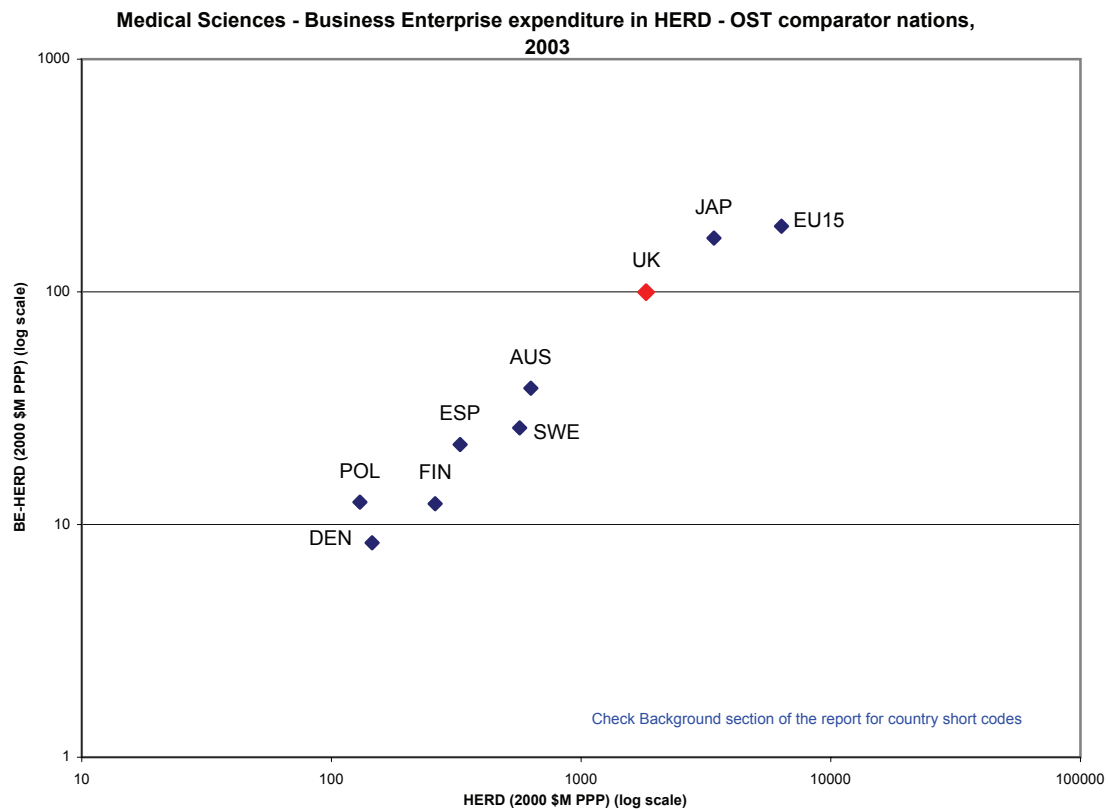|	Average 1998 - 2002	Actual 2003	Ratio or difference
UK - Percentage of BE-HERD within total HERD - Actual	6.70	5.25	0.78
OST comparator group average percentage of BE-HERD within total HERD	4.30	4.27	0.99
UK - Percentage of BE-HERD within total HERD - Rank	1	3	-2
UK - Percentage of BE-HERD within total HERD / OST comparator group average percentage of BE-HERD within total HERD	1.56	1.23	

Natural Sciences - BE-HERD as a percentage of HERD

Data: OECD (RDS & MSTI), UK SET statistics and HESA data

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Description of performance indicator
Condition signalling improvement

7.05 Business R&D investment in HERD (BE-HERD as %ge of HERD) in five main research fields
Increased ratio

Natural Sciences - Business Enterprise expenditure in HERD - OST comparator nations, 2003

Data: OECD (RDS & MSTI). UK SET statistics and HESA data

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Description of performance indicator
Condition signalling improvement

7.05 Business R&D investment in HERD (BE-HERD as %ge of HERD) in five main research fields
Increased ratio

Engineering and Technology

Indicator Headline

BE-HERD is R&D performed in the Higher Education sector that is funded by the Business Enterprise sector.

Data are available only for 8 countries at the OECD field level. These do not include USA, Canada, France and Germany. This explains the somewhat unusual mix of countries shown in the attached graph.

UK Engineering and Technology BE-HERD is highest in absolute terms (just ahead of Japan) among OST comparator group countries but lower as a proportion of HERD than that of Finland. It is of a similar proportion to Spain and Australia. This element of business funding has fallen only marginally in absolute terms and as a proportion of HERD in the UK in the last decade.

Denmark has seen a significant increase moving ahead of the UK in 2003, while Sweden has fallen back somewhat on this indicator.

UK research impact had been less strong in this area but has recently improved (see Indicator 3.09). The pattern of business investment could reflect wider issues, but the high absolute level should be noted as an expression of confidence. Annual variations may reflect other economic issues faced by the engineering industry in the UK.

Some 2003 data are produced by forecasting. Forecasted data are 'sense checked' by comparing forecasts in previous reports with outcomes.

	Average 1998 - 2002	Actual 2003	Ratio or difference
UK - Percentage of BE-HERD within total HERD - Actual	10.85	9.57	0.88
OST comparator group average percentage of BE-HERD within total HERD	9.34	8.98	0.96
UK - Percentage of BE-HERD within total HERD - Rank	4	5	-1
UK - Percentage of BE-HERD within total HERD / OST comparator group average percentage of BE-HERD within total HERD	1.16	1.06	

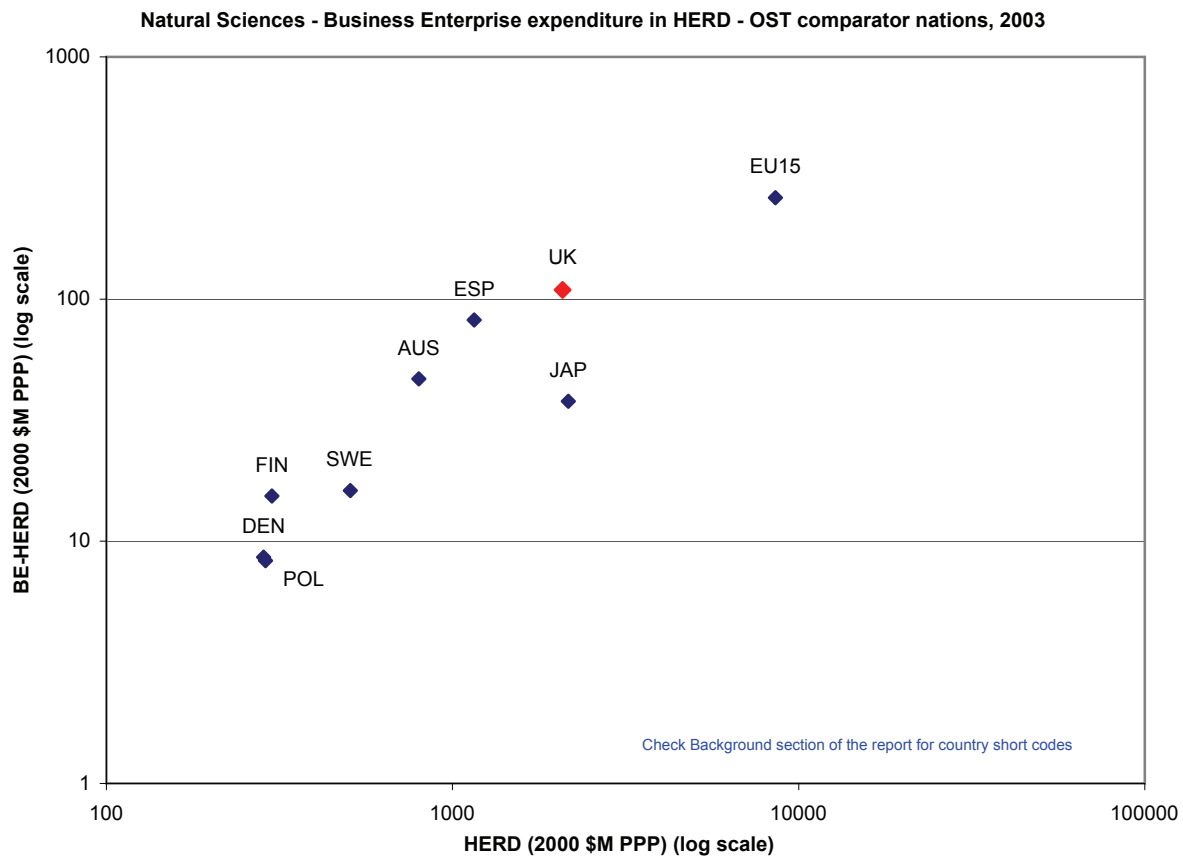**Engineering and Technology - BE-HERD as a percentage of HERD**
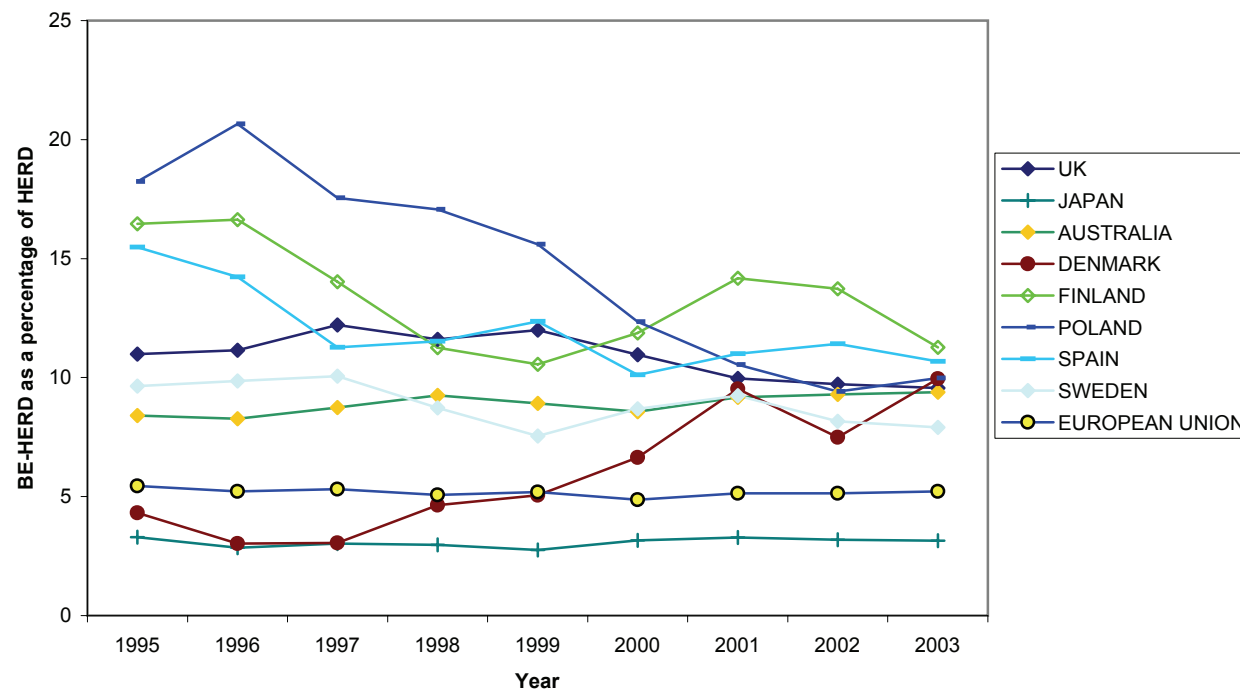
Data: OECD (RDS & MSTI), UK SET statistics and HESA data

