Measuring UK public-funded gross regional capital and non-capital expenditure on research and development

Methods used to produce experimental UK public-funded gross capital and non-capital expenditure on research and development, International Territorial Level 1 geographies, financial year ending 2021.

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1 . Overview

This methodology note accompanies experimental regional estimates of UK public-funded gross capital and non-capital expenditure on research and development (R&D) for the financial year ending (FYE) 2021. These estimates have been developed to serve as a baseline for the measurement of the government's Levelling Up mission on public-funded R&D, as outlined in the Levelling Up White Paper, published on GOV.UK. This requires regional estimates of expenditure on R&D performed both within the government sector (in-house performed R&D) and outside of government (purchased or funded R&D).

The purpose of this note is to explain the methodology and data sources used to compile the estimates. It describes how they differ from the methods and terminology used to produce official gross government-funded R&D expenditure statistics derived from the UK government expenditure on research and development (GovERD) survey.

This methodology note will also discuss data quality, strengths and limitations, and future development plans for producing regional public-funded R&D statistics.

2 . Glossary

Research and development (R&D)

Research and development (R&D) refers to any creative and systematic activity that contains a certain amount of novelty – which includes the development of new concepts, products and processes – with the aim of increasing the stock of knowledge. Statistics presented in this article are compiled in line with internationally-agreed best practice as defined in the Frascati Manual 2015 by the Organisation for Economic Co-operation and Development (OECD).

Frascati Manual

The Frascati Manual (2015) is a guide produced by the OECD on the definition and measurement of R&D. The definition of R&D used to produce these estimates is derived from the Frascati Manual.

Purchased or funded R&D

Purchased or funded R&D is any R&D activity that is conducted by an organisation outside of government but is purchased, or at least partially funded, by the government sector.

In-house performed R&D

In-house performed R&D measures any R&D activity that is conducted within the "general government" sector of the National Accounts, which includes central as well as local government.

Gross capital and non-capital expenditure on R&D

Gross capital and non-capital expenditure on R&D refers to expenditure on R&D before the deduction of R&D related income. This does not include funds for R&D moving from one government department to another as this expenditure is captured in the receiving department's expenditure. However, it does include funding moving from central departments to local authorities who do not provide data on R&D expenditure via UK government expenditure on research and development (GovERD) returns. It is important to note that this differs from gross expenditure on R&D reported in existing GovERD publications, though the estimates used in this publication are consistent with figures produced by the GovERD survey for the financial year ending (FYE) 2021.

3 . Data sources

Experimental UK public-funded expenditure on gross capital and non-capital research and development (R&D) were produced using survey data and R&D expenditure data received from the three central government departments with the highest R&D expenditure for the financial year ending (FYE) 2021. This consists of financial microdata acquired from the Department for Business, Energy and Industrial Strategy (BEIS) – including UK Research and Innovation (UKRI) – and the Department of Health and Social Care (DHSC) – including the National Health Service (NHS). Additionally, aggregated regional R&D expenditure estimates were received from the Ministry of Defence (MoD). Any public-funded R&D expenditure from remaining government bodies was derived using information from the UK government expenditure on research and development (GovERD) survey for FYE 2021.

These estimates are consistent with existing official statistics on UK public-funded R&D from the GovERD survey. Please note, however, that the terminology and methodology used to compile statistics presented in this publication differ from those used to produce current GovERD statistics, meaning that both sets of statistics are not directly comparable.

4 . Methodological approach

These experimental estimates of gross regional capital and non-capital research and development (R&D) expenditure are calculated using a bottom-up approach. This approach consists of using data relating to organisations' operating locations to aggregate these estimates at the International Territorial Level 1 (ITL1) geographies, which cover the nine English regions and the countries of Wales, Scotland, and Northern Ireland. This method provides greater data accuracy than top-down approaches, where estimates of larger geographies are apportioned to lower geographies using a proxy variable or modelling techniques.

