Changes and Choices

Advice on future frameworks for international collaboration on research and innovation, commissioned by the Minister of State for Universities, Science, Research and Innovation

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Professor Smith has worked with the UK Higher Education Funding and Research Councils and was appointed Deputy Chair of the UK Statistics Authority from September 2012. In 2014, he was appointed Chair of the Board of the Diamond Synchrotron at Harwell and in 2018, a board member of the UK Atomic Energy Authority.

Professor Smith is a past President of the Royal Statistical Society and was elected a Fellow of the Royal Society in 2001 in recognition of his contribution to statistics.

In 2003-04 Professor Smith undertook an inquiry into Post-14 Mathematics Education for the UK Secretary of State for Education and Skills and in 2017, on behalf of Her Majesty's Treasury and the Department for Education, published a 16-18 Maths Review. In 2006 he completed a report for the UK Home Secretary on the issue of public trust in Crime Statistics. He received a knighthood in the 2011 New Year Honours list.

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He has spent most of his career at the interface between science and Government, having worked in the Business Department, the Cabinet Office and HM Treasury before moving to UCL.

Professor Reid was specialist advisor to the House of Lords Science and Technology Committee during their extensive inquiries into Brexit and, more recently, industrial strategy. He is a member of the Government's High Level Group on EU Exit, Universities, Research and Innovation. He has led research and innovation policy reviews for the Scottish Funding Council and the Welsh Government.

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INTRODUCTION

The UK Government would like the option to associate to Horizon Europe. It has made clear that position consistently and repeatedly. The UK Government is continuing to actively shape the development of that programme. It is also exploring credible and ambitious alternatives to deliver positive outcomes for science, research and innovation in the event that the UK does not associate.

We prepared this report against that background.

International collaboration is deeply embedded in the research and innovation community across the UK. International collaboration is not an optional extra. It is fundamental to high quality research and business innovation.

The persistent focus on excellence in the funding of research and innovation in the UK has paid huge dividends. Excellent research delivers high levels of economic and social impact across the country. It is a magnet for foreign direct investment in R&D which is vital to increasing overall investment in the UK. And it attracts talented researchers from around the world who go on to deliver further excellent work. We see a compelling case for that focus remaining in future.

The exploration of alternatives to Horizon Europe association is a challenging topic. Many of those we consulted were strongly committed to the principle of association. Some consultees were apprehensive about even exploring contingencies.

The UK's involvement in previous EU research and innovation programmes has been valued highly across the research and innovation community. That involvement has provided access to a common protocol for collaboration across a sizeable population of researchers. Of course, it has provided additional funding. It has also diversified the range of funding opportunities, provided access to research facilities and delivered numerous intangible benefits. But the shape of EU research programmes is changing, as is the UK's relationship with the EU.

We offer no views on the arguments for or against association with Horizon Europe. That is not our role. In any case, we do not yet know the terms under which the UK Government will consider options to associate. Those terms will depend on the outcome of forthcoming negotiations on both the form of Horizon Europe and the future relationship between the UK and the EU.

Whatever the outcome of forthcoming negotiations on Horizon Europe, this is a good time to reflect on future UK arrangements and opportunities for international collaboration globally, post-Brexit. These opportunities reach beyond the boundaries of Horizon Europe and beyond the boundaries of the EU.

That said, we have not attempted any detailed investigation into the future of research funding for Official Development Assistance or the established international activities of Research Councils. These are vital parts of the UK research base but they are largely beyond the scope of this review. Clearly there are levels of detail in individual business sectors and research disciplines which are vital to the success of future plans but beyond the scope of our high level review.

Beyond issues relating to association with Horizon Europe, leaving the EU has other significant potential impacts on the UK's research and innovation ecosystem. We have been struck in the course of this review by evidence across regions of the UK, not least the Devolved Administrations, of the ways in which strands of EU structural funds and regional development support have been combined with research and innovation funding to play a vital role in developing local economies. There will be a need to explore how the Government's new Shared Prosperity Fund can be developed to support further integration of research and innovation into regional economic development in all areas of the UK.

Throughout our consultations, a recurring theme has been that retaining the UK's leading international position in a globally competitive research and innovation environment depends to a large extent on our ability to attract and retain the best international talent. Overwhelmingly, those consulted wished to see explicit alignment of immigration policy with the needs of the research and innovation community in the UK.

Immigration policy and regional development are beyond the formal scope of this review. But, in our view, an exploration of future arrangements for international collaboration in R&D would be incomplete without them.

The recent creation of UKRI; the Government's commitment to raise overall levels of R&D investment in the UK to 2.4% of GDP; and high levels of international R&D activity in business, research institutes and universities make it timely, as we prepare to leave the EU, to review current arrangements with a view to developing a bold new vision for UK research and innovation.

EXECUTIVE SUMMARY

Funding issues

Until now, the cost to the UK of participation in EU research and innovation programmes has been met within the UK's wider financial subscription to the EU. In future, these costs will need to be justified alongside competing demands for public spending.

If the Government decides not to associate with Horizon Europe because the terms of association do not deliver sufficient benefit to the UK, then we are not convinced that a persuasive case can be made for sizeable levels of public spending on activities that replicate, line by line, EU research and innovation arrangements in the UK. However, we do find compelling arguments for public sector investment to stabilise and protect the assets, infrastructure and capabilities that have been created by previous decades of participation in EU research and innovation.

If the UK does not associate with Horizon Europe then we also see powerful arguments for additional UK public investment – redirecting funds that previously went to the EU - on wider forms of international collaboration.