Description of performance indicator
Condition signalling improvement

7.05 Business R&D investment in HERD (BE-HERD as %ge of HERD) in five main research fields
Increased ratio

Engineering and Technology - Business Enterprise expenditure in HERD - OST comparator nations, 2003

Data: OECD (RDS & MSTI), UK SET statistics and HESA data

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Description of performance indicator
Condition signalling improvement

7.05 Business R&D investment in HERD (BE-HERD as %ge of HERD) in five main research fields
Increased ratio

Social Sciences

Indicator Headline

BE-HERD is R&D performed in the Higher Education sector that is funded by the Business Enterprise sector.

Data are available only for 7 countries at the OECD field level. These do not include USA, Canada, France, Germany or Japan. This explains the somewhat unusual mix of countries shown in the attached graph.

UK Social Sciences BE-HERD as a proportion of HERD continues to be the highest in absolute terms among comparator countries, marginally ahead of Spain.

The UK is third highest to Spain and Finland as a proportion of HERD. Finland has improved significantly over the period, and overtook the UK in 2001. The Poland line drops because BE-HERD declines to almost zero while HERD steadily rises in that country.

This element of business funding has grown slowly in absolute terms, in line with total HERD in the UK in the last decade. This pattern is typical of the rest of the group. Overall across the OST comparator group there is a steady rise in business expenditure in these HE research areas in line with the general level of public investment.

Some 2003 data are produced by forecasting. Forecasted data are 'sense checked' by comparing forecasts in previous reports with outcomes.

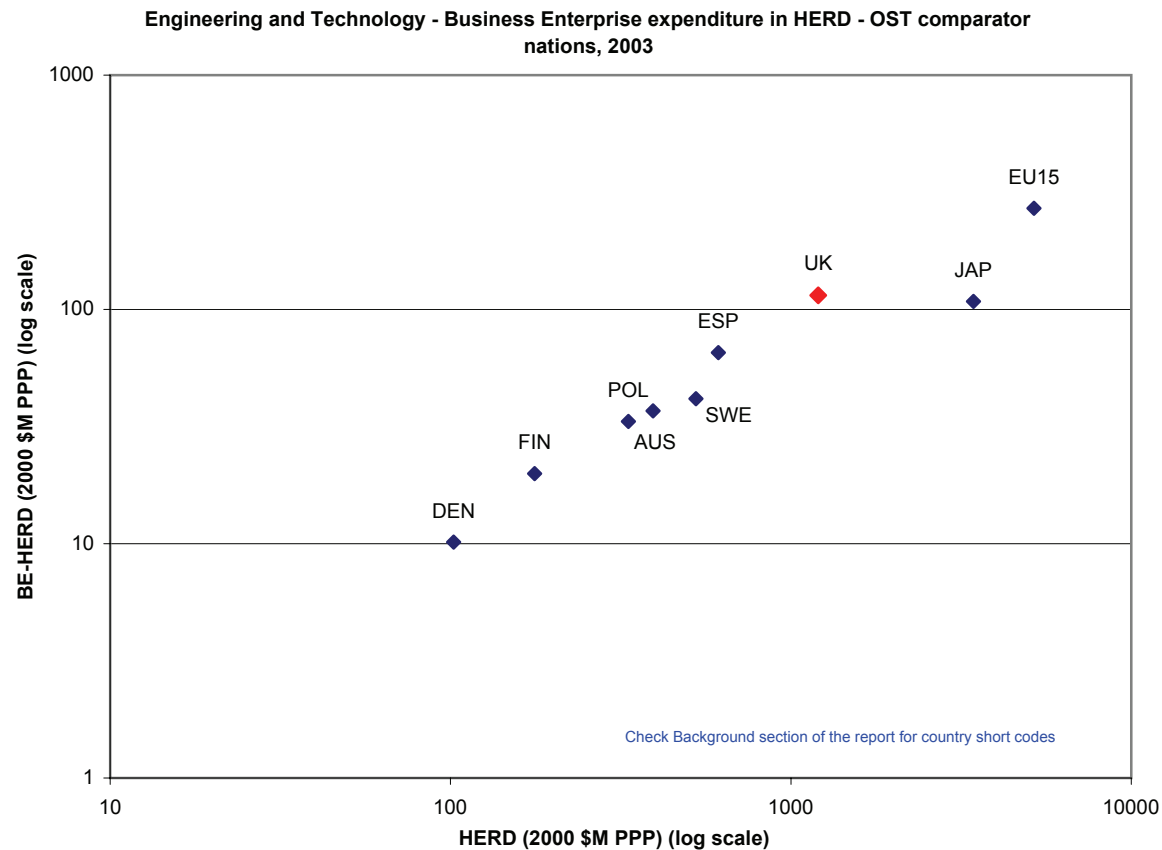|	Average 1998 - 2002	Actual 2003	Ratio or difference
UK - Percentage of BE-HERD within total HERD - Actual	4.43	3.44	0.78
OST comparator group average percentage of BE-HERD within total HERD	2.82	2.82	1.00
UK - percentage of BE-HERD within total HERD - Rank	2	3	-1
UK percentage of BE-HERD within total HERD / OST comparator group average percentage of BE-HERD within total HERD	1.57	1.22	

Social Sciences - BE-HERD as a percentage of HERD
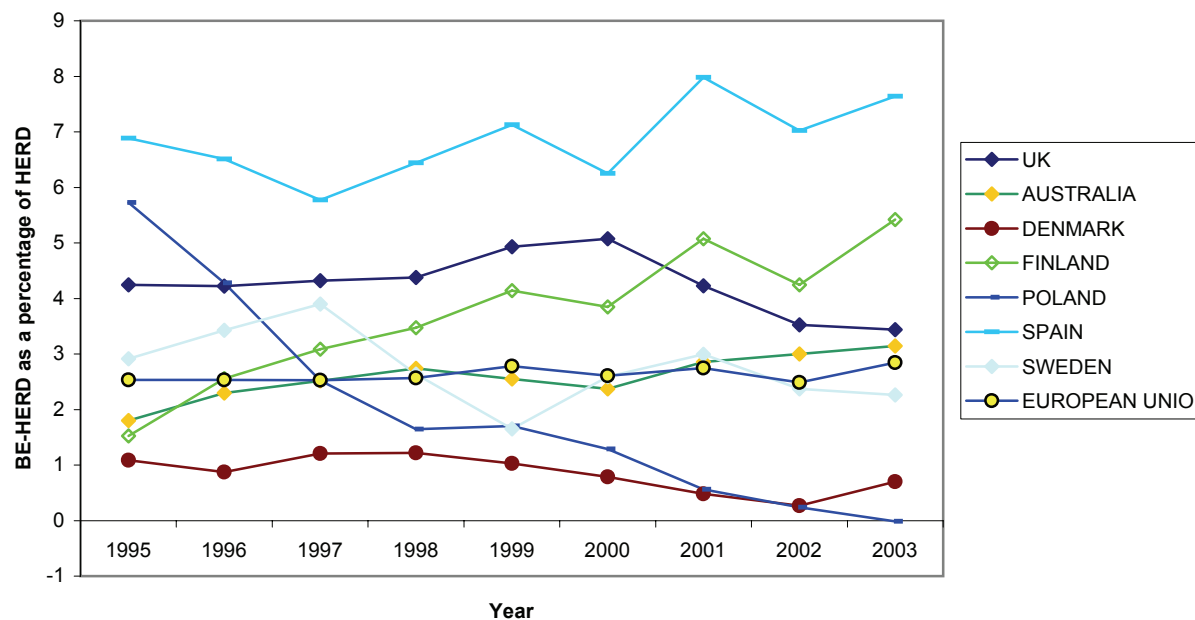
Data: OECD (RDS & MSTI), UK SET statistics and HESA data

