

3 October 2018

Submission to the Commons Science and Technology Committee inquiry into the balance and effectiveness of research and innovation spending

Summary points

- The Royal Society strongly welcomed the government's commitment to achieving the target of 2.4% of GDP being invested in Research & Development (R&D) by 2027, and 3% in the longer term.¹
- In order to get the best from that investment the UK will need to increase its “absorptive capacity” for R&D, and ensure that the pattern of investment is shaped by some key principles.
- Foremost among the principles are that funding should support the full spectrum of enquiry, with awards made on the basis of excellence; and that there should be a diverse range of types of funding, including funding of sufficient duration to allow the pursuit of high-risk but potentially transformative research.
- In order to ensure the best research takes place and that the UK is able fully to benefit from it, it will be essential to have smooth access to a wide range of skilled people.
- As a first step the government should publish its vision for an economy that invests 2.4%, and take action now to create consistent and attractive policy and investment pathways to deliver it.
- Getting a good deal for science as the UK leaves the EU is an essential element of this vision.
- Delivering this commitment will need sustained public investment in UK R&D as well as action to create a vibrant national environment that values research and innovation and fosters that research and innovation throughout UK public services, universities, charities and businesses and attracts global investment, incentivizing companies to locate their R&D here

Introduction

1. The Royal Society welcomes the opportunity to submit evidence to the Committee's inquiry into the balance and effectiveness of research and innovation spending. The Society is the National Academy of Science for the UK and the Commonwealth. It is a self-governing Fellowship of many of the world's most distinguished scientists working across a broad range of disciplines in academia and industry. The Society draws on the expertise of its Fellows and Foreign Members to provide independent and authoritative scientific advice to regional, national, UK, European and international decision makers.
2. This submission draws on the Society's expertise and activity. The Society works to promote excellence in science - including funding researchers working in the UK and overseas – to support international scientific collaboration and ensure that science is recognised as important to every one of us and part of wider conversation².

¹ Throughout this response we use the term 'R&D'. R&D is defined as creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society and the use of this stock of knowledge to devise new applications and includes basic research, applied research and experimental development. Innovation often draws on R&D, but R&D is not always part of the activity of innovation. An innovation is defined as the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations.

² Royal Society Strategic plan 2017-22 <https://royalsociety.org/-/media/about-us/governance/royal-society-strategic-plan-2017-2022.pdf?la=en-GB> [accessed 21 September 2018]

Key principles that should shape public investment into research and innovation

3. The Society welcomes the government's commitment to "reach 2.4 per cent of GDP investment in R&D by 2027 and to reach 3 per cent of GDP in the longer term, placing us in the top quartile of OECD countries"³ and the adoption of this commitment as the central vision for UK Research & Innovation (UKRI)⁴.
4. This is an ambitious commitment - in 2016, investment in UK R&D totaled 1.67% GDP⁵ - and could play a major role in delivering the ambitions of the government's Industrial Strategy to change people's lives around the UK. Delivering this commitment will need sustained public investment in UK R&D as well as action to create a vibrant environment that fosters research and innovation throughout UK public services, universities, charities and businesses and attracts global investment, incentivizing companies to locate their R&D here. As UKRI highlights in its strategy, this change this will require a concerted effort by the Government and business⁶. Public investment into research and innovation will not be sufficient; a range of broader policy changes will be needed as well, examples will be provided later in this submission.
5. There are a number of key principles that should inform decisions over the balance of public R&D investment. The UK has a uniquely diverse funding system, creating flexibility that allows us to fund in innovative ways, contributing to what is a hugely efficient and cooperative system, demonstrated by the fact that despite having less than 1% of the world's population, the UK produces 15% of the most highly cited scientific papers⁷. We also know that public investment in R&D is highly effective in leveraging further investment by creating an environment that attracts this – for every £1 spent by government on R&D, private sector R&D output rises by 20p per year in perpetuity by raising the level of the UK knowledge base⁸. To deliver on the government's commitment the UK must identify and build on the strengths of its existing research system as well as addressing gaps and working in innovative new ways.
6. **To fully realise the economic and social benefits of research and innovation, there must be support for the full spectrum of inquiry.** Applied investigation needs a constant stream of ideas from discovery-oriented work; indeed many benefits of 'blue skies' research are unforeseen but are of transformative use to society.
7. **Funding should be awarded on the basis of excellence, assessed by international peer review, and insulated from political pressure.** It is important that excellence should remain the basis for funding research in the UK. Excellence in research and innovation brings major economic, social and health benefits. It is directly related to impact – they are interdependent and vital for the development of new ideas. This is recognised by UKRI in its strategic perspective, which commits to "Continue the commitment to the Haldane principle and make funding decisions on the basis of excellence. We will make proper use of expert review in our research funding and assessment