Taken together, funding for stabilisation, protection and wider forms of international collaboration would be at about the same scale as this country has received in the past from participation in EU programmes - around £1.5bn per annum. Our recommendations are based on the availability of at least that level of funding.

We advise against the disruption of existing research and innovation activities to release resources for our recommendations. Such disruption would destabilise the UK's highly successful research and innovation ecosystem just at a time when it faces uncertainty and change. This in turn would have unpredictable effects on businesses and charities contemplating new investments in UK R&D.

Whether or not the UK associates with Horizon Europe, we recommend that Brexit is used as a stimulus for an exciting new vision for the UK. This should focus on the Government's commitments to raise overall levels of R&D investment, to reduce regional disparities in wealth and opportunity and to work towards a new global positioning for the UK.

A new vision

Many of those we consulted asked for the outline of this new vision to be prepared quickly and promoted widely. They argued that the vision will provide a sense of direction for the UK research base, helping to mitigate the inevitable uncertainty that will follow decades of participation in EU programmes. Detailed arrangements for component parts of the vision would then be developed in consultation with the business, academic and charity communities. But those consultations would take place in the knowledge that resources are available.

As first steps, the vision should include:

Strides towards – or beyond - 2.4%

- An international version of the highly successful UK Research Partnership Investment Fund should run competitions with sizeable rewards for the universities or research institutes that attract large amounts of foreign direct investment in R&D to the UK.
- A coherent Global Talent Strategy, combining reforms to immigration policy with a suite of fellowship and post graduate programmes to attract and retain many of the world's most talented researchers in the UK.
- Substantial additional funding for basic research, recognising that significant levels of support for this important work currently come from EU collaborations.
- A flagship programme of research fellowships offering large awards over long periods of time for exceptional researchers in all disciplines to expand the frontiers of knowledge in areas they have identified. Awards would be overseen by a prestigious international faculty of peer reviewers, recruited through national academies in several countries.

Opportunities for all regions of the UK

- Integration of the forthcoming Shared Prosperity Fund with the Innovate UK agenda. This should take full advantage of Innovate UK's potential to guide and shape sizeable parts of the Shared Prosperity Fund, in partnership with the Ministry of Housing, Communities and Local Government, Devolved Governments and the wider UKRI agenda, ensuring direct connectivity with the university sector. Innovate UK also has the potential to manage distinctive new investment streams, responding to any reduction in support for UK SMEs under Horizon 2020.

Greater agility

- Two major new funding streams to capture fast-moving and unexpected opportunities:

  a. The first of these should provide additional financial support through quality-related (QR) funding - and devolved equivalents - for the spontaneous, organic collaborations that are woven into the fabric of research and innovation but can so easily be inhibited by funding models that are tied to specific projects.

  b. The second should be an 'Agility Fund' with distinct strands. The first should enable the UK to invest in emerging international programmes of significant potential benefit to UK research. The second to capture opportunities that arise unexpectedly, including during interactions with other countries at Ministerial levels.

Funding bodies

International collaboration on this scale will require distinctive administrative structures. Much of the funding will be deployed in partnerships with funding agencies and businesses in other countries, rather than under the exclusive control of the UK. We offer a set of principles for the design of such administrative structures and several high level options for the structures themselves. Of course, some of these principles already operate in domestic funding arrangements.

- Robust governance to ensure effective stewardship of public funds and maintain the confidence of BEIS and HMT
- Independence and transparency to maintain the confidence of new investors from other countries and the research community in the UK
- Expertise in the distinctive nature of international collaborations as well as access to expertise and administrative support on research and innovation funding
- Maintain or enhance the diversity of funding sources for research and innovation in the UK
- Introduce the lowest extra costs of administration consistent with the four principles above.

It is beyond the scope – and authority - of this review to design detailed arrangements for management and governance. On the basis of discussions with well-informed stakeholders, we identified many options for the management of new funding streams within these principles.

These options include:

1. Creating a new, stand-alone public body that would manage most or all of the new funds, becoming a 'champion' for international collaboration.

2. Allocating the funding across the existing nine councils of UKRI so that several Councils each led appropriate parts of the international agenda.

3. Creating a new cross-cutting funding stream at the UKRI centre alongside the Industrial Strategy Challenge Fund (ISCF) and Global Challenges Research Fund (GCRF) that work in collaboration with existing UKRI Councils where appropriate.

4. Creating a new, independent Council within UKRI, (along the lines of a science and humanities Council as defined in the 2017 HE & Research Act) that would be a champion for international collaboration, manage much of the new funding itself and work in collaboration with existing Councils where appropriate.

Different components of funding might well be managed through different options.

THE PROCESS OF THE REVIEW

Ministerial Commission

In March 2019 the BEIS Secretary of State commissioned independent advice on the potential design of the future UK funding landscape in the context of the UK's future ambitions for international collaboration on research and innovation.

Ministers said that this advice will inform policy thinking already being undertaken by BEIS, UKRI, the National Academies and the Devolved Administrations on plausible alternatives to Horizon Europe, and broaden-out thinking to encompass the longer-term international perspective as set by the recently published International Research and Innovation Strategy.

The terms of reference for the review are at Annex A.

Gathering evidence

- A call for written evidence was published on gov.uk using the BEIS consultation hub. Over 130 responses were received from businesses, institutions and individuals. The call for evidence text is at Annex B, and a list of respondents at Annex C.
- Discussions were convened on our behalf by organisations around the country. These included meetings in Scotland, Wales, Northern Ireland and the North, Midlands and South West of England as well as several meetings in London. A list of these meetings is at Annex D.
- Discussions were held with Government at ministerial and official levels, including the Ministers' High Level Group, the Government's Chief Scientific Adviser, Departmental Chief Scientific Advisors and with the Treasury.