Of total non-devolved UK government gross capital and non-capital expenditure on R&D for the financial year ending (FYE) 2021, 93.3% came from the:

- Department of Health and Social Care (DHSC), including the National Health Service (NHS)
- Department for Business, Energy and Industrial Strategy (BEIS), including UK Research and Innovation (UKRI)
- Ministry of Defence (MoD)

The three central government departments also constituted 87.5% of total gross capital and non-capital expenditure on R&D, inclusive of expenditure by devolved authorities.

A bottom-up approach was used where central departmental R&D expenditure microdata was available. Elsewhere, a top-down approach was used, relying on regional civil service employment figures from Civil Service statistics: 2021, published by GOV.UK, with expenditure by devolved administrations attributed to the relevant UK country.

5 . Bottom-up aggregation of research and development (R&D) expenditure microdata

Financial microdata was received from the following government bodies:

- the Department for Business, Energy and Industrial Strategy (BEIS)
- UK Research and Innovation (UKRI)
- the Department of Health and Social Care (DHSC)

These government organisations accounted for 79.8% of total UK public-funded gross capital and non-capital expenditure on research and development (R&D) for the financial year ending (FYE) 2021. This section outlines the methodology used to produce regional R&D expenditure statistics for each of these government bodies.

Department of Health and Social Care

DHSC provided R&D expenditure microdata related to their central department and the NHS through the National Institute for Health and Care Research (NIHR), which oversees DHSC's R&D expenditure. This was in addition to R&D expenditure data provided by the UK Health Security Agency (UKHSA).

In-house expenditure on R&D includes expenditure attributed to DHSC associated institutes and arm's length bodies, hospitals, clinical care groups (CCG) and NHS health trusts. Where specific locations, such as hospitals or specific research institutes, are listed as the funding receivers, expenditure was attributed to International Territorial Level 1 (ITL1) geographies associated with the provided postcode.

However, CCGs, Clinical Research Networks (CRN) and NHS health trusts cover larger geographic areas that often cross ITL1 geographical boundaries. As such, expenditure attributed to CCGs and NHS health trusts that cross ITL1 geographical boundaries required apportioning across the relevant UK countries or regions. The apportioning of this expenditure is based upon two assumptions:

1. The research capability of hospitals correlates with hospital size.

2. The size of hospitals correlates with the size of the population they serve.

These assumptions allowed us to use local population figures as a proxy for apportioning expenditure received by CCGs and NHS heath trusts. CCGs have defined geographical boundaries; for instance, where a CCG crosses an ITL1 geographical boundary, population estimates were used for the segments of the CCG that fall with each relevant ITL1 geography to apportion R&D expenditure.

Health trusts do not have defined geographical boundaries, therefore defining the population they serve required the use of additional data. The NHS provides lists of all NHS operated hospitals and data on health trusts and their associated sites. To define the boundaries of health trusts, the postcode of hospitals associated with trusts were used to assign each hospital to its relevant local authority district (LAD) geography. The population estimates of each LAD where hospitals associated with a health trust were located were then aggregated to the ITL1 geography in which the LAD is situated. The expenditure attributed to the health trust was then apportioned to ITL1 UK countries and regions using the aggregated population figures.

An issue with this method is that data on NHS hospitals and health trusts published on the NHS digital website are current, and therefore not necessarily accurate and therefore not necessarily accurate for the FYE 2021 period. This is worsened by the coronavirus (COVID-19) pandemic, that was at its peak in this period, and the subsequent introduction of Nightingale Hospitals to cope with increased demand for hospital services. To account for these issues, an internet archiving tool was used to access archived editions of the NHS Digital site and download hospital and health trust data that were available in 2020.

The current hospital and health trust lists were compared with their 2020 counterparts. When hospitals and the health trusts they were associated with triangulated, they were added to the finalised list to be used for apportionment between ITL1 geographies. If discrepancies between the 2020 and 2022 data were found, they were investigated individually and then attributed to the correct health trust in the final list.