³ BEIS (2017) Industrial Strategy: building a Britain fit for the future

<https://www.gov.uk/government/publications/industrial-strategy-building-a-britain-fit-for-the-future> [accessed 21 September 2018]

⁴ UKRI (2018) Strategic Prospectus: Building the UKRI Strategy <https://www.ukri.org/files/about/ukri-strategy-document-pdf/?pdf=Strategic-Prospectus> [accessed 21 September 2018]

⁵ ONS (2018) UK gross domestic expenditure on research and development 2016

⁶ UKRI (2018) Strategic Prospectus: Building the UKRI Strategy <https://www.ukri.org/files/about/ukri-strategy-document-pdf/?pdf=Strategic-Prospectus> [accessed 21 September 2018]

⁷ Elsevier. International comparative performance of the UK research base 2016. A report prepared by Elsevier for the UK's Department for Business, Energy and Industrial Strategy.

⁸ Jonathan Haskel, Alan Hughes, Elif Bascavusoglu-Moreau (2014) The Economic Significance of the UK Science Base A REPORT FOR THE CAMPAIGN FOR SCIENCE AND ENGINEERING

processes and continually strive to maximise our impact and efficiency.”⁹ A focus on excellence must be the driving principle in providing support across disciplines and across the full spectrum of research inquiry. It is possible to identify emerging areas of technology and take steps to ensure that the research ecosystem is prepared to develop and exploit these. These steps must complement, but not overrule, the focus on excellence. Successful models exist such as the Office for the Strategic Coordination of Health Research (OSCHR) that support the application and translation of basic research into patient care and economic benefit and approaches taken by the Alan Turing Institute and Faraday Institute, in creating institutional hubs or focal points for research that cuts across a range of domains.

8. **A diversity of funding to support a diverse system.** One of the UK’s strengths is the breadth of its research and innovation base¹⁰. A healthy research ecosystem supports many different types of research activity that interact and relate in different ways. Therefore it is important that there are a range of different types of funding and investment to support and incentivise these different behaviours. Central to this is the dual support system which consists of two complementary streams, one targeted at specific discipline areas (allocated by the Research Councils) and the other a block grant to institutions (allocated by Research England and its equivalents). The latter block grant can be deployed on research priorities at the discretion of the universities themselves. As a recent Wellcome Trust report highlights “no other funding source currently offers this unique combination of scale, stability and flexibility.”¹¹ **The balanced funding principle is enshrined in law¹² and requires a reasonable balance in the allocation of funding by the seven research councils and Research England. However Innovate UK and UKRI’s direct funding activities sit outside this balance. Recognising the value of the dual support system, it will be important to consider the impact of any change in the relative allocations to the UK’s research ecosystem as a whole.**
9. The National Productivity Investment Fund¹³ targets spending at a number of areas that are critical for UK productivity, including R&D. A number of targeted funds stem from this including:
 - the Industrial Strategy Challenge Fund, created to provide funding and support to UK businesses and researchers, to meet the major industrial and societal challenges of our time and allocated by UKRI with partners;
 - the Strategic Priorities Fund that will invest in strategically important research and innovation and emerging priorities, in multi- and inter-disciplinary research, and will support collaboration with Government departments and the priorities of BEIS Public Sector Research Establishments. This is allocated by UKRI.
 - the Strength in Places fund intended to support innovation-led relative regional growth by identifying and supporting areas of R&D strengths, and enhance local collaborations involving research and innovation. This UK-wide fund will be implemented by Research England in a delivery partnership with Innovate UK, on behalf of UKRI.