Timing

The Minister asked that the review would be carried out in time to inform Government thinking during the summer of 2019, in preparation for any forthcoming Spending Review. The review's subsequent focus on high level issues was consistent with this timetable.

THE UK IN A EUROPEAN RESEARCH LANDSCAPE

Historic relationships with European Science

The UK has long-standing scientific relationships with Europe. For example, Rosalind Franklin was taught X-ray crystallography in Paris before returning to the UK where her expertise led to the discovery of the structure of DNA. Alexander von Humboldt, the Prussian polymath and naturalist, maintained professional relationships with many British scientists, including Charles Darwin.

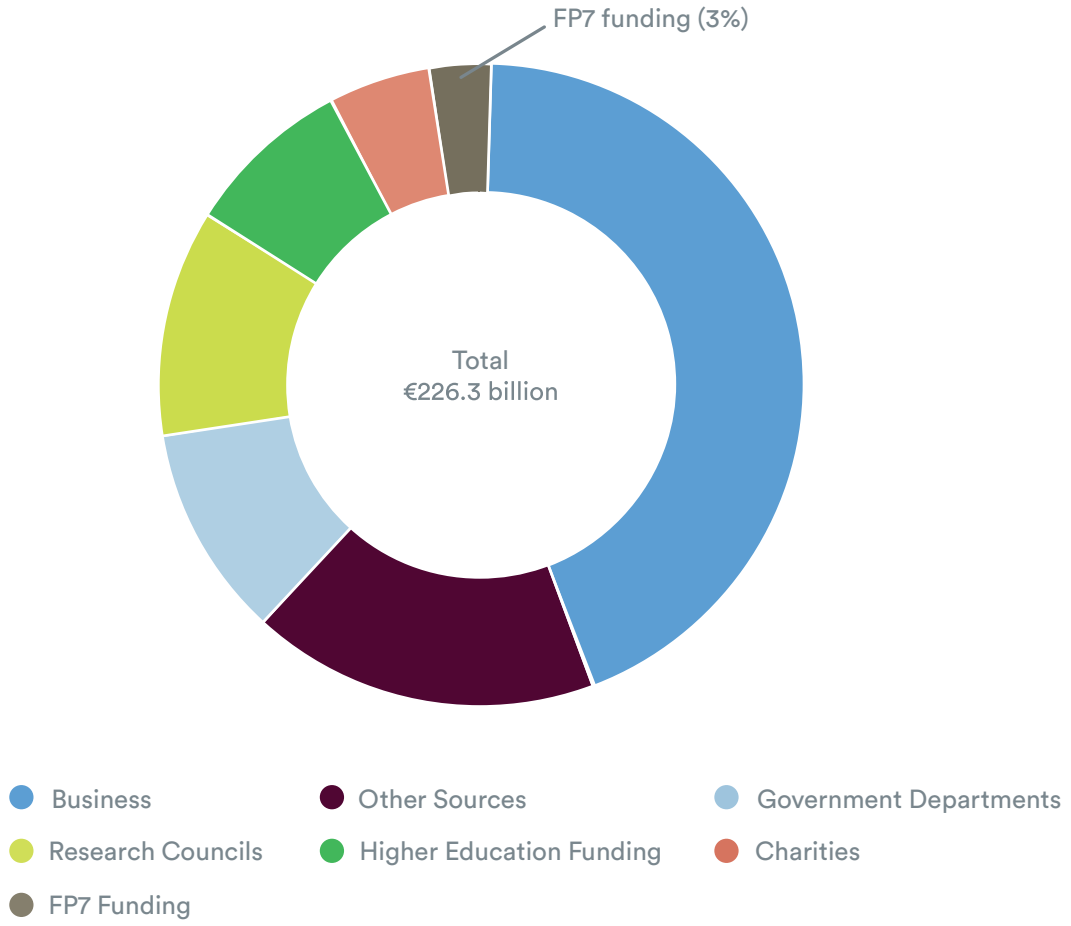
More recently, collaborations with Europe have been cemented through the EU Framework Programmes, which began in 1984 and are now in their 8th iteration. During Framework Programme 7 (FP7), which ran from 2007-2013, the UK participated in over 10,000 projects with over 18,000 participants. In total, the UK secured around €7 billion in funding (15% of total awarded funding) over that period. The UK had the second greatest share of participations and of EU funding, behind Germany in both cases.

More recently

Around 3% of the total expenditure on R&D in the UK comes from EU Framework programmes or their successors. The Royal Society illustrated the distribution of R&D expenditure for the last Framework Programme in Figure 1.

Across the 28 EU member states, around 3.5% of Gross domestic Expenditure on Research and Development (GERD) comes from the latest EU Framework Programme, Horizon 2020.

Figure 1 UK expenditure on R&D by source of funding (2007-13)



Source: Royal Society[1]

As of June 2019, the UK has around 13,000 project participations in Horizon 2020, the second highest number of project participations.[2] UK businesses have the fifth highest level of participation rates of EU countries (around 3,000 participants under Horizon 2020), securing just over €1billion in funding since 2014.