CRNs are research networks that are associated with partner health trusts. This means that the method used to apportion health trusts could be adapted to suit CRNs. As such, the proportional population estimates by ITL1 UK country or region that were used to apportion health trusts, were aggregated to create a set of population proportions for each CRN by ITL1 geography. This was then used to apportion expenditure received by CRNs to ITL1 areas.

Other organisations that received funding for R&D from DHSC were subject to checks. This was to ensure that the effect of headquarters was taken into account, and to understand whether attributing the expenditure given in the data to the organisations' headquarters location was correct. The methods used to check headquarters are detailed further in Section 6: Headquartering checks.

Some DHSC expenditure on R&D flows through other government departments whose expenditure on R&D is captured elsewhere. Section 7 provides more information on the approach for these cases.

Department for Business, Energy and Industrial Strategy

BEIS provided microdata on R&D expenditure allocated to BEIS partner organisations and programmes. In FYE 2021, BEIS allocated R&D budget to the following partner organisations:

- the UK Space Agency
- the UK Atomic Energy Authority
- the Met Office
- the National Measurement System – provided via the National Physical Laboratory
- the four National Academies – the Royal Society, the British Academy, the Royal Academy of Engineering and the Academy of Medical Sciences

BEIS microdata also captured programmes that are part of R&D-specific funding pots as well as expenditure on other projects that contain a R&D element. Some BEIS programmes are allocated to arm's length bodies, such as the Government Office for Science, the UK Research and Innovation (UKRI) or the Office for Life Sciences, and to external organisations such as Diamond Light Source Ltd.

Please note that the following BEIS programmes, that are conducted by UKRI via Innovate UK, are not included in this microdata:

- Aerospace Technologies Institute
- Automotive Innovation Programmes
- Centre for Connected Autonomous Vehicles
- Building Information Modelling
- Energy Research Accelerator
- Materials Processing Institute

These programmes are included in the microdata received from UKRI. Section 7: R&D funds flowing within government provides further details about R&D funds flowing within government organisations.

The location information associated with each organisation that received R&D funding from BEIS were checked with the locations of their UK sites to understand whether the provided information reflected the location where they performed R&D activities. Section 6 provides more information about the method used for headquartering checks. However, different data collection and methods to record R&D expenditure across BEIS, its arm's length bodies, and partner organisations showed varying level of detail across BEIS microdata.

UK Research and Innovation

UKRI expenditure microdata captured expenditure on R&D from UKRI, its arm's length bodies (ALBs) and research councils, including the seven research councils, Innovate UK (IUK) and Research England (RE). This includes centres and institutes directly funded as part of their operational expenditure by UKRI's component organisations to complete R&D.

Organisations that received funding for R&D from UKRI were also subject to headquartering checks to understand whether attributing the expenditure given in the data to the organisations' headquarters location was correct. Section 6: Headquartering checks provides more information about the methods used to check headquarters in UKRI microdata.

Some UKRI expenditure on R&D is flows through other government departments whose expenditure on R&D is captured elsewhere. Section 7: R&D funds flowing within government provides more information on the approach for these cases.

Ministry of Defence

The MoD provided internally-produced regional estimates for expenditure on R&D in FYE 2021. These estimates were constructed using the MoD's R&D expenditure microdata, collated from their Office for National Statistics (ONS) GovERD survey return for FYE 2022. This was adjusted to reflect changes in project funding since the previous year. Estimates provided by the MoD account for 7.8% of total UK public-funded gross capital and non-capital expenditure on R&D.

6 . Headquartering checks

Research and development (R&D) expenditure microdata acquired from the Department of Health and Social Care (DHSC), the Department for Business, Energy and Industrial Strategy (BEIS) and UK Research and Innovation (UKRI) showed R&D location at point of allocation. This may not necessarily be the location where an organisation's R&D activity takes place (R&D performance). If, for example, the headquarters location of a private company is the only location information that is provided in the microdata, but the company performs R&D projects over several sites across the country, it would be inaccurate to attribute all R&D expenditure to its headquarters' location.