⁹ UKRI (2018) Strategic Prospectus: Building the UKRI Strategy <https://www.ukri.org/files/about/ukri-strategy-document-pdf/?pdf=Strategic-Prospectus> [accessed 21 September 2018]

¹⁰ Elsevier (2018) International comparative performance of the UK research base 2016. Among the five core findings of the report is that ‘The UK research base is well-rounded and demonstrates excellence in diverse research fields’

¹¹ Wellcome (2018) *Empowering UK universities: how strategic institutional support helps research thrive*

¹² Higher Education and Research Act (103:4; 95:1; 97): <https://www.legislation.gov.uk/ukpga/2017/29/part/3> [accessed 24 September 2018]

¹³ Initially announced in the 2016 Autumn Statement <https://www.gov.uk/government/publications/autumn-statement-2016-documents/autumn-statement-2016>

10. These funding streams seek to incentivize different, valuable behaviours and sit alongside funds that support and incentivize the full spectrum of inquiry.- A challenge-based approach can help develop applications that address real-world issues. Many of the major challenges that society faces today will require solutions developed through innovative interdisciplinary and cross-disciplinary collaboration. Improving support for and addressing the barriers to this work will contribute to scientific advances at the interface of disciplines, spur the development of new technologies and ultimately support the economy and develop novel solutions to societal challenges. Different sectors and places may offer distinct opportunities. Regional strategies should foster local strengths in research, innovation and businesses, taking opportunities to better integrate and grow these, as well as boosting existing centres of excellence. It is important that excellence should remain the basis for funding research in the UK; at a recent event that the Society hosted in Newcastle exploring what the 2.4% target may look like in the North East region, participants from all over the North East were clear that they wanted to have the tools to be able to compete on a level playing field with other regions of the UK. **As they progress, these funds should be evaluated thoroughly, both in isolation and in terms of their roles as parts of the UK's wider research ecosystem.**
11. **Funding of sufficient duration to allow the freedom to pursue high-risk, investigator led ideas.** Discovery-oriented research can deliver unforeseen but transformative benefits. However long-term timeframes are required to make new scientific discoveries and realise the full potential of these, whether that is bringing a new drug to market or developing technologies to meet challenges such as energy or climate change. Both research funding and support for commercialization must recognise these timeframes and help create the necessary freedom within the system to pursue promising ideas. Initiatives such as R&D tax credits represent significant government investment in R&D and are well-liked. However there is value in exploring a range of initiatives and incentives that can support the development of emerging R&D-intensive sectors by both supporting R&D and driving demand for new products and increasing the confidence of investors. For example, the Society's Machine Learning report¹⁴ recommended a mix of initiatives to enable the UK to capitalize on its strong history of leadership in this area. These include public-sector procurement processes and support for businesses using machine learning as part of the Small Business Research Initiative.
12. **Investing in research and innovation also requires investing in skilled people:** Decisions over the balance of research and innovation investment and evaluation of its effectiveness cannot be taken in isolation from skills and immigration policy. People with the right skills are essential for all parts of the research and innovation ecosystem including established industries, start-ups, scale ups and academia. The UK benefits from a highly international research workforce – its reputation for excellence attracts people from around the world, and allows it to compete with other scientifically excellent nations for international talent. However it also has significant skills gaps. To remain a world leading destination for science, research and business, the UK needs to invest in its own workforce, including introducing a broad and balanced post-16 curriculum that includes science, arts and humanities education up to age 18 - while continuing to attract the best international talent. Funding should be open to all – it is ideas that matter, not nationality or career stage. It is also very important to invest in increasing the diversity of our research workforce.
13. Any lack of diversity within science, technology, engineering and mathematics careers represents a waste of talent that the UK should be accessing to reach its full potential.

