



National Audit Office

Report

by the Comptroller
and Auditor General

Department for Business, Energy & Industrial Strategy

Cross-government funding of research and development

Key facts

£8.75bn

total expenditure on research and development by UK government departments, the research councils and the Higher Education funding councils in 2015

1.7%

total UK expenditure on research and development in 2015 as a proportion of GDP

£4.7bn

additional government investment in research and development by 2021

**Around
£3 billion**

total estimated expenditure on research in 2015-16 by the Ministry of Defence, the Department of Health, the Department for International Development and the Department for Environment, Food & Rural Affairs.

6

research areas we examined in detail in this report: human health, animal and plant health, climate, energy, robotics and autonomous systems, and advanced materials.

**Above
£3 billion**

total estimated annual expenditure in these six research areas

Summary

The research and development environment

1 Research and development is important for a number of reasons. It promotes economic prosperity, it assists in tackling challenges to our society and it helps to expand human knowledge. Research can encompass basic research to acquire new scientific knowledge, applied research to solve specific problems, and translational research aimed at exploiting technologies to develop new products or processes.

2 In 2015, the UK spent £31.6 billion on research and development. Around half of this total investment was funded by the business sector, while government funding of research, including spending by UK government departments, the research councils and higher education funding councils, totalled £8.75 billion. Most of the remaining funding came from overseas funders or not-for-profit organisations.

3 The Department for Business, Energy & Industrial Strategy (BEIS) has responsibility for the majority of government investment in science. It funds research and development principally through its partner organisations, the research councils, Innovate UK and the Higher Education Funding Council for England (HEFCE). In addition, around a third of public funding of research and development comes from other government departments, including the Department for Environment, Food & Rural Affairs (Defra), the Ministry of Defence (MoD), the Department for International Development (DFID) and the Department of Health, who fund research specific to their own policy areas.

4 The UK research environment is undergoing significant change. In 2015, Sir Paul Nurse's review of the research councils recommended better coordination of the research landscape and new cross-government arrangements to facilitate strategic research priorities.¹ A new body, UK Research and Innovation (UKRI), will bring together the research councils, Innovate UK and Research England (HEFCE's research funding functions). UKRI will be in place from April 2018, and is intended to create an integrated research and innovation system. In January 2017, the government published its Industrial Strategy green paper which highlighted the importance of research for economic growth.

¹ Sir Paul Nurse, A review of the UK research councils, *Ensuring a successful UK research endeavour*, November 2015.