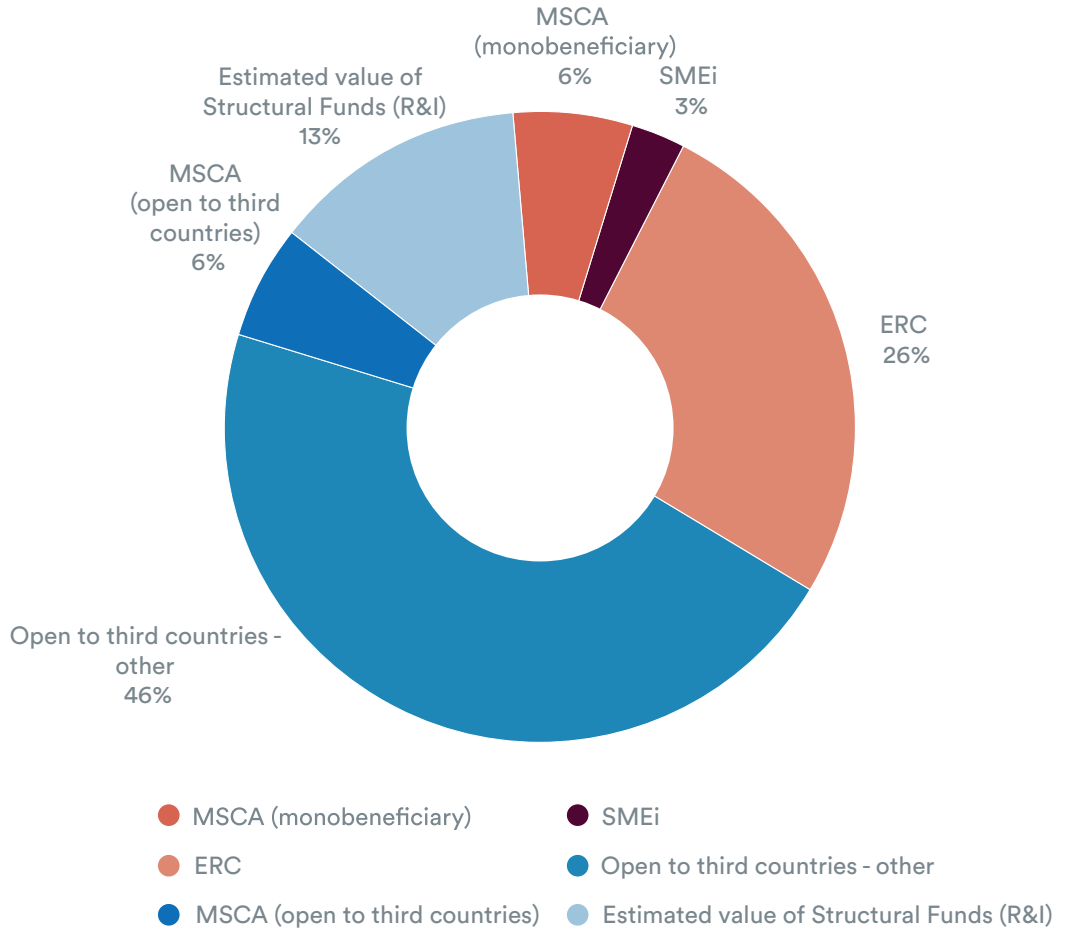
Overall, the UK has secured around €5.9 billion in funding from Horizon 2020, as at June 2019 (13.5% of the total, second only to Germany). R&D funding makes up about 18% of EU awards coming to the UK and is the second largest component of EU funding into the UK after agriculture.[3]

[1] https://royalsociety.org/~/media/policy/projects/eu-uk-funding/uk-membership-of-eu.pdf

[2] European Commission data (eCorda).

[3] https://royalsociety.org/~/media/policy/projects/eu-uk-funding/uk-membership-of-eu.pdf

Figure 2 EU research funding - value of signed for Horizon 2020 grants and structural funding for research and innovation 2015-17