Description of performance indicator
Condition signalling improvement

7.05 Business R&D investment in HERD (BE-HERD as %ge of HERD) in five main research fields
Increased ratio

Social Sciences - Business Enterprise expenditure in HERD - OST comparator nations, 2003

Data: OECD (RDS & MSTI), UK SET statistics and HESA data

Description of performance indicator
Condition signalling improvement

7.05 Business R&D investment in HERD (BE-HERD as %ge of HERD) in five main research fields
Increased ratio
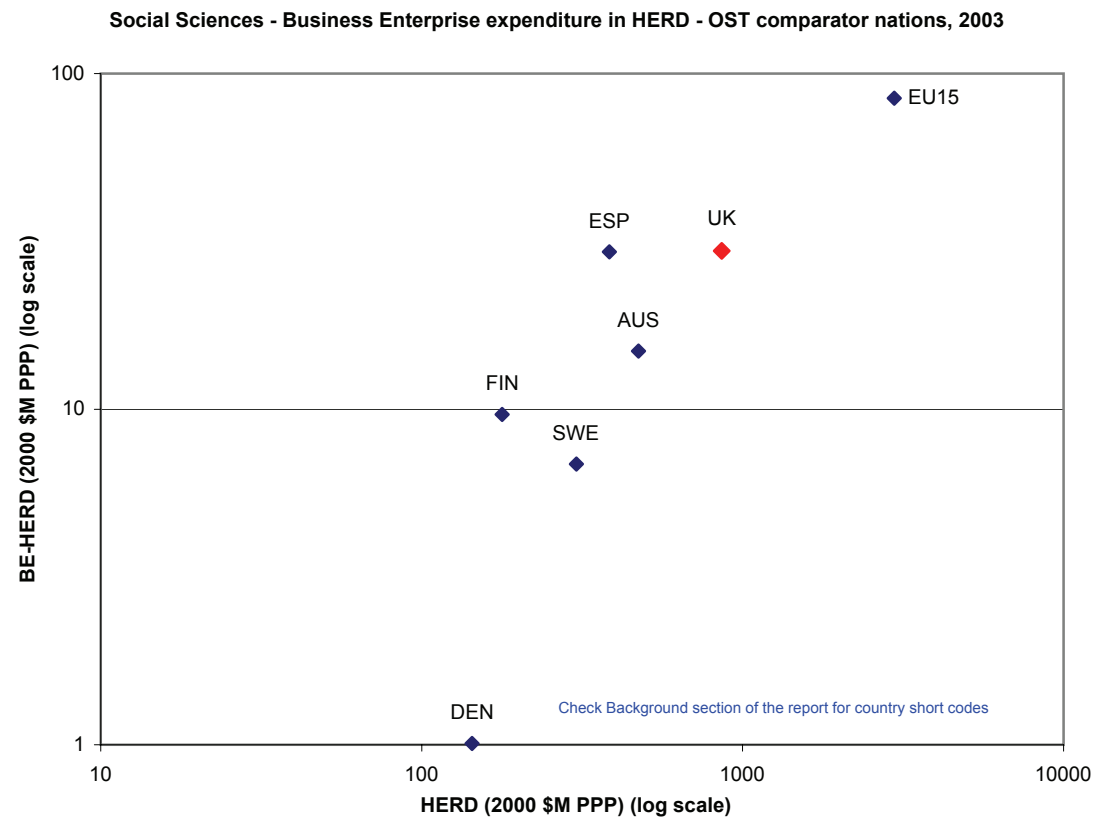
Humanities

Indicator Headline

This is the first time that data for this indicator have been analysed for Humanities and Arts.

BE-HERD is R&D performed in the Higher Education sector that is funded by the Business Enterprise sector.

Data are available only for 7 countries at the OECD field level for Humanities & Arts. These do not include USA, Canada, France, Germany or Japan. Data for Sweden only cover some years. This explains the somewhat unusual mix of countries shown in the attached graph.

UK BE-HERD is about half that of Spain but much more in absolute terms than other countries. As a proportion of HERD, the UK is broadly in the main group of countries where data are available. The level of investment has been stable over the period.

The index for Spain is extremely high and this is due to high BE-HERD not low HERD. The Poland figures are slightly erratic.

Excepting Spain, the UK appears to attract a relatively good level of BE-HERD into a well supported research base in these disciplines.

Some 2003 data are produced by forecasting. Forecasted data are 'sense checked' by comparing forecasts in previous reports with outcomes.

|	Average 1998 - 2002	Actual 2003	Ratio or difference
UK - Percentage of BE-HERD within total HERD - Actual	1.30	1.07	0.82
OST comparator group average percentage of BE-HERD within total HERD	1.76	2.00	1.14
UK - percentage of BE-HERD within total HERD - Rank	3	3	0
UK percentage of BE-HERD within total HERD / OST comparator group average percentage of BE-HERD within total HERD	0.74	0.54	

Humanities - BE-HERD as a percentage of HERD
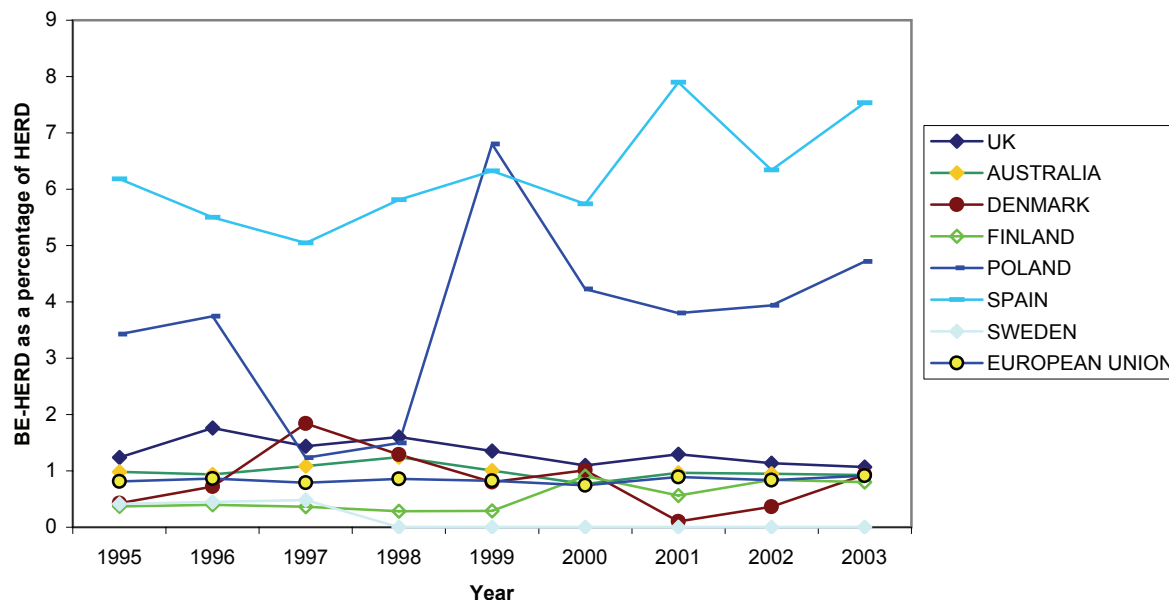
Data: OECD (RDS & MSTI), UK SET statistics and HESA data

Description of performance indicator
Condition signalling improvement

7.05 Business R&D investment in HERD (BE-HERD as %ge of HERD) in five main research fields
Increased ratio

Humanities - Business Enterprise expenditure in HERD - OST comparator nations, 2003
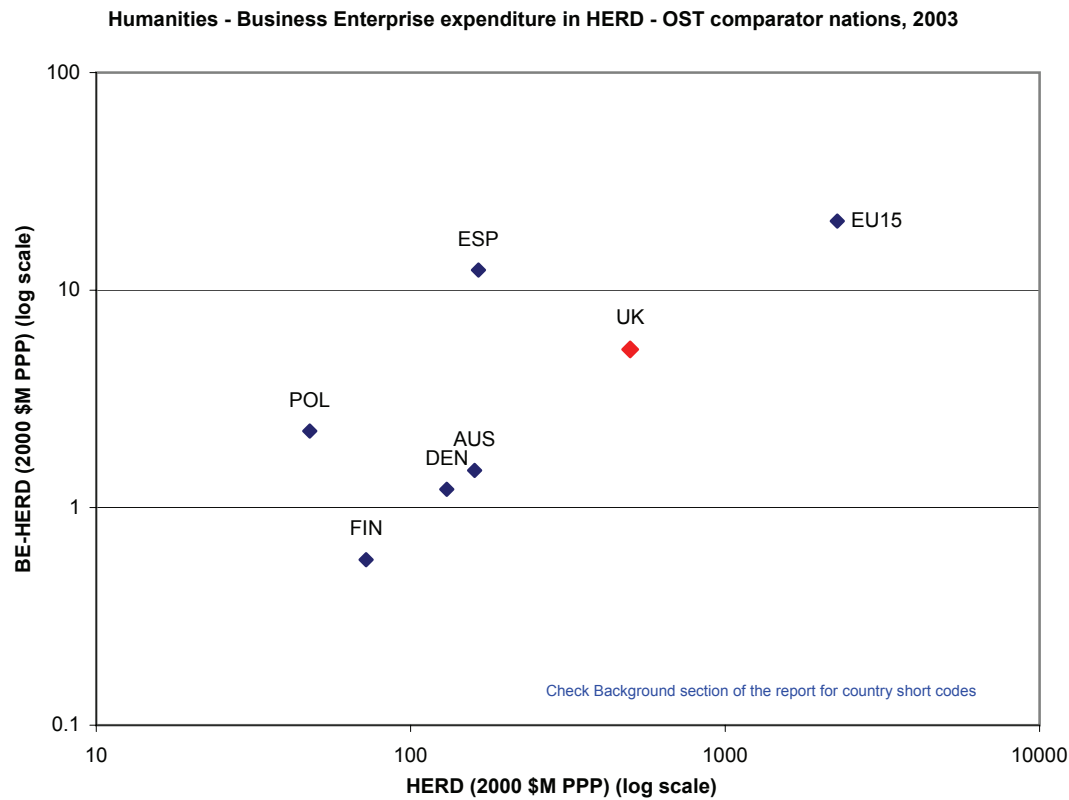
Data: OECD (RDS & MSTI), UK SET statistics and HESA data

Background to the indicators

The following pages provide background information on data sources, international coverage, subject level disaggregation, time frames and the theory and methodology used in bibliometric analyses.