The location of R&D performance was confirmed using a multi-faceted approach. The data were first linked to the Inter-Departmental Business Register (IDBR), a government repository of business enterprise data to identify the number of operating locations held by each business. As no identifying reference was provided for enterprises in the microdata, fuzzy matching was used to merge the microdata with the IDBR.

Once the datasets were merged, the number of operating locations were identified for each enterprise. Where an enterprise had only one operating location, or all operating locations were in the same ITL1 UK country or region, it was confirmed that this is the single performance location of the R&D. Enterprises with multiple sites spread over more than one ITL1 geography were assessed on a case-by-case basis. If it was likely that their R&D activities spread over multiple sites, we used employment figures derived from the IDBR for each site as a proxy to apportion R&D expenditure across sites.

Where an enterprise had no match in the IDBR, we conducted location checks manually using desk research. How R&D expenditure should be allocated across operating locations of these enterprises was assessed on a case-by-case basis. Please note that time and resource constraints meant that manual checking of locations was limited to organisations with a combined R&D expenditure value of £2.0 million in DHSC microdata, and any organisations with a combined R&D value of £1.0 million in UKRI and BEIS microdata. In addition, manual location checks were conducted for government institutes who received significant R&D funding. Higher education institutions were assumed to perform R&D in their primary regional location, even if some do have outpost campuses outside of their local region.

7 . Research and development funds flowing within government

It is common that research and development (R&D) expenditure flows from one government department to another, either to conduct R&D activities or contract its performance outside of the government sector. There are many examples in the microdata where the same R&D fund appeared in both the funding central government department's data and that for the receiving government body. Where microdata had differing levels of information, it is expected that such R&D flows would be included in the receiving government body's microdata. Any R&D funding flowing within government was excluded in the funding central department's microdata, to avoid double-counting spend-lines. It also prevents over estimation of R&D expenditure in cases where the receiving government organisation does not spend R&D funds in the same financial year as they are received.

8 . Constraining of estimates to government expenditure on research and development (GovERD) totals

The development of experimental regional estimates of UK public-funded gross capital and non-capital expenditure on research and development (R&D) aims to provide evidence for the measurement of the government's Levelling Up mission on public-funded R&D. Unlike official R&D expenditure estimates, that focus on net expenditure on R&D, statistics in this release measure gross public-funded R&D expenditure. This excludes any income that government bodies recoup from their gross R&D expenditure, by allowing private sector organisations to conduct their R&D activities in government facilities. Examples of this include hospitals that provide drug trial facilities for pharmaceutical companies, and catapult programmes designed to encourage UK growth within certain business sectors.

The departmental estimates derived from financial microdata or aggregated regional estimates were constrained to departmental gross expenditure on capital and non-capital assets using their reported R&D expenditure in their government expenditure on research and development (GovERD) survey return for the financial year ending (FYE) 2021. This differs to the gross R&D estimates reported in the Office for National Statistics' (ONS') GovERD publication. This means that these estimates are consistent with their GovERD equivalent but are not directly comparable because of differences in methodology and data sources.

For each department, in-house performed R&D expenditure is constrained to the sum of its capital and non-capital expenditure, and any purchased or funded R&D expenditure originally conducted by local government. Please note that purchased or funded R&D expenditure from local government bodies is estimated using the value of public-funded R&D funds that central government departments allocate to local government. This is because the GovERD survey does not collect any R&D expenditure data directly from local government bodies.

Departmental purchased or funded R&D expenditure were constrained using their reported R&D spending allocated to higher education institutions, private companies, and private not-for-profit organisations in their GovERD return for FYE 2021. This total excludes any R&D located outside the UK, as overseas purchased or funded R&D estimates in this publication are derived directly from GovERD survey returns. The regional distributions derived from departmental financial microdata or aggregated regional estimates were used as a proxy to apportion this purchased or funded R&D value across all the International Territorial Level 1 (ITL1) UK countries and regions.