What does a UK economy that invests 2.4% of its GDP into research and development (R&D) look like?

14. To fully realise the economic and social benefits of research and innovation, the Government needs to provide a consistent policy and investment environment over time. This is challenging at a time of

¹⁴ Royal Society (2017) *Machine learning: the power and promise of computers that learn by example*

significant change in the UK's international relationships. The government must signal its intentions to provide consistency as well as articulating its vision for a UK economy that invests 2.4% of its GDP into R&D. There are a number of steps that it should take to do so.

15. Scientific research needs sustained, significant funding with long-term commitments. The roadmap that the government has committed to publishing in 2018¹⁵ provides the opportunity to make spending commitments to 2027¹⁶, enabling UKRI to develop robust, long-term strategic processes to allocate this investment over time. All government departments contribute to shaping the UK's research ecosystem and building the UK's capacity to absorb research and deliver its full range of benefits. For example, the Society and British Academy will shortly publish a report on the future of Education Research. **It is important that all government departments recognise their role in delivering the 2.4% commitment alongside UKRI. The roadmap may provide a helpful tool to highlight this across government and encourage the 'buy in' of departments to delivering the 2.4% commitment.**
16. Public investment into R&D alone will not deliver 2.4%. The current roughly 1:2 ratio between public and private investment is unlikely to hold without addressing broader structural issues such as supply of skilled people, infrastructure and connectivity alongside direct investment into R&D¹⁷. These are issues that involve multiple government departments and external stakeholders. While UKRI's vision is to deliver 2.4%, only some of the interventions needed to do so sit within its power. **Much like the Industrial Strategy that it sits within, the roadmap must be co-produced across government, with the input of external stakeholders, to agree a suite of coordinated policy interventions to ensure that the 2027 economy is in a position to invest 2.4% of its GDP into research and development (R&D) and maximize the benefits that stem from this. Delivering this will require effective working between UKRI and multiple government departments.**
17. European Union research funding awarded in the UK contributes to the UK's total spend on R&D. The UK receives over £1 billion a year from the EU to support research and innovation¹⁸, making up part of the 1.67% of GDP that is currently invested into UK R&D¹⁹ and this funding leverages further investment²⁰. Therefore changes to the UK's relationship with the EU, and so access to these funding streams, will impact on the UK's government's ability to deliver the 2.4% target by 2027.

¹⁵ Hansard, Research: Investment: Written question – 118061, answered 13 December 2017
<https://www.parliament.uk/business/publications/written-questions-answers-statements/written-question/Commons/2017-12-06/118061/> [accessed 24 September 2018]

¹⁶ The UK government has currently committed to increasing public investment into research and innovation to 2021-22 See figure 3, *Investing in UK R&D* <https://royalsociety.org/~media/policy/projects/investing-in-uk-r-and-d/investing-in-UK-r-and-d-may-update-2018.pdf>

¹⁷ The Society provided more detailed comments on the broader environmental changes that are needed in its submission to the *Building our Industrial Strategy* Green Paper in April 2017.

¹⁸ Annual UK research funding from the EU calculated using the average Horizon 2020 funding received by the UK per year between 2015 – 2017 plus the average amount received by the UK through ESIF to support research and innovation activities calculated by Technopolis (2017) *The role of EU funding in UK research and innovation – an analysis commissioned by the UK's National Academies – The Royal Society, British Academy, Academy of Medical Sciences and Royal Academy of Engineering*. This gives an average of Euro 1.5 billion per year.

¹⁹ See Royal Society, Royal Academy of Engineering, Academy of Medical Science, British Academy (2017) *Investing in UK R&D* figure 1 <https://royalsociety.org/~media/policy/projects/investing-in-uk-r-and-d/investing-in-UK-r-and-d-may-update-2018.pdf> [accessed 23 September 2018]

²⁰ Technopolis (2017) *The role of EU funding in UK research and innovation – an analysis commissioned by the UK's National Academies – The Royal Society, British Academy, Academy of Medical Sciences and Royal Academy of Engineering*.