Codes and abbreviations for countries and for fields of research are defined in the appropriate sections.

There is also a glossary for other terminology and abbreviations.

Data and sources

With the exception of the UK, the main data sources used for OST indicators are:

- **Finance and people – OECD**

- **Publications – Thomson Scientific[®]**

For the UK, OST has drawn our attention to the most recent data available from SourceOECD and ONS.

The OECD is the main provider of internationally comparable data on research and development. Its two products on the measurement of science and technology, Main Science and Technology Indicators (MSTI, 2005-1, first edition) and Research and Development Statistics (RDS, 2004-2, second edition) provide the basis for much of the data used in these analyses. The latest editions of each of these products were used to generate the indicators listed in the table below. In addition, OECD provides the only reliable international comparisons of educational data via its online Education Database.

The OECD provides comments on a number of the data points in RDS and MSTI, explaining their derivation or discussing their accuracy. These comments have not been reproduced here but are available to the interested reader when referring to the original data. Sources can be found at: http://www1.oecd.org/dsti/sti/stat-ana/index.htm

There are some points of difference between MSTI and RDS. MSTI has been the preferred database for most of the analyses in this report as it provides data on a greater range of countries. RDS, however, provides data disaggregated at the level of fields of science and also covers PNPERD.

Data are presented for the years 1995 to 2003/4. Gaps of one or two years in the time series have been filled by interpolation, whilst missing values at either end of the time series were created by extrapolation where appropriate.

Rolling 5 year averages have been created for researchers, population and labour-force data in order to enable like-for-like comparisons with ISI data. The average is produced from the value for the year in question, and the four years which precede it.

In this report, OECD data are usually available for 21 countries. Coverage for the 17 OECD nations is broadly complete, but data for some countries are

Indicator	Basic source
BE-GOVERD	OECD Research and Development Statistics
BE-HERD	OECD Research and Development Statistics
BE-HERD by field of science	OECD Research and Development Statistics
BE-PNPERD	OECD Research and Development Statistics
GDP	OECD Main Science and Technology Indicators
GERD	OECD Main Science and Technology Indicators
GOVERD	OECD Main Science and Technology Indicators
HERD	OECD Main Science and Technology Indicators
HERD by field of science	OECD Research and Development Statistics
National populations	OECD Main Science and Technology Indicators
PhD graduates	OECD Education Database
PhD graduates by field of science	OECD Education Database
PNPERD	OECD Research and Development Statistics
R&D personnel	OECD Main Science and Technology Indicators
Researchers	OECD Main Science and Technology Indicators
Labour (work) force	OECD Main Science and Technology Indicators

missing from some tables. This may be because there were no data available, or that there were so many missing data points in the data available that no meaningful attempt to interpolate and extrapolate could be made.

Where necessary and feasible, OECD data has been supplemented by data sourced from EUROSTAT, the UN, the Higher Education Statistics Agency (HESA), and the statistics' portals of individual national governments.

Financial data is given in units of Million constant US$ at 2000 prices and corrected for Purchasing Power Parity (PPP). This is a change from last year, where PPP-1995 was used.

The interpretation of OECD science and technology data is governed by the Frascati Manual, which has become the internationally recognised methodology for collecting and using R&D statistics. Some basic definitions from the Frascati manual appear below; detail is in the Glossary.

The OECD Education Database provides internationally comparable data on key aspects of education systems. It makes use of data collected by UNESCO, OECD and EUROSTAT. The interpretation of OECD education data is governed by the OECD publication 'Data Collection on Education Systems: Definitions, Explanations, and Instructions'.

There has been a change in UK postgraduate data because of changes in data collection by HESA, the UK Higher Education Statistics Agency. This affects the status of awards made from dormant registrations and increases the numbers of PhD awards from 2001 onwards by about 4.5% compared to previous data. More information is available in an article published by HESA at the time, see: http://www.hesa.ac.uk/holisdocs/pubinfo/student/changes.htm

All publication and citation data are provided by Thomson Scientific®. The NSICCOD2004 was the specific database from which figures were taken for these analyses. Two main methods are used in analysing these data:

- **NSI1**: analyses based on data from the most recent (or any specific) calendar year use the ISI NSI1 data frame, looking at the numbers of articles published and the citations they have accumulated to date;

- **NSI5**: analyses based on a select period are most effective if a five-year window is taken, using the ISI NSI5 data frame. This takes the publications for a stated five-year period (e.g. NSI5 for 2004 is the 5-year window 2000-2004) and the citations to those articles in the same five-year period.

Frascati manual data definitions (see also Glossary)

GERD: Gross domestic expenditure on R&D

BERD: Total R&D performed in the business sector

GOVERD: Total R&D performed in the government sector

PNPERD: Total R&D performed in the private non-profit sector

HERD: Total R&D performed in the higher education sector (which is very broadly defined and may in some countries cover more than universities and colleges)

Where the prefix BE- is used, this denotes that portion of the R&D within the sector concerned that is financed by the business enterprise sector (a table below illustrates this)

Researchers: professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems

R&D personnel: all persons employed directly on R&D, and those providing direct services such as managers, administrators, and clerical staff

Labour force (workforce): Total number of persons available for work, whether in employment or not

Other data definitions

PUBERD: the sum of GOVERD and HERD, equating to R&D performed in the publicly funded sectors

Notes on data manipulation

Extrapolation was achieved using Excel's FORECAST function. Forecasted data are 'sense checked' by comparing forecasts in previous reports with outcomes. Where outcome clearly differed from forecast, e.g. because of marked inflections in trend, then forecasting has been omitted for the latest report.

Interpolation was achieved by adding the difference between the available upper and lower values divided by the number of missing years to the lower figure.

OECD field of science categories: a single category covers both agriculture and natural sciences

GDP (Million constant $ 2000 prices and PPPs) was translated to GDP (Million current PPP$) using OECD's Implicit GDP Price Indices (2000 = 1.00)

UK HERD was rebuilt by field of science using:

- HESA data on Total HEI Research Grant & Contract Income (from Resources of Higher Education, Table 4: Research Grants and Contracts Income by Cost Centre, Source and Institution). HESA cost centre codes were mapped to OECD fields of science, and agricultural sciences combined into natural sciences, and income allocated to administration and services (<1% of the total) was pro-rated across OECD fields of science.

- OST data on HEFC R&D Expenditure by subject area (ONS Government R&D survey reproduced on the OST's SET statistics website: Table 5.3 Higher Education Funding Councils R&D and SET expenditure by subject area (http://www.ost.gov.uk/setstats/index.htm).

This accounted for 95% of HERD on average, and the shortfall was pro-rated across OECD fields of science.

Proportions of HERD by field of science were then calculated, and values extrapolated for 1995 and 2003. These were then used to split the available totals for these years.

UK BE-HERD was rebuilt by field of science using:

- HESA data on Total HEI Research Grant & Contract Income (UK industry, commerce, public corps) (from Resources of Higher Education, Table 4: Research Grants and Contracts Income by Cost Centre, Source and Institution). HESA cost centre codes were mapped to OECD fields of science, and agricultural sciences combined into natural sciences, and income allocated to administration & services (<1% of the total) were pro-rated across OECD fields of science.

The following table is adapted from Table 6.1 of the Frascati manual. It shows the distinction between funding and performing sector in establishing the composition of HERD and sets out the disaggregation of HERD in order to illustrate the nature of BE-HERD, business funded research performed by the HE sector.