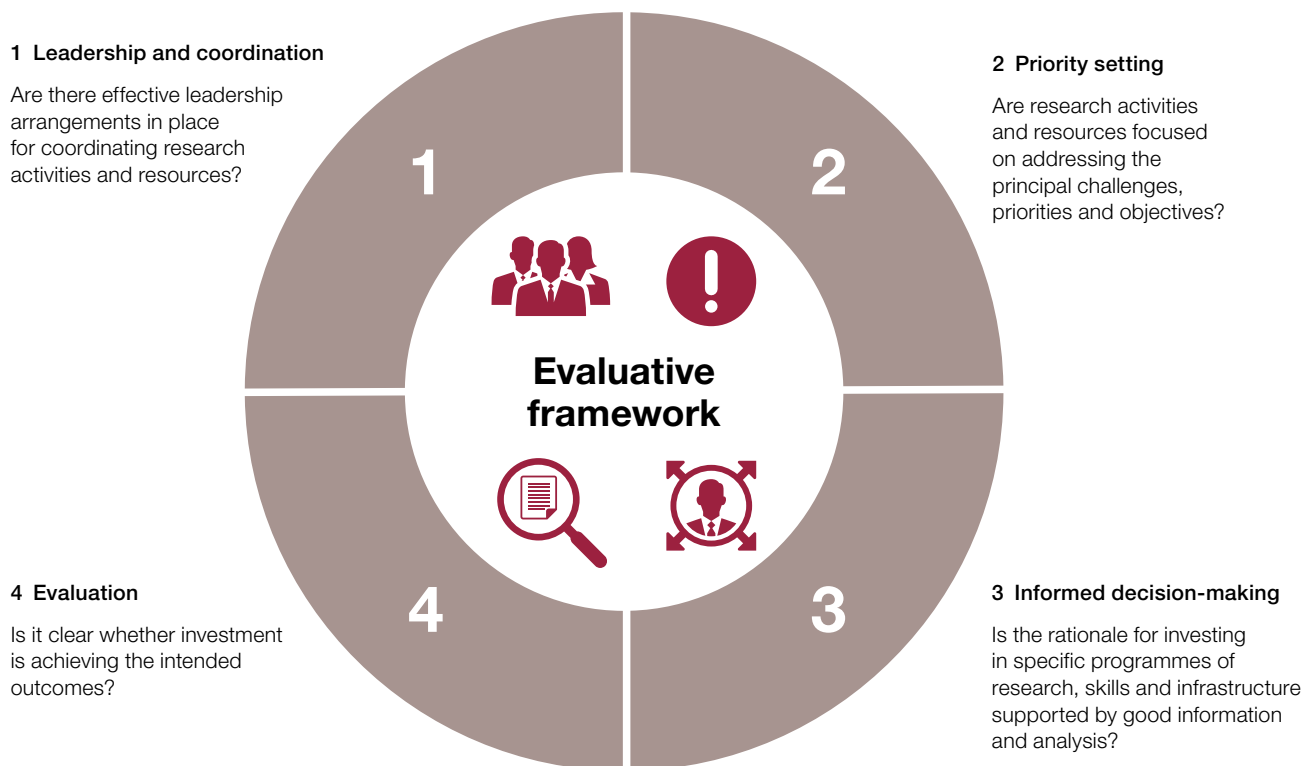
Focus of our report

5 Research and development activity receives multiple sources of public funding, including from government departments, research councils, higher education funding councils and international funds. This cross-government activity requires strategic vision and clear information about how funding is used. Funding decisions need to be supported by a good understanding of past, current and planned research investment by all funders to ensure that investment is targeted where it is most needed, and that the risks of overlap or duplication of research activity are avoided.

6 In response to this challenge, we developed a set of principles which bring together the features of well-coordinated funding of research and development (**Figure 1**). We drew on frameworks for evaluating research used by other organisations, as well as existing frameworks developed by the National Audit Office.² We also consulted on the principles with government departments that fund research and with the Government Office for Science.

Figure 1

Evaluative framework: Principles for evaluating coordination arrangements



Source: National Audit Office

² Comptroller and Auditor General, *Government's management of its performance: progress with single departmental plans*, Session 2016-17, HC 872, National Audit Office, July 2016.

7 We used these principles as an evaluative framework to assess the effectiveness of arrangements for coordinating research activity and maximising the value of government's investment in research. Our work focused on six areas of research involving multiple government departments, agencies and research councils, and substantial public funding. We compared arrangements across the six research areas in order to highlight good practice and identify where improvements could be made. The six research areas are:

- human health;
- animal and plant health;
- climate;
- energy;
- robotics and autonomous systems; and
- advanced materials.

8 The report includes an introductory chapter providing background and context to research and development (Part One), and is then structured according to the set of principles (Figure 1):

- leadership and coordination (Part Two);
- priority setting (Part Three);
- informed decision-making (Part Four); and
- evaluating the impact of investing in research (Part Five).

9 We set out our audit approach in Appendix One and our evidence base in Appendix Two. In addition, we have published our evaluative framework and a range of case studies covering the areas we examined, available at: www.nao.org.uk/report/cross-government-funding-of-research-and-development/

10 This report builds on existing work by the National Audit Office on science and research which aims to improve accountability and transparency, disseminate good practice and influence future changes to the science and research landscape. In 2016, we published a report which examined the former Department for Business, Innovation & Skills' (BIS) approach to investing in science infrastructure projects.³

11 The funding of research and development is a broad and wide ranging topic, and our focus was restricted to examining six areas of research against the key principles we identify in Figure 1. As a result, there are issues that this report does not directly address, such as the mechanisms by which individual departments manage their research budgets, the balance between public and private funding of research, and government's investment in translational research to support innovation. Such topics may be considered in future NAO work in this area.