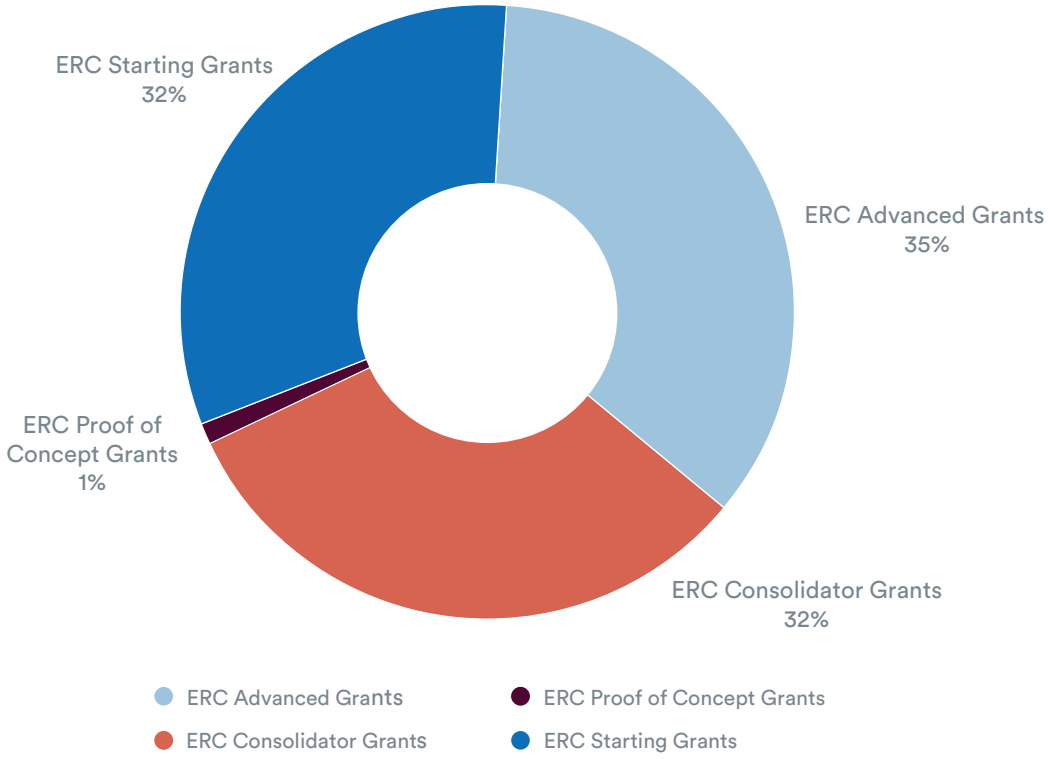
Source: eCORDA, Royal Society

Key sources of European research and innovation funding are Horizon 2020 and the European Structural and Investment Funds (ESIF).[4] Figure 2 shows the levels of funding secured by the UK over the period 2015 to 2017. This shows just over €4.5billion of European funding was secured for research and innovation activity in the UK over that period, with most of this coming through Horizon 2020. Around a quarter of European funding came to the UK via the European Research Council (ERC) (26%), 12% via the Marie Skłodowska-Curie actions (MSCA) and 13% through structural funds.

[4] Other R&I focussed EU funds include the Euratom Research and Training programme, ITER ('The Way' in Latin; an ambitious energy project based in Southern France), Galileo, Copernicus as well other EU programmes containing elements of R&I.

Figure 3 shows that funding through the ERC to the UK is spread about evenly between Advanced Grants[5], Consolidator Grants[6] and Starting Grants.[7] Proof of Concept Grants make up around 1% of overall ERC funding to the UK.[8]

Figure 3 Breakdown of European Research Council grants received by the UK 2015-2017



Source: eCORDA, Royal Society

Funding concentration

The overall figure of 3% at Figure 1 masks concentrations of funding into important subsets of institutions, research disciplines and geographic regions.

EU government research income represented 11% of the collective research grant income to Russell Group universities in 2017/18.[9]

[5] Advanced grants provide funding to researchers to pursue ground-breaking high-risk projects.

[6] Consolidator grants provide funding to researchers to consolidate their independence by establishing a research team.

[7] Starting grants provide funding to enable researchers to work independently.

[8] Proof of concept funding allow commercial or societal potential of researcher work to be explored.

[9] Russell Group data.

Figure 4 lists the disciplines for which funding from the EU made up over a quarter of its total income in 2014/15. Archaeology is the discipline that receives the highest proportion of its income from EU government bodies (38%).

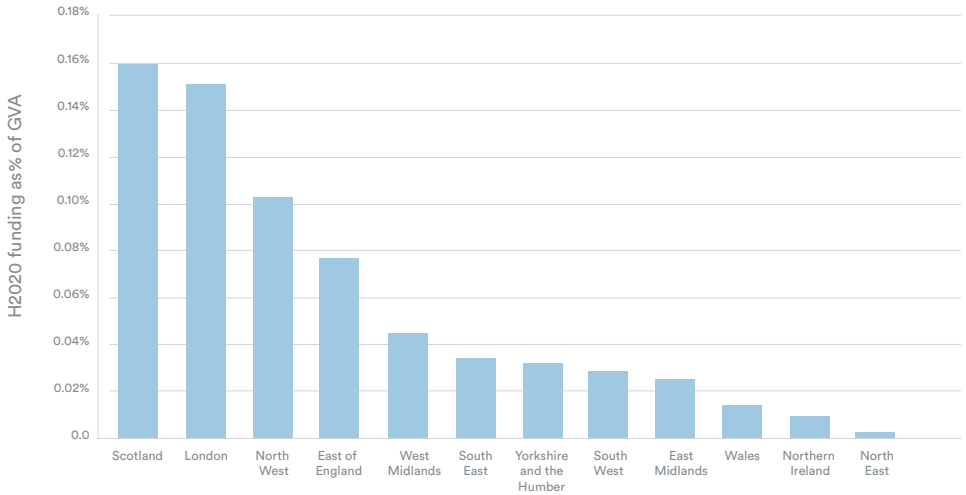
Figure 4 *Disciplines for which funding from the EU makes up over a quarter of their total income (2014/15)*

Discipline	EU government bodies income over total income in 2014/15
Archaeology	38%
Classics	33%
IT, systems sciences and computer software engineering	30%
Media Studies	27%
Law	26%
Philosophy	25%

Source: HESA data by cost centre from Technopolis (2017) 'The role of EU funding in UK research and innovation' – commissioned by the four UK national academies.[10]

Figure 5 illustrates the distribution of annualised Horizon 2020 funding by geographic region as a proportion of economic output (Gross Value Added or GVA).[11] It shows concentrations of EU funding in Scotland and London along with the North West and East of England.