Sector of funding source	Sector of performance				Total	
	Business enterprise	Private non-profit	Government	Higher education		
Business enterprise	BE-BERD, i.e. private sector R&D financed by companies	BE-PNPERD	BE-GOVERD	BE-HERD, e.g. industrial research contracts to universities	Total domestic performance financed by the business enterprise sector	^
Government	GOV-BERD, i.e. Government R&D contracts and grants to industry			GOV-HERD e.g. contracts from Government departments	Total domestic performance financed by the government sector	'
Public general university funds (GUF)				GUF, i.e. from DfES via HEFCs	Total domestic performance financed by public general university funds (GUF)	'
Higher education				HE-HERD, i.e. from own funds incl. endowments	Total domestic performance financed by the higher education sector	GERD
Private non-profit (PNP)				PNP-HERD	Total domestic performance financed by the private non-profit sector	'
Abroad				HERD other	Total domestic performance financed by abroad	' v
Total	Total performed in the business enterprise sector	Total performed in the private non-profit sector	Total performed in the government sector	Total performed in the higher education sector		
	BERD	**PNPERD**	**GOVERD**	**HERD**		
			< - PUBERD (OST category) - >			
	< - - - - GERD - - - - >					

OECD Indicators were created from the following source files, fields and criteria:

Indicator element	OECD source filename	Fields & criteria
BE-GOVERD	RDS2004-2 Table 1. Gross domestic expenditure on R&D -- GERD -- by sector of performance and source of funds	MEASURE=Million constant $ 2000 prices and PPPs; SECTFIN=Gov. fin. by Bus. enter.
BE-HERD	RDS2004-2 Table 1. Gross domestic expenditure on R&D -- GERD -- by sector of performance and source of funds	MEASURE=Million constant $ 2000 prices and PPPs; SECTFIN=Higher educ. fin. by Bus. enter.
BE-PNPERD	RDS2004-2 Table 1. Gross domestic expenditure on R&D -- GERD -- by sector of performance and source of funds	MEASURE=Million constant $ 2000 prices and PPPs; SECTFIN=PNP fin. by Bus. enter.
PNPERD	RDS2004-2 Table 1. Gross domestic expenditure on R&D -- GERD -- by sector of performance and source of funds	MEASURE=Million constant $ 2000 prices and PPPs; SECTFIN=TOTAL PRIVATE NON-PROFIT (PNP)
HERD by OECD Field of Science	RDS2004-2 Table 18. Higher education intramural expenditure on R&D -- HERD -- by field of science	MEASURE=Million constant $ 2000 prices and PPPs;
BE-HERD by OECD Field of Science	RDS2004-2 Table 20. Higher education intramural expenditure on R&D -- HERD -- by field of science and source of funds	MEASURE=Million constant $ 2000 prices and PPPs; HE/FIN=Business enterprise
GERD	MSTI2005-1 Indicator 3. GERD -- (Million 2000 dollars -- constant prices and PPPs	
Researchers	MSTI2005-1 Indicator 7. Total researchers (FTE)	
R&D personnel	MSTI2005-1 Indicator 9. Total R&D personnel (FTE)	
R&D personnel per thousand labour force	MSTI2005-1 Indicator 10.a. Total R&D personnel per thousand labour force	
HERD	MSTI2005-1 Indicator 47. HERD -- (Million 2000 dollars -- constant prices and PPPs	
GOVERD	MSTI2005-1 Indicator 54. GOVERD -- (Million 2000 dollars -- constant prices and PPPs	

GDP	MSTI2005-1 Indicator A.2. Gross Domestic Product (Million Current PPP$)	Converted to Million 2000 dollars -- constant prices and PPPs using MSTI2005-1 Indicator B. Implicit GDP Price Indices (2000 = 1)
Population	MSTI2005-1 Indicator E. Total Population (Thousands)	
Labour force	MSTI2005-1 Indicator H. Labour Force (Thousands)	
PhDs awarded	OECD Education Database: Number of graduates by field of study, level of education, programme orientation, duration of programme and sex	Country=[ALL]; Duration of programme=All educational programmes - 900000; Sex=Total males + females - 90; Level of education=Advanced research programmes - 60; Type of programme=All educational programmes - 900000; Year=[ALL]; Educational/labour market destination of programme=Total - 900000; Field of study=[ALL]
PhDs awarded by OECD Field of Science	As above	As above

The most recent UK data on GERD, GOVERD and PNPERD have been taken from SourceOECD supplemented by data from ONS, HESA and OST's own SET statistics, and have been adjusted for Million constant $ 2000 prices and PPPs.

International comparisons and data coverage

There are 25 countries (the OST comparator group) covered in this report in addition to the UK.

The OST comparator group is spread by geography and type, and are thus of value for comparisons with any national research base.

The combined output of the selected countries in the OST comparator group accounts for more than 95% of the world's relatively highly cited papers over the last twenty years. Highly cited papers are, in this context, those that have been identified by Thomson Scientific® as the most cited 1% by field and year of publication. The group covers similar proportions of total world outputs.

The EU15 non-national group was introduced in the 2004 report to summarise research activity in Europe, because of increased interest in the development of the European Research Area. The EU15 are the countries that were members of the EU for most of the period covered by the report; new member states increased the EU to 25 in 2004.

The EU15 is not included in the aggregate statistics for the OST comparator group. The EU15 bibliometric data generally reflect true aggregate figures and do not duplicate activity that is collaborative between member states. This is not always true, however, of the OECD data where some countries' data are missing from some variables.

The OST group includes the full G8, a combination of some larger and OECD countries from different continents with research bases both similar and contrasting in structure to the UK, and a spread of smaller nations with active and rapidly growing research bases with specific strengths.

Country groups

Some countries would form the normal core of any international reference set. These are major economies with a strong and diverse research base. They include countries with University-based research systems very similar to that of the UK and others with systems that are based more strongly on research institutes outside Universities. Additional performance factors related to research system can thereby be examined.

European countries provide a fuller regional economic context. Those in the OST group include medium to large research economies, have active and well established research bases and interact substantially with the UK.

Social and economic change in the former Soviet Union and among EU candidate countries suggests that monitoring research developments in this

Country group	Country name	Short code
G8	UK	UK
	USA	USA
	Canada	CAN
	France	FRA
	Germany	GER
	Italy	ITA
	Japan	JAP
G8/E Europe	Russia	RUS
Other W Europe	Belgium	BEL
	Denmark	DEN
	Finland	FIN
	Netherlands	NED
	Spain	ESP
	Sweden	SWE
	Switzerland	SUI
Other E Europe	Poland	POL
Other Europe	EU15 group	EU15
Other World	Australia	AUS
	Brazil	BRA
	China	CHI
	India	IND
	Iran	IRA
	Israel	ISR
	Singapore	SGP
	South Africa	SAF
	South Korea	SKO
	Taiwan	TWN

area will extend information gained from the core European analysis. It should be noted, however, that post-Soviet economic changes produce somewhat anomalous indicators if estimated GDP changes rapidly.

A spread of leading research economies in other continents provides a broad overview of the UK's relative international standing. This year, the rapidly evolving research performance of China has made it central to any international research comparison. India is developing more slowly but is likely to become a key focus within a few years.

Finally, smaller research economies are active in specific 'niche' areas often related to key technologies of economic significance. The countries of interest in the OST comparator group are likely to change from time to time. Those initially included continue to show rapid recent growth and a significant increase in research impact.

Reference benchmarks

Two baselines have been created as reference benchmarks, and they are used for each indicator and field. The first reference benchmark is the global total or average. The second reference benchmark is the total or average for the OST comparator group. Within the report, the specific benchmark that has been used is specified. [The relevant one depends on the availability of data for each indicator.]

Note that summed bibliometric data for the OST comparator group may appear to exceed world totals, because of joint publications between countries. This is discussed in a methodological note (below).

International data coverage

Finance and workforce data may be limited for some countries and some subject areas, particularly in the social sciences and in the arts and humanities.

Work carried out for the Economic & Social Research Council highlighted some deficits and some inconsistencies with regard to postgraduate training data for some smaller countries. Data for the G8 appear generally sound.

Bibliometric data are generally available for all countries. For the social sciences, while some larger fields appear to be reasonably well covered internationally there are other specific disciplines in which there are clear deficits for non-Anglophone countries. This means that comparisons between the USA, UK and Canada may be sound but the relative position of e.g. France and Germany would be less certain.

The research base varies in structure between countries (as noted above) and there are also differences – possibly but not necessarily as a consequence - in research culture and thus in activities such as publication and citation behaviour. We comment below on some possible factors that arise from this.

Subject disaggregation

Three principal levels of subject disaggregation are used in this report: System (i.e. country level); OECD; and UK-SUoA.

The subject disaggregation used here is nested and hierarchical. 'System' breaks down into five 'OECD' categories some of which are then broken down into the ten 'SUoAs'.

Mapping data at a subject level

Research data can be grouped at a system level (total national papers, total science and arts expenditure) or at levels of detail described as fields, subjects or disciplines. A balance needs to be struck between a coarse level of analysis and too fine a level, both of which can obscure information.

For analyses of output performance patterns, the UK's SUoAs (see below) can be used, but it is also feasible to use finer levels of discrimination. *Evidence* Ltd has developed a number of methodologies for mapping data from different sources to a common set of categories.

System (Country)

System refers to the country as a whole. This gives a national overview of research activity and performance.

System is often the only available level because data are not attributed to any specific subject category. It is not entirely satisfactory because of the innate cultural differences between major research fields. The relative size of different fields may swamp important differences between fields within countries.

OECD categories

OECD coarse-level categories are broad fields used for categorising much of the OECD database. This provides a satisfactory separation between major parts of the research base, but still obscures some performance detail.

For this OST report we have combined the OECD data for natural and agricultural sciences. The category for agriculture is useful for measuring the specific economic activity in this sector but it is of much less significance as a separate grouping for research base analyses.

The five OECD categories used here are

1. Medical Sciences
2. Natural and Agricultural Sciences
3. Engineering and Technology
4. Social Sciences
5. Humanities [including Arts where data permits]

Units of Assessment

Units of Assessment (UoAs) are the 68 subject categories established in the UK for the cyclical Research Assessment Exercises up to 2001.

A list of these categories is available from the HEFCE website

http://www.hefce.ac.uk/Research/assessment/

These categories are generally too fine and numerous for international comparisons, other than those focussing on a single discipline.