³ Comptroller and Auditor General, *BIS's capital investment in science projects*, Session 2015-16, HC 885, National Audit Office, March 2016.

Government funding of research and development

12 As a percentage of Gross Domestic Product (GDP), the UK spends less on research and development than the average for European Union (EU) and Organisation for Economic Co-operation and Development (OECD) countries.

The EU has set a target to increase combined public and private investment in research and development to 3% of GDP by 2020. In 2015, the UK (the second largest EU economy, accounting for 16% of the EU's total GDP in 2016) spent a total of £31.6 billion on research, 1.68% of UK GDP, an increase from 1.66% in 2014. This compares with an average of 2.03% across all EU countries and an OECD average of 2.4%. The UK spends less on translating research into commercial applications than some other countries including Israel and China (paragraphs 1.4 to 1.6).

13 Since 2015, the government has made various commitments to increase research funding. In 2015 spending by UK government totalled £8.75 billion. Recent commitments include the £1.5 billion Global Challenges Research Fund, and an additional £4.7 billion spending on research by 2021 (paragraphs 1.4 and 1.9).

14 The UK's withdrawal from the EU could affect how UK research is funded in future. The UK is a net receiver of competitive EU funding for research. Between 2007 and 2013, the UK contributed €5.4 billion and received €8.8 billion. In August 2016, the government guaranteed future funding for grants won by British businesses and universities while the UK remains a member of the EU, and encouraged UK researchers to continue to bid for EU funding. However the longer-term implications for funding, freedom of movement and collaborative research projects will depend on the outcome of the UK's negotiations with the EU and future UK Government decisions (paragraphs 1.10 and 1.11).

Key findings

NAO assessment

15 Given this context, we assessed the six research areas against the set of principles in our evaluative framework. Our overall assessment (**Figure 2**) brings together our findings across the key principles of leadership and coordination, priority setting, informed decision-making, and evaluating the impact of investing in research and development.

Figure 2

Overall assessment

Overall assessment**Well established**

Coordination mechanisms and leadership arrangements are well established and functioning, consolidated data on funding and capability is used to support decision-making, and steps are being taken towards consolidated evaluation of research outcomes.

Research area (and indicative level of public funding)

Human health
(£2.3 billion in 2015)

**Progressing**

There is broad consensus of a need for coordination and leadership; mechanisms for setting strategy and sharing information are in development.

Animal and plant health
(above £0.2 billion per annum)



Energy (£0.38 billion in 2014)

**In early development**

Some evidence of coordination mechanisms but strategic leadership and coordination, and consolidated information to inform decisions and evaluation, are not yet sufficiently developed.

Climate
(above £0.09 billion per annum)



Robotics and autonomous systems
(£0.38 billion incurred or planned between 2012 and 2020)



Advanced materials
(above £0.6 billion invested in current research programmes)

**Note**

1 Total funding for each research area is not reported on a consistent basis or in one place. The data is not presented here for the purpose of comparison but to give an indication of the estimated scale of funding. Further details including sources, at Figure 9.

Source: National Audit Office

Leadership and coordination

16 While there are examples of well-coordinated research and development, or areas of progress, some important areas of science lack sufficiently developed leadership. Our examination has demonstrated that strong leadership is the driving force for coordination and making everything else happen – this includes setting priorities, and having good information to make decisions and evaluate the impact of investment. In human health, various forums play a role in ensuring a strategically coherent approach to funding research and funders of energy and animal and plant health research are currently developing leadership arrangements. Other areas are less developed. Despite consensus that it is needed, BEIS has not yet established government leadership and a strategy for investing in robotics. Government has faced challenges in establishing stable leadership in advanced materials research. The Advanced Materials Leadership Council was dissolved in December 2016 and it was not clear at that time what would replace it. It was reconvened in June 2017 as a smaller industry-led group that aims to be more responsive than its predecessor (paragraphs 2.3 to 2.13 and Figure 10).