Figure 5 *Regional distribution of annual Horizon 2020 funding to the UK (as at June 2019) as % of Gross Value Added*



Source: Horizon 2020 eCorda Database and ONS GVA

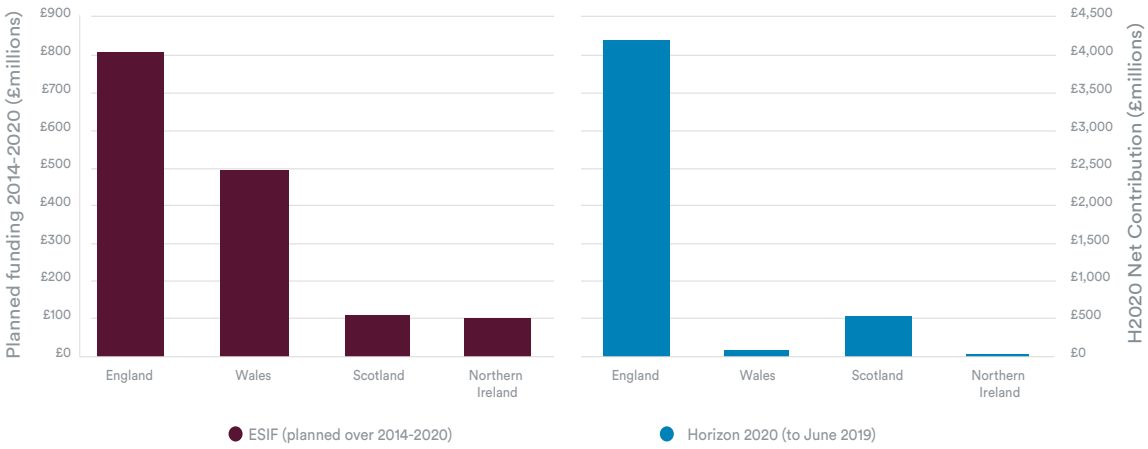
[10] https://acmedsci.ac.uk/policy/policy-projects/the-role-of-eu-funding-in-uk-research-and-innovation

[11] As with other R&D investment data, the location where R&D activity is registered may not always be where it takes place. For example, businesses often have headquarters registered in London, but with R&D facilities elsewhere in the country.

Structural Funds

Figure 6 shows the UK distribution of planned allocations under the European Structural and Investment Funds (ESIF) from 2014 to 2020, compared to funding awarded under Horizon 2020.

Figure 6 EU Research & Innovation funding to the UK



Source: European Commission, eCORDA

Horizon 2020 funding awarded to date is around three times that anticipated from ESIF. This reflects differences in the design of the two funds. The Horizon 2020 programme awards funds on the basis of excellence through competition while structural funding is allocated on the basis of need. For example, Wales, which has a relatively high number of assisted areas, has a received relatively high level of structural funds.

Intangible benefits

Finances present only part of the picture. Figure 7 outlines some of the intangible (i.e. non-financial) benefits The Research Council of Norway have articulated from participating in Framework Programmes.

Figure 7 Benefits of Framework Programme participation (summary of Research Council of Norway findings)

- Access to complementary and state-of-the art knowledge
- Building networks with other European research organisations
- Increasing international co-publications with European partners which generally have a higher scientific impact than national publications
- Access to customers and suppliers through collaborative projects for firms
- A positive effect on the higher education modernisation agenda

These are similar to the intangible benefits identified by UK organisations and communicated to the then Science Minister in 2018 in the letter in Annex E.

THE UK IN A GLOBAL RESEARCH LANDSCAPE

The excellence of UK research has been built on its global reach and collaborative partnerships including the mobility of individual researchers, the UK's role in international research infrastructures, institutions, research programmes and inward investment in R&D from global businesses.

With 0.9 per cent of the world's population and 4.1 per cent of researchers, the UK accounts for 10.7 per cent of citations and 15.2 per cent of the world's most highly cited research papers. Government programmes have supported new collaborative partnerships, including Official Development Assistance funds.

The global landscape for research is changing. Access to knowledge, markets, skills and partners is easier – and more international – than ever. The worldwide estimate of total R&D expenditures more than doubled over the 15-year period between 2000-2015.[12] Non-OECD countries account for a growing share of global R&D, both in terms of researchers and investment.

Collaborative partners

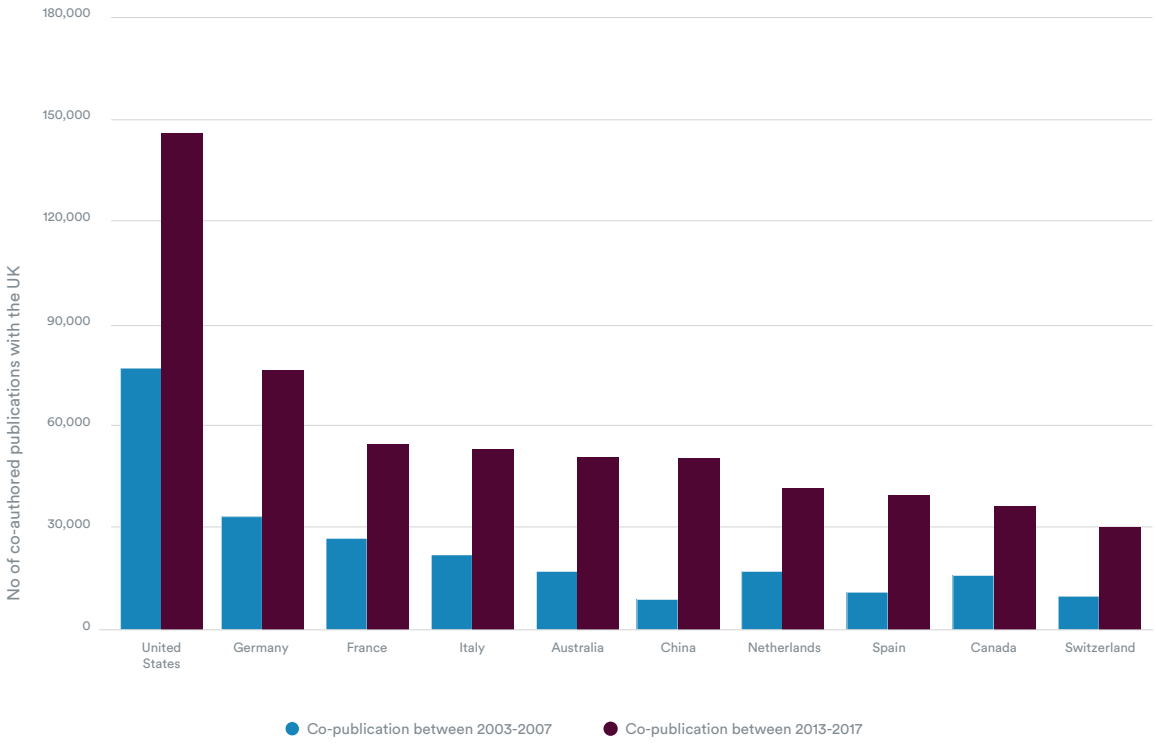
In 2017, over half of all peer-reviewed publications by UK researchers were co-authored by at least one non-UK researcher. The UK is ranked as the second most collaborative country amongst similar research-intensive comparator countries after France. In 2007, 36% of such publications had an international co-author and the UK was ranked as the fourth most collaborative country.