SUoAs (Super-UoAs)

SUoAs are grouped *Unit of Assessment* (UoA) subject categories. This usefully separates some of the major sub-divisions within the OECD categories, such as biological, physical and environmental sciences within the OECD Natural Science and Agricultural Sciences category.

The groups are based on an analysis of similarity of journal usage by researchers submitting to the UK Research Assessment Exercise in 1996 and 2001. Some of the groups are substantially larger than others and might be identified as 'major' fields, but this designation refers to size only rather than policy significance.

The ten SUoA categories used here are

Clinical (major) = OECD category 1

Pre-clinical and health = OECD 1

Biological sciences (major) = OECD 2

Environment = OECD 2

Mathematics = OECD 2

Physical sciences (major) = OECD 2

Engineering (major) = OECD 3

Social science (major) = OECD 4

Business = OECD 4

Humanities, languages and arts = OECD 5

Economic and social research

The application of some research indicators to the economic and social sciences is disputed, as we have noted elsewhere in this report.

Recent work for the Economic & Social Research Council has confirmed that bibliometrics must be used with caution in this area. The economic and social coverage of the Thomson Scientific journal databases is not balanced in the same way as natural science disciplines. The lower language diversity results in a deficit in coverage for some large European research economies.

The bias towards Anglophone journals may affect the UK in two ways: it is relatively less well covered than the USA, so the database has less utility, but more 'average' material may be covered than for other European competitors, so its net indexed impact may be reduced.

It is also noteworthy that a high proportion of the material cited by articles in social science journals is not covered by the Thomson databases, although this varies between disciplines.

Although the defects of existing bibliometrics are familiar to social science researchers, many of them make extensive use of journal, article and citation information in reaching judgements about research quality. However, they do so in an 'expert' fashion alongside other data and it is not possible readily to translate their approach into systematic evaluation.

The use of journal articles as a preferred output mode for economic and social research appears to be increasing, as judged by RAE data and survey outcomes. Bibliometrics are likely to be of increasing importance and bibliographic databases and indices are likely to be of increasing value to social scientists over the next few years.

Humanities, languages and arts

Previous reports have focused on the fields of Natural and Social Science research covered by the Research Councils then funded by the Office of Science and Technology. They therefore excluded the broad-based Arts and Humanities.

In 2005, a new Arts and Humanities Research Council took responsibility from the former Arts and Humanities Research Board (AHRB) and has become part of the UK's national Research Council system.

New indicators appropriate to the different research paradigms in these disciplines are likely to be required. While research funding and research training are clearly common to all disciplines their relation to performance is not the same in all cultures. Publication and citation behaviour also differs markedly, perhaps more so in the Humanities than in the Social Sciences.

Background data is being gathered by relevant agencies to support the development of new indicators and the AHRC will be exploring the options that arise. Their staff are in regular contact with the OST on this.

In the interim, it has been decided that, where the data allow, the existing indicators should be extended to capture information about humanities research. Data on the language disciplines and on the visual and performing arts is very sparse but this has been included where available.

The international databases are often much weaker on humanities and arts research activity. Many countries make no returns in this area and others, with significant research bases, supply data only in some years. This further reduces the capacity for analysis.

It is acknowledged that indicators in this report, and elsewhere, have been developed principally for use alongside the 'science research paradigm'. Their relationship to 'research performance' in the humanities is only partly understood. This year's presentation is therefore one that should stimulate the wider debate on the assessment of research in the humanities but should not be taken to provide any grounded or authoritative measure of the UK's recent standing.

Time frames

This report uses analyses of:

- Current performance, in the latest year (or five-year period) for which data are available.

- Comparisons of recent performance with an average for the previous five-year period.

- Trends in performance over the last ten years.

The emphasis in performance analysis indicators is on the current position of absolute and relative indicators for one or a group of countries.

Current performance can only be fully understood, however, if it is also set against recent and longer-term trends

Some data series only make more sense in a longer time context because of missing values or exceptional year-to-year variation.

Time windows

Five-year windows address annual activity fluctuations within subjects, smooth out marked annual changes in inputs and outputs, help to compensate for missing values in a data series and present a more readily understood profile of research performance.

Thomson Scientific® data make use of overlapping five-year windows for appropriate comparisons of e.g. citation counts across time. Because citation counts are less on average for more recent years a direct comparison between two years is sometimes meaningless. If the citations that accumulate over a fixed period of years are used then this provides a sensible reference point between publications from different years or periods.

Thomson recommends using a five-year (NSI5, National Science Indicators over 5 years) period for papers and the citations that are attributed to them. Thus the NSI5 for 1996 is the set of papers published in the years 1992-1996 and the citations to those papers that had accumulated by the end of 1996. The NSI5 for 1997 will overlap with the last four years of papers and include the next later year, with the citations that accumulate for those papers to the end of 1997.

Evidence groups data into five-year windows using the same convention. The average annual performance for a five-year window labelled 2001 will be the average for the years over the period 1997-2001.

Moving five-year windows also help to overcome the problems of missing years in OECD data.

Current performance

The last calendar year (2004) has been used for many of the indicators.

In some instances there are as yet no data for the last year, so the most recent year for which data are available is used instead. This is usually 2003.

Where five-year windows are employed, the current performance is usually based on data for 2004 or the 2004 'window' which covers the average performance for 2000-2004.

Recent performance

When 'recent' performance is calculated, this is done using the latest available data. Because some data from earlier years will be revised later, this means that the 'recent' value in on report may differ from the calculation for the same value given in an earlier report.

Recent data for the UK include selectively updated figures from the ONS.

If 'recent' data are changed then rankings may be revised as a consequence. Thus, the UK may in one report be ranked 10th recently and currently, yet in the next report be said to have improved from 12th to 10th. This will be because either the UK or another country's data has changed so that the UK's relative position for past years has fallen.

Current performance is usually compared with the average performance in recent years.

For this report, recent usually means the previous five years. If the current data refer to 2004 then the recent data refer to the average for 1999-2003.

For five-year windows, the window used for the recent comparator is specified in the particular analysis.

Longer-term patterns

Trends are important where year on year variation can only properly be interpreted in the context of the longer term. Different forms of trend analysis may require annual data or rolling five-year windows. Each can help to establish, first, whether the current snapshot is a good reflection of performance and, second, whether any projection can be made of likely future performance.

Lags between inputs and outputs

The timing (or phase) relationships between different types of data are important for SEB indicators. For example, inputs precede outputs. A specific project grant will precede the publications that report on the project outcomes by some years.

A three-year lag has sometimes been inferred in UK policy studies, mostly because this fits with a long established three-year project structure where funding is allocated in year 1 for activity that starts immediately and begins to show substantive results in year 2 leading to articles being written in year 3 and later. Publication may occur 12-18 months after an article is written.

The time lag between input and output may vary between indicators and change over time and there may be other, less transparent, links to elucidate. There is therefore no simple, universal time lag that could readily be applied to this indicator system.

We could also consider not three- or five-year lags but the longer term. For example, we could explore patterns at institutional level over ten-year or even longer periods that take into account investment through capital as well as recurrent spend.

Furthermore, there is no evidence either that all national systems have the same time lags or that these differ. We do know that there are differences in citation behaviour between countries (we discuss this in more detail below) which sometimes leads to a 'spike' in relative UK citations soon after publication at the same time as a relative 'trough' in Japanese citations. Later analyses shows the Japanese tend to pick up but at a slower rate while some UK papers may peak early.

To summarise, no time lag has been applied to the secondary indicators in the first cycle of OST SEB indicators because we have no clear and uniform basis on which to make general assumptions. Output data are therefore compared with input data for the same year, although these inputs cannot have funded these outputs. More specific analyses with different time lags may be used in a future indicator cycle, but this will depend on exploring alternative scenarios to throw light on this aspect of research performance.

Bibliometrics

Bibliometrics are important in indexing research performance. Bibliometric data have particular characteristics of which the user should be aware, and these are considered here.

The data come from Thomson Scientific® databases, a single source collated to the same standard and therefore providing a level of comparability not found in other data. The data are also valuable because they can readily be disaggregated by field, by year and for most countries.

Journal papers (publications, sources) report research work. Papers refer to or 'cite' earlier work relevant to the material being reported. New papers are cited in their turn.

Papers that accumulate more citations are thought of as having greater significance or influence in their field. Citation counts are therefore recognised as a measure of impact, which can be used to index the excellence of the research from a particular group, institution or country.