18. It is helpful that the UK government has made a number of guarantees to ensure that, in the case of the UK leaving the EU without a deal, the UK government would provide funding to enable UK-based researchers to continue to participate in some of these EU research funding streams. The Chancellor's clarification that money to cover projects agreed before the UK leaves the EU on 29 March 2019 will be additional money, i.e. not taken from money already earmarked for research and innovation is very helpful²¹. **It would be helpful to clarify that the further guarantees in the event of the UK leaving the EU without a deal²² will also be covered from additional money and to explain how those guarantees will be monitored and safeguarded over time.** However it is important to recognise that even with these guarantees, as a third country, the UK would not be able to participate in a number of schemes that together invest approximately half a billion pounds into UK R&D annually²³. It could take years to develop alternatives, meaning that valuable research could be stopped in its tracks and the UK risks losing the people and projects that will be crucial to delivering 2.4% GDP investment into UK R&D by 2027. It is not just access to this funding that is important to UK R&D but also immigration policy that will impact on the ability of highly-skilled people to come and work here. **To ensure that the UK is in a position to invest 2.4% of GDP into UK R&D by 2027, the UK must leave the EU with a deal that keeps highly-skilled scientists working in the UK, keeps access to money and networks that support the UK to work with scientists around the world, and maintains regulatory alignment that allows access to new medicines and technologies.**
19. If the UK leaves with the deal as agreed to date, it will continue to participate fully in Horizon 2020 and the Prime Minister has stated her intention to seek "the option to fully associate ourselves with the excellence-based European science and innovation programmes – including the successor to Horizon 2020 and Euratom R&T"²⁴. The successor programme to Horizon 2020, Horizon Europe, is still being finalised, and until it is, association to the programme will not be possible, meaning that there is a period of uncertainty for UK-based researchers and businesses over the UK's future funding environment. **While this uncertainty is inevitable, the UK government could ameliorate the damage that this may do to UK confidence and progress towards 2.4% by publicly committing the public money now to either buy into Horizon Europe once it is agreed, or invest into alternatives.**

Don't hit the target and miss the point

20. As outlined in UKRI's vision, the government's commitment to reach 2.4% of GDP invested in UK R&D by 2027 is part of their ambition for the UK to become the most innovative country in the world. There are theoretically many ways to hit the 2.4% target and make a considerable difference to peoples lives, however an eye to delivering the broader ambition should shape the UK's approach.

²¹ Evidence to the Commons Treasury Committee by the Chancellor, Philip Hammond MP. 12 December 2016 Q314 <http://data.parliament.uk/writtenevidence/committeeevidence.svc/evidencedocument/treasury-committee/autumn-statement-2016/oral/44385.html>

²² Announced in a Treasury Written Ministerial Statement on 24 July 2018 HLWS897: "The Treasury is also guaranteeing funding in event of a no deal for UK organisations which bid directly to the European Commission so that they can continue competing for, and securing, funding until the end of 2020."

²³ The UK Government's guarantee announced on 24 July 2018 will cover the cost of UK participation in Horizon 2020 as a third country in the event of leaving the EU with no deal. As a third country, UK-based academics will not be able to access funding from the European Research Council or Marie Skłodowska-Curie Actions and UK-based SMEs will not be able to access SME Instrument funding. Over the period 2015-17, the UK received an annual average of Euro 601 million from these three funding streams. See <https://royalsociety.org/~media/policy/projects/brexit-uk-science/references-and-workings-for-brexit-no-deal-factsheet.xlsx> for the calculations on which this is based.