Figure 8 shows the UK's top ten collaborative partners between 2013 and 2017. Compared to 2003-2007, the UK's top collaborative partners remain broadly unchanged[13], with levels of collaboration increasing by almost 140% across these countries. Five of these top ten partners are outside the EU. The highest levels of growth in co-authorship were with China, Australia and Spain.

[12] National Science Board – Science and Engineering Indicators 2018

[13] Between 2003-2007, Japan was ranked the 10th most collaborative country with the UK. This has now changed to Japan ranking the 13th most collaborative country. China on the other hand has rapidly moved up the rankings from 12th position to the 6th.

Figure 8 *UK's top 10 collaboration partners by volume of internationally co-authored publications*



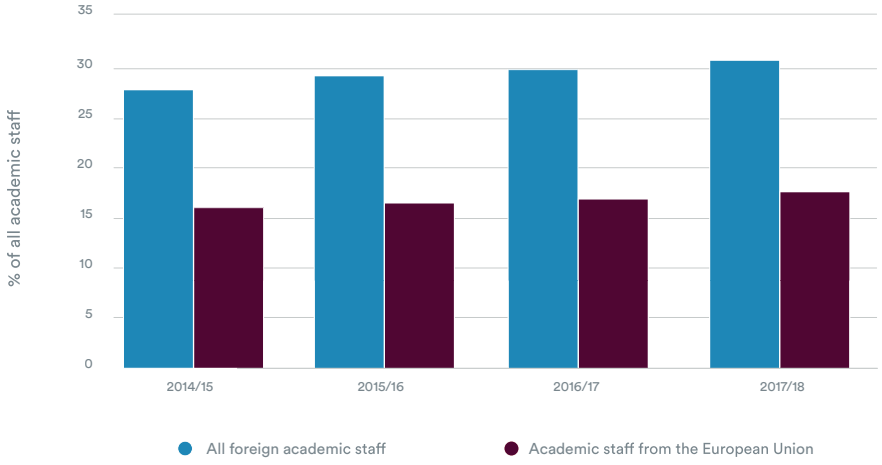
Source: Elsevier Scival Database

Academic staff by nationality

Figure 9 shows that in the academic year 2017/18, almost one third of all academic[14] staff in UK universities were foreign (including the EU) and almost a fifth are from other parts of the EU. The proportion of foreign academics has increased by 2.5% over the past four years. EU academics have maintained a strong presence (growing by 1.4% since 2014/15). This does not reflect media reports of an outflow of EU nationals from the UK research base following the UK referendum on EU membership. However, these numbers do not reveal future intentions or recent moves and so we interpret this data with a degree of caution.

[14] Academic contract staff are defined as professionals holding a contract for planning, directing and undertaking academic teaching and research within Higher Education providers. Examples of such contracts include those for vice-chancellors, medical practitioners, dentists, veterinarians and other health care professionals who undertake lecturing or research activities.

Figure 9 *Academic staff in the UK by nationality*



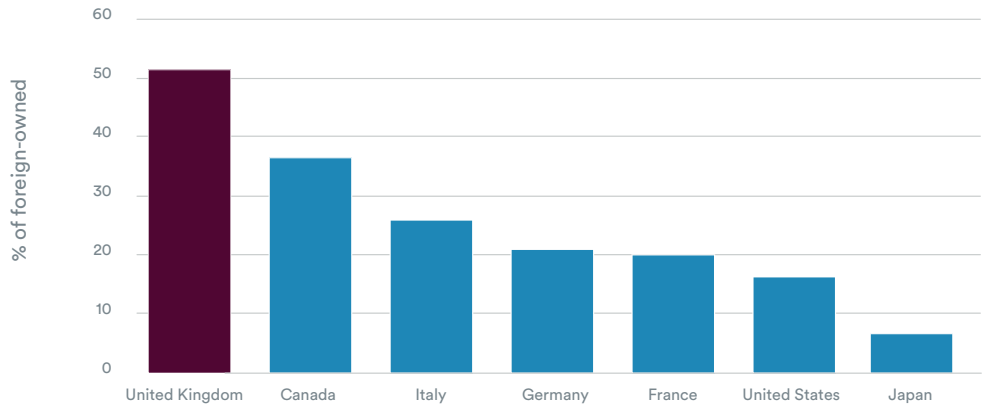
Source: HESA

Foreign direct investment in R&D

Foreign business investment in R&D performed in the UK can be described through two measures published by the ONS: the first is business R&D expenditure by affiliates of foreign-owned companies. The second is funding from overseas of R&D performed in the UK. The first measure describes Foreign Direct Investment (FDI), i.e. multinational enterprises investing in the UK with ownership and control of the firm in question lying outside the UK. This report uses this first measure.