Most impact measures use average citation counts from groups of papers, because some individual papers may have unusual or misleading citation profiles. These are diluted in larger samples.
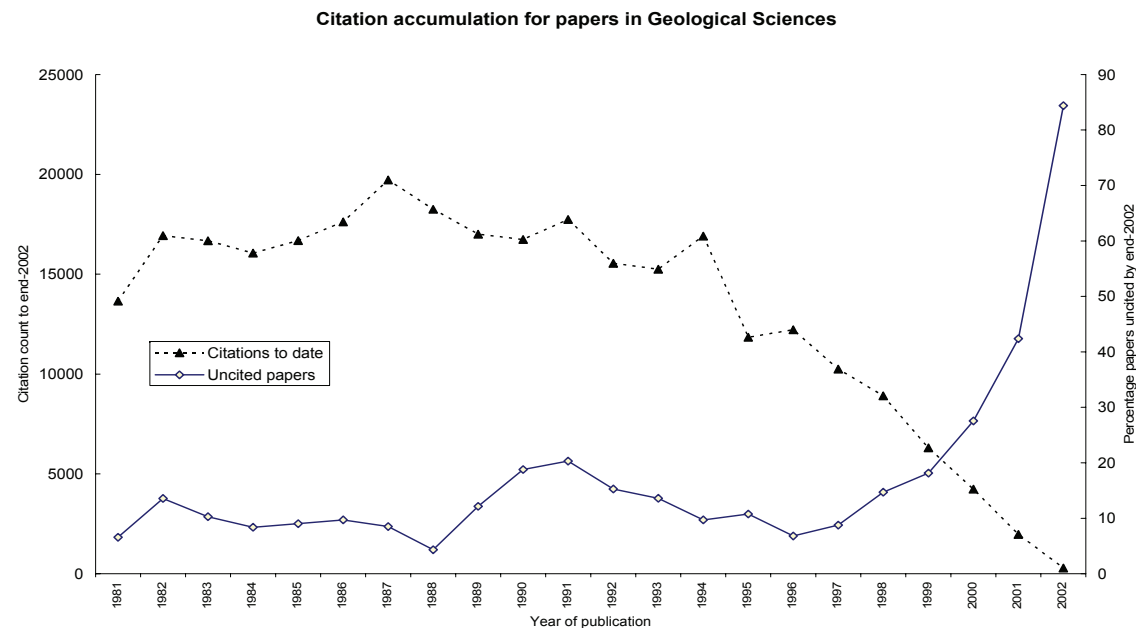
Time factors

Citations *accumulate* over time. Older papers therefore have, on average, more citations than more recent work. The following Figure shows the pattern of citation accumulation for a set of 30 journals in Geological Sciences. Papers less than 8 years old are, on average, still accumulating additional citations. Only for older sources has the citation count plateaued.

Papers are also *more likely* to be cited at all over time. The Figure shows that the percentage of papers that have never been cited drops over about five years. Beyond five years, some 10% or more of papers continue uncited.

Account must be taken of these time factors in comparing current research with historical patterns. For these reasons, it is sometimes more appropriate to use a fixed 5-year window of papers and citations to compare two periods than to look at the longer term profile of citations and of uncitedness for a recent year and an historical year.

Citation accumulation for papers in Geological Sciences

Discipline factors

Citation rates vary between disciplines and fields. On the whole, citations accumulate more rapidly and plateau at a higher level in Biological Sciences than Physical Sciences, and Natural Sciences generally cite at a higher rate than Social Sciences.

There is no intention that the indicators reported here should be used for disciplinary comparisons within countries. Account must be taken of disciplinary factors in comparing impact indices. For example, a direct comparison of citations per paper between Biochemistry and Economics is inappropriate and would be misleading. The world average in a given field, however, can provide a useful reference point for comparisons between countries. It is more informative if the values for each country within any discipline are normalised, or REBASED against a world average for that field. Rebased impact factors in this report refer to a world average index of 1.0 for that field

All comparisons made in this report are "like-for-like". Citation rates may be less informative about performance in some fields because they may be lower or citation behaviour (the reasons why people cite other work) may be poorly understood. Nonetheless, so long as we use fair comparisons we should expect that such variations do not unbalance our conclusions. For example, UK Natural Science is compared with USA and Germany Natural Science, and UK Social Science in 2003 is compared with UK Social Science in 1998-2002. Only if behaviour within a discipline differs significantly between countries or if the data for one country is unrepresentative compared to others would the comparisons become invalid.

Bibliometric data for Social Science should always be regarded with caution. Recent analyses confirm that, while they may be both valid and useful, there are issues about national imbalances – especially at a disaggregate field level – and any publication analyses must be interpreted against the background context of other indicators and detailed commentary.

Location factors

Citations accumulate for each author on a paper and for each institution and country included in the authors' addresses. The world total of citations is consequently less than the sum of national citations.

- As an example, imagine a set of four papers. One has a German author, one has a UK author and two have both UK and German authors.

- Each paper is cited twice. There are a total of eight (8) citations.

- There are six UK citations: two to the UK only paper and two to each of the jointly authored papers.

- The (UK + Germany) citations = 12, because there are similarly six German citations. This exceeds the actual total of 8.

While it is feasible to create an overall total for numbers of world papers and citations, from which duplication can be removed, it is onerous to do this for a changing sub-set of countries for each data analysis. De-duplication has been done for the EU15.

Data are only available for some countries in the OST comparator group for some analyses, (e.g. data on researchers are a sub-set). Consequently, where the sum of papers or citations is calculated for the sub-set (e.g. to index citations per researcher), then the total includes duplicates for joint papers.

The value of the UK activity in relation to both the OST comparator group and the world total is given for indicators involving only publications data. In these cases, it will be seen that the UK is apparently smaller as a proportion of the OST comparator group than of the world, because of the duplication between countries. Nonetheless, this has no effect on comparative values such as rank or ratios of activity.

National factors

The volume of papers on Thomson databases for G8 countries is not disproportionate in the Natural Sciences, although there is said to be an Anglophone bias and some of these countries do not have English as a first language. The imbalance in some – if not all - the Social Sciences and in the Humanities is greater.

There is some selectivity in publication behaviour in some countries. For example, a study of Spanish Earth scientists (J Rey-Rocha, Scientometrics (2002) 55, 377) showed that they publish parochial reports in Spanish journals not indexed by Thomson. The effect of this on Spanish citation indices is not clear but it may mean that only higher impact work is indexed. If a similar pattern is true for other countries, there would then be a consistent sampling bias in favour of more citable publications for non-Anglophone countries (i.e. lower volume but higher average quality).

Citation behaviour also differs between countries. UK researchers tend to access new work and cite it more rapidly than researchers do elsewhere. This means that some high UK relative citation rates may dip later. This does not distort overall perceptions of relative national performance but it is important to be aware that this is a background component.

Glossary

AHRC The Arts and Humanities Research Council funds research and postgraduate study within the UK's **HEIs** in traditional humanities subjects, such as history, modern languages and English literature, and in the creative and performing arts. It also provides funding for museums, galleries and collections that are based in, or attached to, HEIs in England. The AHRC was established on 1 April 2005, and replaced the Arts and Humanities Research Board.

BBSRC The Biotechnology and Biological Sciences Research Council receives money from **OST** through the Science Budget to fund academic research and training in biosciences. It was formed in 1994 by the merger of the former AFRC with the biotechnology division of the former SERC.

BERD is the total R&D performed in the business sector. Where the prefix BE- is used for other R&D spend (e.g. BE-HERD), this denotes that portion of the R&D within the sector concerned that is financed by the business enterprise sector.

Bibliographics is used as a term for descriptive data referring to publication activity or submissions that do not provide a direct measure of performance.

Bibliometrics are measures of research activity and performance derived from databases of journal articles and of citations of those articles. There are associated secondary measures based on relative journal and article citation rates.

BSTS refers to OECD's Basic Science and Technology Statistics. These are disaggregated further than **MSTI** but cover fewer countries. In 2004, BSTS was succeeded by Research and Development Statistics (**RDS**).

Chief Scientific Adviser is the head of **OST** and provides advice to the Government on science, engineering and technology matters.

Citations are the formal references made in a journal paper or other publication to earlier work. These citations (or cites) usually indicate that the earlier work supports the publications methods, data or claims in some way. Negative citations may also occur.

DG-RC is the Director General of **Research Councils**, a senior member of the **OST** who advises on the allocation of the UK **Science Budget**.

Efficiency in the context of *Evidence* Ltd reports is the relationship between the volume of outputs from the system and a stated volume of inputs.

Effectiveness in the context of *Evidence* Ltd reports is the relationship between the volume of outputs and their average quality.

EPSRC The Engineering and Physical Sciences Research Council is the UK's main agency for funding research and related postgraduate training in engineering and the physical sciences. It emerged from the former SERC in 1994.

ESRC The Economic and Social Research Council is the UK's leading research funding and training agency addressing economic and social concerns. Its predecessor until 1983 was the Social Science Research Council, established in 1965.

Eurostat is the Statistical Office of the European Communities situated in Luxembourg. It had a budget of €140 million in 2000. Established as a directorate of the European Community in 1959, its modern task is to provide the European Union with a high-quality statistical information service at European level that enables comparisons between countries and regions.

Expected citation rate – see Journal Average Impact factor

Frascati Manual was first published as the outcome of an OECD meeting in June 1963 with national experts on R&D statistics at the Villa Falcioneri in Frascati, Italy. The result was the first official version of the *Proposed Standard Practice for Surveys of Research and Development*, now commonly known as the Frascati Manual. The Working Party of National Experts on Science and Technology Indicators (NESTI) has now developed a "Frascati Family" of methodological manuals, including publications on innovation (**Oslo Manual**), human resources (**Canberra Manual**) and the technological balance of payments and patents.

FTEs Full Time Equivalents. Many research and other posts are filled on a fractional basis and there are also a significant number of part-time research students. The balance of full and part-time posts and students varies between institutions and a direct head-count may therefore be a poor indication of the actual volume of activity. To account for this, head-count numbers may be converted to full-time equivalents (e.g. two 0.5 FTE posts equate to 1.0 FTE). In other cases the actual head count may be more relevant.

G8 refers to a group of eight leading economies. This comprises the UK, USA, Canada, France, Germany, Italy Japan and Russia. The G7 is an earlier version of the same group, without Russia.

GERD is Gross Expenditure on R&D

GOVERD is total R&D performed in the government sector.

HE is higher education in the broad sense.

HEIs are higher education institutions. In the UK specifically they are the universities and colleges funded for teaching and research by the regional HEFCS.