²⁴ Theresa May (2018) *PM speech on science and modern Industrial Strategy: 21 May 2018* <https://www.gov.uk/government/speeches/pm-speech-on-science-and-modern-industrial-strategy-21-may-2018>

Currently over half of people in the UK do not feel informed in science.²⁵ This likely includes many people who are running companies that could benefit from innovative technologies, or are making investment decisions. Delivering this target provides an opportunity to address this and deliver the wholesale cultural shift that will be required to become the most innovative country in the world. A number of initiatives can help us to do so:

21. Science should be a source of pride and inspiration for the whole nation. Science must be part of wider conversation; this exchange of thinking and dialogue can valuably shape approaches to deliver the target, helping to maximise its relevance, accessibility and impact. UKRI has undertaken to “work closely with the public, to understand their concerns and aspirations, build trust and appreciation of the importance of knowledge, and inspire future researchers and innovators with the aim of delivering maximum societal value.” and will develop a new public engagement vision and strategy by March 2019.
22. We should seek to better understand the benefits that stem from investment into R&D to inform our investment decisions in future and publicly demonstrate the value of a 2.4% target to everyone in the UK. Whilst we know that investment into R&D brings considerable benefits overall, as the Industrial Strategy Commission highlighted in making proposals for an Office for Strategic Management²⁶, further thinking is required to develop new ways to better understand how public investment can best deliver economic returns and deliver broader societal ambitions. New evidence and insights could support more public conversations stretching across all sectors, not just those that are research intensive, about how best to invest in research and innovation activities around the UK as we deliver the 2.4% target and the outcomes that we wish to maximize. It is important to recognise that not all of these activities can be captured and understood through simple metrics.
23. The Royal Society has been working with its sister national academies (the Academy of Medical Sciences, British Academy and Royal Academy of Engineering) to better understand the existing evidence for the range of benefits that research and innovation bring to the UK, the geographic distribution of these benefits, how they are achieved and how best to measure them to inform future decisions on investment in research and innovation. The findings from this work will be published shortly. The national academies are also producing resources and holding events to encourage wider conversations about the value of creating a more research and innovation intensive economy in the UK to all UK citizens, and how best to invest resources wisely and efficiently in the national interest.
24. Use techniques such as evidence synthesis to bring together information from a range of sources and disciplines to inform debates and decisions on specific issues. This is one of the most valuable contributions that the research community can offer policymakers as they make decisions that will affect the lives of everyone in the UK. The Royal Society and Academy of Medical Sciences have developed a number of principles for good evidence synthesis, which include making these accessible to all and available online.
25. In academia, commercialization of research should be accepted as a normal activity and its outputs (such as patents) held in the same regard, particularly in recruitment, retention and promotion of staff, as publication records currently are. Researchers need to be given the time and opportunity to explore the translation of their research, and training and development and support to enable them to do so successfully. Many of our fellowship alumni have commercialized their research with major economic and social impacts. The majority of recipients of fellowships take part in some kind of knowledge exchange or commercialization on a regular basis. Our recent Career Pathway Tracker found that just under two thirds of alumni did this at least one a year²⁷. The Society’s Science, Industry and Translation programme seeks to connect academia, industry and government and

²⁵ Ipsos MORI (2014) Public Attitudes to science

²⁶ Industrial Strategy Commission (2017) *The Final Report of the Industrial Strategy Commission*

²⁷ Royal Society (2018) *Career pathway tracker: 35 years of supporting early career research fellows*

reintegrate science and industry throughout our work. This includes supporting 19 Entrepreneurs in Residence in UK universities. These are experienced industrial scientists and entrepreneurs who are working to increase the knowledge of cutting edge industrial science, research and innovation in our universities. We are promoting mobility between industry and academia through support of 35 Industry fellows who are working on collaborative research projects. We are also hosting a series of conferences in different parts of the UK focused on creating connections between local business, policymakers and academia and better understanding the challenges and opportunities for research and innovation in that region. The most recent of these took place in September 2018 in the North East and planning is underway for a future conference in Wales in 2019. We hope that the outputs will support strategic decisions at a local level, as well as underpinning the Society's work at a national level to reflect regional strengths and best practice.

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