17 Key features of effective coordination include involvement of the right participants, clarity around participants' objectives, production of tangible outputs, clear roles and responsibilities and effective incentives for staying involved. Furthermore, the costs associated with leadership and coordination can be minimal compared to the level of investment in research and the value to funders (paragraph 2.3 and Figure 11).

18 BEIS and UKRI have an important role to play to incentivise and enable effective leadership arrangements across research areas. The creation of UKRI offers an ideal opportunity to encourage and support research areas to develop effective arrangements, using good practice examples to inform changes (paragraphs 2.1 and 2.2).

Priority setting

19 Where there is effective leadership, funders work together to prioritise research investment. We found that investment priorities are well coordinated in one research area (human health) where funders use opportunities provided by forums such as the Office for Strategic Coordination of Health Research (OSCHR), to discuss and align research priorities. OSCHR was established in 2007 to ensure a more strategically coherent approach to publicly-funded health research. Two research areas (animal and plant health and energy) are in the early stages of developing new arrangements to align priorities. Some individual funders have well-developed arrangements for setting priorities that others could learn from. For example, following a review by the Government Office for Science, the Ministry of Defence has developed a process for consolidating and aligning its research priorities (paragraphs 3.2 to 3.4 and Figures 12 and 13).

20 However, collective action is needed to prioritise investment in three research areas we examined, to ensure efforts are focused on addressing the principal challenges. For research on the global climate, funders have identified a need for a strategic core climate plan to direct research efforts and discussions are under way to consider how research councils and government funders can contribute to delivery of a national climate capability. In robotics and autonomous systems, and advanced materials, key players have identified strategic themes for investment but a top-down strategy would help reach consensus on priorities (paragraphs 3.1, 3.3 and Figure 12).

Informed decision-making

21 We found that most research areas we examined lacked coherent and complete information on funding of research, skills and infrastructure. Funders recognised the importance of having data on what activities are being funded and the results of research, and have made efforts to improve shared information. However, collecting and analysing data is challenging. For example, funders found exercises to map funding information in animal and plant health and climate research time-consuming and resource intensive, particularly where data from different funders is not recorded consistently. In robotics, or advanced materials, where funders and other stakeholders are still emerging, research activity is not tracked or analysed. (paragraphs 4.5, 4.7 and Figure 14)

22 The UK needs good information on funding, skills and infrastructure to establish which research programmes and facilities are potentially affected by the UK leaving the EU to inform future priorities for UK investment in science. BEIS told us that it has collected data on which specific research disciplines have majority funding from the EU, worked with its partner organisations to understand the impact of leaving the EU on research infrastructure, and is involved in wider cross-government work to assess the impact of migration on skills. This information will support the UK's ongoing EU exit negotiations (paragraph 4.11).

Evaluation

23 Most research areas we examined lack consolidated analysis of the impact of research and development. Where leadership arrangements are established or developing, funders have taken steps to evaluate the collective impact of research funded by different organisations. In human health, funders have undertaken detailed assessments of the impacts of research funded by government and charities, and Defra has made a broad estimate of the value to society of healthy animals and plants, taking into account research funded by multiple parties. In other areas, the absence of consolidated data makes it difficult for funders to evaluate the collective impact of research (paragraphs 5.1 to 5.5 and Figure 17).

Conclusion

24 Government needs a coherent view of the UK's research strengths relative to other nations and analysis of funding in key areas of research, so that it can prioritise areas where activity is lagging behind and ensure the UK is investing in the right areas. While some of the more mature areas of research we examined have well-established arrangements to support coordination and collaboration between public-sector funders, some newer areas, including important emerging technologies and areas of national importance currently require more effective leadership. As a result, there is a risk that funders do not have coherent data across research areas on capability, funding gaps, or outcomes of research and development to inform decisions on national priorities and strategic direction.

25 The UK research landscape is set for major changes, including the formation of UKRI, the UK's withdrawal from the EU, the prominent role of science in the government's industrial strategy, and the additional funding committed to research. Given these changes, BEIS and UKRI have a significant opportunity to work with funders of research across government to continue to address the main challenges we set out in this report.