HERD is total R&D performed in the higher education sector (which is very broadly defined by OECD and may in some countries cover much more than universities and colleges). That part of HERD funded by the business enterprise sector may be denoted as BE-HERD.

HESA The Higher Education Statistics Agency was established in 1993 and is the central source for HE statistics. It seeks to standardise data collection processes and formats.

Impact is the average citation rate of the outputs for a specified source (country, organisation, author). This is a simple and direct measure of research performance since citations usually reflect acknowledgement by later authors of the value of a published item. The impact figure can be taken as a local measure of the 'worth' of publications. In this report, impact figures are *rebased* to take account of the world average figure in the field. In this way, comparisons can be made between fields that have different raw impact values to judge their effectiveness.

ISI is the older name for the Philadelphia based division of **Thomson Scientific**. The former Institute for Scientific Information was founded by Eugene Garfield in 1958. It is the world's premier source of information on journal outputs and their citations. ISI provides a range of commercial information products designed to support research and research management, including 'Current Contents' and the Science and Social Science Citation Indexes. ISI indexes over 8,000 journals in 35 languages, which is agreed to represent most or all of the material likely to be recognised as having significant value to others for most science fields. ISI data may under-represent new and emerging fields and so disbenefit interdisciplinarity and is less rich in coverage of the Social Sciences. It covers the Arts and Humanities less well.

Journals Research findings are published in journals, conference proceedings and books. Journals are the main mode of rapid output for most scientific fields. The first research journal was reputedly the *Journal des Scavans*, inaugurated in 1665. It was published by Denys de Sallo in Paris. By 2000 there were estimated to be about 20,000 journals carrying over one million research papers per year.

Journal Average Impact Factor (JAIF) can be calculated as the average number of citations received by the papers in a stated journal in a particular year. JIF varies between journals: those such as 'Nature' and 'Science' tend to publish papers that receive many citations and they have a high JIF. Publication in a journal with high impact is often seen as a mark of prestige. JIF for any one journal varies between years, because more recent years have obviously had less time to accumulate citations.

JIF is also calculated through a more complex algorithm by ISI. The ISI® impact factor system is a commercial product available through Thomson Scientific.

MRC The Medical Research Council was founded in 1913 (initially as a Medical Research Committee, under the provisions of the National Health Insurance Act, 1911). It promotes research into all areas of medical and related science with the aims of improving the health and quality of life of the UK public. It funds research both in Universities and through its own institutes and units.

MSTI refers to OECD's Main Science and Technology Indicators. These are at a summary level compared to **RDS (BSTS)** but cover more countries.

NERC The Natural Environment Research Council was established by the **Science and Technology Act (1965)** with responsibilities transferred from the Nature Conservancy and the National Oceanographic Council. It now promotes and support research, survey, long-term environmental monitoring and related postgraduate training in terrestrial, marine and freshwater biology and Earth, atmospheric, hydrological, oceanographic and polar sciences and Earth observation. It funds research in Universities and in its own institutes.

NSI refers to Thomson ISI ®'s National Science Indicator product. The NSI5 is the standard five year grouping of bibliometric data used in the NSI to provide constant time windows for trend analysis, because citations accumulate over time and comparisons between years would otherwise be problematic.

OECD is the Organisation for Economic Cooperation and Development and is a major source of data for international R&D statistical R&D statistical analyses. It evolved in 1961 from the former Organisation for European Economic Co-operation which was formed to administer American and Canadian aid after World War II. It now has 30 member and 70 associate countries. Its members account for about two-thirds of global goods and services.

Office of Science and Technology – see OST

ONS is the Office for National Statistics. It was created in April 1996 when the Central Statistical Office merged with the Office for Population, Censuses and Surveys. It is the government department that provides statistical and registration services. The Director of ONS is the National Statistician who is also Registrar General for England & Wales. ONS is responsible for producing economic and social statistics used by Government to create evidence-based policies and monitor performance against them. The Office builds and maintains data sources both for itself and for customers.

OST is the UK Government's Office of Science and Technology. It was created in 1992 by the amalgamation of the Cabinet Office's Science and Technology secretariat and the Science Branch of the former Department of Education and Science. The head of OST is the **Chief Scientific Adviser**. OST is also the home of the **Director General of Research Councils**

Output is specifically the numbers of journal articles recorded on the databases of ISI but is used generically to refer to other outputs from research, including patents and highly trained people.

Output volume in research journals world wide was estimated in 2000 to be about one million research papers per year in some 20,000 titles.

PDRAs are Post-Doctoral Research Assistants, the non-permanent research workers in the transition between PhD training and full independence. They are usually employed on short–term, e.g. 3 year, research grants and contacts.

Performance in regard to research is frequently indexed as the impact of outputs. In *Evidence* reports there are a wider range of performance indicators, and the ratio between research input and output as well as impact can be an important measure.

Period is used for various time windows:

- The period for which ISI data on outputs and impact are available, 1981-2000

- The period to present from the first Research Selectivity Exercise in 1986.

- The period between RAEs, e.g. a recent 1996 and current 2001 RAEs.

PGRs are Post-Graduate Research students. Along with journal articles they are one of the key outputs from the research base.

PNPERD is the total R&D performed in the private non-profit sector

PPARC The Particle Physics and Astronomy Research Council funds research and training in particle physics, astronomy, solar system science and particle astrophysics. It supports international scientific facilities in Edinburgh, La Palma and Hawaii.

PPP Purchasing Power Parity states that exchange rates between currencies are in equilibrium when their purchasing power is the same in each of the two countries. This means that the exchange rate between two countries should equal the ratio of the two countries' price level of a fixed basket of goods and services. The simplest way to calculate PPP between two countries is to compare the price of a "standard" good that is identical across countries. Sophisticated versions of PPP look at a large number of goods and services. One of the key problems is that people in different countries consume very different sets of goods and services, making it difficult to compare purchasing power.

PSA refers to the Public Service Agreement system. This was introduced in 1998 with the intention of setting out publicly clear objectives and targets showing what Government departments aimed to achieve in terms of public service improvements.

PUBERD is the sum of GOVERD and HERD, equating to R&D performed in the publicly funded sectors

Purchasing Power Parity, see PPP.

R&D is defined by the **OECD** as Research and Development.

R&D personnel is defined by **OECD**/**Frascati** as all persons directly employed on R&D, as well as those providing direct services such as R&D managers, administrators and clerical staff.

Ranking refers to the position an institution holds relative to others in the same field. The data may be ranked according to output volume (numbers of

papers produced in a given period) or impact (average of citations per paper in some given basket of publications).

RBI ReBased (or relative) Impact compares performance to a world average for that discipline and year. At a fine level this relative impact can be assessed for specific journals. Science papers tend to attract more citations than social sciences, and there are variations within science. Older papers naturally have more citations than new papers. Unless these factors are taken into account it is not reasonable to compare citation rates. Reference to the appropriate world average allows this comparison.

RDS refers to the OECD's Research and Development Statistics which replaced the former **BSTS** in 2004. They are disaggregated further than **MSTI** but cover fewer countries.

Relative citation rate – see rebased impact.

Research Assessment Exercise The RAE is the cyclical process of assessing UK University research. RAE grades are used as weighting factors to determine the allocation of research resources. RAEs have taken place in 1986, 1989, 1992, 1996 and 2001. The next is in 2008.

Research Councils are independent Non-Departmental Public Bodies (NDPB), established by Royal Charter and accountable to Parliament through the DTI's Office of Science and Technology (**OST**).

Researchers is an **OECD**/Frascati definition used to denote professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems and also in the management of the projects concerned

Royal Society, The, is the UK's national academy of science. It was founded in 1660, is independent of UK government (although receiving a grant-in-aid through the **Science Budget**) and has some 1300 Fellows and Foreign Members. It is the world's oldest scientific academy in continuous existence.

Science Budget is the money allocated to the **Research Councils**, which funds their own institutes and HEIs, usually in the form of peer-reviewed grants for specific research projects as part of the dual support system and through research studentships. There are also directed programmes, initiatives and centres

Science Citation Index is a main ISI database of scientific journal publications and their citations and can be searched electronically.

SEB is the national Science and Engineering Base (the acronym also refers to the Society for Experimental Biology).

SET refers to Science, Engineering and Technology.

Share is the fraction or percentage of e.g., outputs published by the peak compared to the UK total. It is also used for other research activity measures.

Sources are the publications (papers, articles) in journals tracked by the ISI database. In this report, sources are presented at the UoA level where possible. For example, when reporting on UoA 3 (Hospital-Based Clinical) all relevant sources for the institution are reported.

SUoAs (Super-UoAs) are disciplinary groupings of cognate UoAs with similar publication profiles.

Super-UoAs see SUoAs.

Thomson Scientific is the current name of the former **ISI**.

Thomson Corporation is a leading international business with annual revenues of approximately US$6billion and employing about 35,000 people worldwide. The Corporation's common shares are listed on the Toronto (TSE: TOC) and London stock exchanges. *Evidence* has a strategic alliance with Thomson Scientific®.

UoAs are Units of Assessment, the disciplinary units used as subject categories for research assessment. In 1992 there were 72 UoAs, but in the 1996 and 2001 RAEs a system of 69 UoAs was used, not all of which were active on both occasions.

UK average impact is the average number of citations per paper attributable to an UK address for publications in that field. For UK HEIs the average impact is the average of the total HEI dataset and not the average of the individual HEIs.

Workforce (labour force) is an OECD term used to denote the total number of persons available for work, whether in employment or not