9 . Regional estimation of expenditure from other government departments

This section describes the methods used to apportion regional R&D expenditure across the rest of the government sector, that is directly taken from the UK government expenditure on research and development (GovERD) survey. This includes other central government departments, government agencies and devolved administrations, among others.

Devolved administrations

Each devolved administration reported their public-funded R&D expenditure in their GovERD return for the financial year ending (FYE) 2021. This information was directly attributed to the relevant UK country. Overall, devolved administrations contributed to 6.2% of total UK public-funded gross capital and non-capital expenditure on R&D during FYE 2021.

Other central government departments

All UK government departments that conduct R&D activities within the UK report their R&D expenditure through their GovERD survey return. For any government department from which financial microdata or regional aggregated estimates were not received, their reported public-funded R&D expenditure in their GovERD return was used. The methods used to apportion their R&D expenditure across all the International Territorial Level 1 (ITL1) UK countries and regions vary depending on whether the government sector conducted R&D “in-house” (in-house performed R&D) or contracted R&D to organisations outside of government (purchased or funded R&D).

In-house performed R&D was apportioned to the relevant ITL1 UK country or region using regional employment figures taken from official Civil Service employment statistics. This accounted for 1.6% of total UK public-funded gross capital and non-capital expenditure on R&D.

Purchased or funded R&D expenditure conducted in the UK was apportioned across all the ITL1 geographies using the regional distribution of UK public-funded R&D expenditure reported by the Department for Business, Energy and Industrial Strategy (BEIS), UK Research and Innovation (UKRI) and the devolved administrations. This is because BEIS and UKRI undertook a broader range of research topics than the Department of Health and Social Care (DHSC) or the Ministry of Defence (MoD), and therefore provided a more general regional distribution of R&D expenditure across the government sector. As R&D activities for some UKRI component organisations, such as Research England, are almost entirely conducted in England, R&D expenditure funded by devolved administrations are also accounted for. This included expenditure from their devolved counterparts, to avoid under-weighting of R&D expenditure in Wales, Scotland, and Northern Ireland.

Overall, purchased or funded R&D undertaken in the UK by other central government departments accounted for 1.7% of total UK public-funded gross capital and non-capital expenditure on R&D. Overseas purchased or funded expenditure by other government departments accounted for 2.9% of total UK public-funded gross capital and non-capital expenditure.

Overseas performed R&D

Any purchased or funded R&D expenditure conducted outside of the UK was derived directly from GovERD survey returns. This accounted for 7% of total UK public-funded gross capital and non-capital expenditure on R&D.

10 . Limitations and recommendations

The most significant limitation to the described methods is that financial microdata received from the Department for Business, Energy and Industrial Strategy (BEIS), UK Research and Innovation (UKRI) and the Department of Health and Social Care (DHSC) only provided information on their research and development (R&D) expenditure at point of allocation. This may not reflect the location where R&D activities are undertaken (R&D performance).

The regional apportionment methods used helped to produce more accurate estimates of R&D expenditure at point of performance, but this will never provide the accuracy of recording the location of R&D performance at project inception or contract tender. The increasing interest for more granular statistics at lower geographies show the need for improving the granularity of R&D expenditure data to accurately measure R&D performance location. The Office for National Statistics (ONS) is working with the Government Office for Science (GO-Science) to support government bodies in improving their R&D expenditure data collation processes, for the development of more accurate regional estimates of R&D expenditure in the future.