Recommendations

26 Since our fieldwork concluded in March 2017, strategic arrangements for government-funded research have developed in a number of areas. UKRI is being developed in shadow format, building on the roles played by individual research councils in coordinating research in their individual areas. In addition, arrangements for coordinating energy and animal and plant health are continuing to progress, a new Strategic Coherence of Official Development Assistance funded research board has been created to coordinate international development research, and the Advanced Materials Leadership Council has been reconvened. The BEIS/UKRI-led Industrial Strategy Challenge Fund is also providing increased oversight by, for example, coordinating future investments from a range of funders on research into robotics in extreme environments.

27 UKRI will not be formally established until April 2018, therefore the precise arrangements by which it will undertake its pivotal role of maintaining the health of UK research are still to be determined. Given this, our recommendations are designed to support the evolving UKRI to make sure that it is well placed to deliver stronger collaboration between research councils and other government departments, as recommended by Sir Paul Nurse in his 2015 review.⁴ We recognise that UKRI is one of many bodies that fund UK research, so our recommendations are directed collectively at UKRI, BEIS and government departments, with the understanding that UKRI will play a significant role in taking them forward.

4 See footnote 1.

Leadership and coordination

- a UKRI and BEIS:** UKRI has an important role to play in setting the tone at the top by providing strategic leadership, promoting collaboration, and enabling the funders of research across government to work together. By April 2018, UKRI and BEIS should build on the coordinating roles played by the research councils and begin work with other government departments and the Government Office for Science to identify the areas of research that need strategic leadership and coordination. They should bring key players together, coordinate activity where possible, and promote collective working. BEIS and UKRI should also work actively with departments to assess pre-existing leadership mechanisms and identify improvements needed to strengthen translation of research and secure benefits.
- b Funders:** Once leadership arrangements have been established and the purpose and anticipated benefits of participation clearly articulated, funders should identify opportunities and risks, address barriers to collaboration, and take collective action in response to the most significant challenges.

Priority setting

- c UKRI:** Following its establishment in April 2018, UKRI should work with BEIS, the Government Office for Science and other government departments to ensure that best use is made of the government's investment in research and development. Through its engagement with research communities, government and business, UKRI can lead efforts to join up the research landscape and address cross-cutting challenges such as robotics.
- d Funders:** Should ensure that they anticipate future challenges, use information on the results of existing research as well as current gaps to inform and shape priority setting, and make the case for where investment is required.

Informed decision-making

- e Funders:** Should put arrangements in place to collect data and make them accessible to other funders. This will aid and inform others' understanding of funding gaps, skills needs and infrastructure requirements, and help inform investment decisions. Funders should consider approaches that avoid data collection and analysis becoming a resource-intensive exercise that quickly becomes out of date: for example, by automating and standardising data collection, or by categorising types of activity at point of funding.
- f UKRI:** Improving the quality of evidence on the UK's research and innovation landscape should be one of the benefits of UKRI. We see potential for UKRI to play an important oversight role in bringing together and analysing data on publicly-funded research, and in raising awareness of gaps or overlaps in research programmes, skills, capability or infrastructure requirements.

- g UKRI and BEIS:** Working with other government departments, UKRI and BEIS should ensure that data on funding and potential skills gaps which may result from the UK's exit of the EU are used to establish the position across research areas and whether key capabilities are at risk. Once decisions on EU exit have been reached, this information should be used to inform future spending priorities across government.

Evaluating the impact of investing in research

- h UKRI and BEIS:** Should clearly articulate their expectations as to how the impact of a whole programme of investment across a research area should be collectively evaluated. Although the long-term outcomes of investment in research can take many years to establish, the results of early evaluations should prompt discussions and help inform views on what research requires ongoing investment or where resources may be better directed elsewhere.
- i Funders:** Should plan at the outset how they will evaluate the impact of investment and how they will address challenges. For example, funders should record the results of all relevant research in a way that allows outcomes to be collated and analysed across the piece. Funders should also plan how they will deal with time lags so that they can assess the short- or medium-term benefits of investment in individual programmes, as well as evaluate the outcomes of long-term investment across research areas.