Another limitation is the handling of expenditure attributed to UK extra-regio geography and in-house performed R&D conducted overseas. It was not possible to include any in-house performed R&D expenditure conducted outside the economic territories of the UK to align with government expenditure on research and development (GovERD) statistics. GovERD estimates ultimately feed into the ONS Gross Expenditure on R&D (GERD) publication, that measures UK R&D expenditure across all four sectors of the UK economy. The purpose of these estimates is to serve as a baseline for the measurement of the government's Levelling Up mission on R&D, so it is important that they align with outputs from future iterations of the GovERD and GERD publications.

It is worth noting that the exclusion of R&D expenditure in UK extra-regio and in-house performed R&D outside the UK made a negligible impact to the regional distribution of UK public-funded R&D expenditure. Where R&D was performed in-house overseas, such expenditure was reallocated to the corresponding UK location of the organisation. The most notable example of this is the British Antarctic Survey, that performed R&D in Antarctica and the Falkland Islands, but their in-house performed R&D expenditure were attributed to their UK base of operations in Cambridge. Where possible, R&D expenditure in UK extra-regio were re-allocated to their primary UK location; elsewhere, these spend-lines were excluded.

There are some inconsistencies in the methods used to produce UK public-funded R&D expenditure across the government sector. For example, Ministry of Defence (MoD) R&D expenditure was estimated by apportioning their R&D expenditure in the financial year ending (FYE) 2021 to the regional distribution of their R&D expenditure in FYE 2022. Additional adjustments to account for year-on-year changes in R&D expenditure were made.

Currently, there are no data collection for any R&D expenditure from local authorities and health trusts. This expenditure is derived from reported R&D funding provided to local authorities and health trusts by sampled government organisations in GovERD. It is assumed that local authorities' R&D expenditure is performed in-house R&D, but this may not be necessarily the case.

Official Development Assistance (ODA) is funding provided by government bodies in the UK to promote economic development in developing countries. Some ODA funding is used for R&D development purposes. The received microdata showed that ODA funding was mostly distributed to organisations located abroad, with some funding allocated to UK higher education institutions collaborating with overseas organisations, or providing research fellowships for overseas academics. Currently, there is no information available about the proportion of ODA-related R&D funding going to UK institutions that is subsequently transferred to overseas institutions. These regional UK public-funded R&D estimates include any ODA-related R&D expenditure to any organisation conducting R&D activities in the UK. Therefore, any ODA-related R&D expenditure directly spent abroad is excluded in these estimates.

11 . UK public-funded gross regional capital and non-capital expenditure on research and development data

UK public-funded gross regional capital and non-capital expenditure on research and development
Dataset | Released 17 April 2023
Experimental UK public-funded gross capital and non-capital expenditure on research and development (R&D) by International Territorial Level 1 (ITL1) geographies during the financial year ending 2021.

12 . Related links

UK public-funded gross regional capital and non-capital expenditure on research and development: financial year ending 2021
Article | Released 17 April 2023
Experimental UK public-funded gross capital and non-capital expenditure on research and development (R&D) by International Territorial Level 1 (ITL1) geographies during the financial year ending 2021.

Frascati Manual 2015
Methodology | Released 8 October 2015
A set of internationally recognised guidelines for collecting and reporting research and development expenditure outlined by the Organisation for Economic Co-operation and Development (OECD).

Population estimates – local authority based by single year of age
Dataset | Released 30 June 2021
The mid-year (30 June) estimates of population are based on results from the latest Census of Population with allowance for under-enumeration. Available at local authority level and above.

Research and development expenditure by the UK government: 2021
Bulletin | Released 30 March 2023
Research and development and related expenditure by UK government departments, UK Research and Innovation (UKRI) and higher education funding bodies. Formerly released as UK government expenditure on science, engineering and technology (SET).

Regional UK business research and development, methods
Methodology | Released 17 April 2023
Exploring models and data linkage to develop estimates of business expenditure on research and development at International Territorial Level (ITL) 1.

13 . Cite this methodology

Office for National Statistics (ONS), released 17 April 2023, ONS website, methodology, Measuring UK public-funded gross regional capital and non-capital expenditure on research and development