Figure 10 shows R&D expenditure by affiliates of foreign owned companies. By this measure, the UK has a higher level of foreign direct investment in R&D than any other G7 nation.

Figure 10 *2015 R&D expenditure of foreign affiliates as a percentage of R&D expenditures in businesses*



Source: OECD, MSTI Database

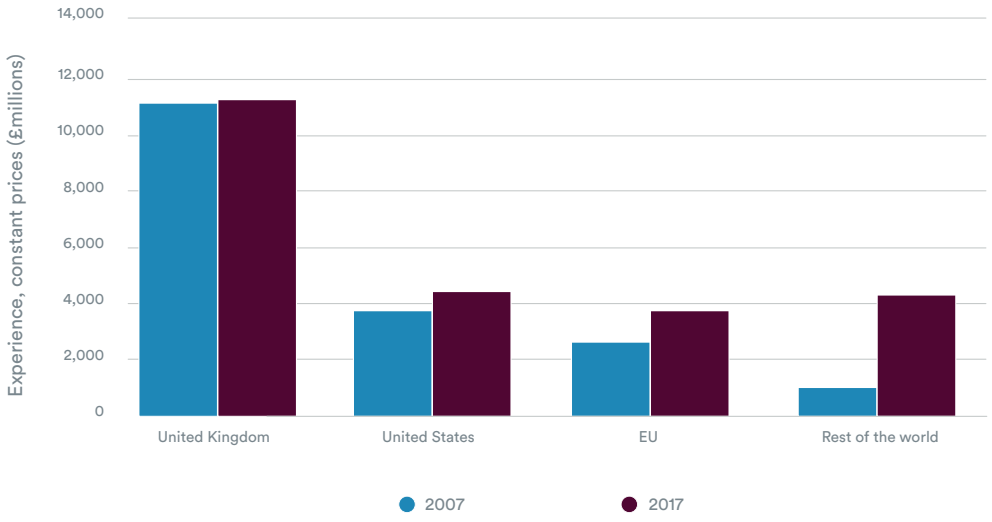
Future trends in FDI will have a significant impact on overall R&D levels in this country. This issue has been given even greater prominence by the Government's commitment to raise R&D investment to 2.4% of GDP by 2027.

By 2017, the volume of R&D expenditure in the UK by foreign-owned companies had increased by almost 70% since 2007, with the increase being largely driven by countries from outside of the US and the EU (see Figure 11).

UK-owned business spending on R&D remains the largest source in this country, accounting for around half the total. However, it is also the area of least growth. Over this period, US owned businesses have increased R&D expenditure in the UK by 22%, EU owned businesses by 42% and other internationally owned businesses by over 300%.

Examples of recent investments in UK R&D from business headquartered overseas can be seen in Figure 12. Outward investment in R&D also occurs. For example, in June 2019 it was announced that GSK will invest $67m over five years in the University of California. [15]

Figure 11 *Expenditure on R&D performed in UK businesses by country of ownership of businesses performing the R&D*



Source: BERD statistics, ONS

[15] https://www.gsk.com/en-gb/media/press-releases/gsk-joins-forces-with-the-university-of-california-to-advance-genomic-research-and-improve-drug-discovery/

Public expenditure on international collaboration

BEIS spends around £440m a year on its Official Development Assistance (ODA) focussed on research and innovation, and around £230m on its other international research and innovation programmes.[16]

The UK Government also contributes to the cost of international EU Research and Innovation programmes, including Horizon 2020, Euratom Research and Training, ITER, Copernicus and Galileo through the EU budget. The cost to the UK of these activities cannot be calculated explicitly. Assuming a proportional share of the EU budget attributed to the UK is applied to the budgets for these EU programmes, BEIS estimates the collective expenditure on research and innovation to be just over £1.5bn a year.

Figure 12 Examples of recent investments relating to UK R&D from businesses headquartered overseas

Boeing in Sheffield, October 2018[17]

"Boeing Sheffield is a direct result of this longstanding and successful relationship with the AMRC and its world-class research and development."

Merck (MSD) in London, November 2017[18]

"We believe London to be a unique bioscience centre of excellence... MSD believes that locating a research facility in London will expand MSD's opportunity to engage with leading researchers in the UK and Europe."

Samsung in Cambridge, May 2018[19]

"The Cambridge area is a global epicentre of machine learning and one of the world's foremost hubs for AI research and development, home not only to world-class talent but also some of the most well-renowned AI scholars with whom we will cooperate closely."

Reckitt Benckiser in Hull, July 2014[20]

"The Center for Scientific Excellence is a truly exciting project, which reconfirms the relevance of Hull to our global R&D operations."

Source: CaSE

[16] BEIS Data. Further information is in Annex F.

[17] https://boeing.mediaroom.com/news-releases-statements?item=130324

[18] https://www.msd-uk.com/static/pdf/MSD%20press%20statement-Jewel%20announcement.pdf

[19] https://news.samsung.com/uk/samsung-to-open-new-ai-lab-in-the-uk

[20] http://www.rb.com/us/innovation/innovation-at-rb/centers-of-excellence-hull/

KEY THEMES FROM THE EVIDENCE

Evidence gathering meetings

To inform this review, evidence gathering sessions were convened across the UK, as listed at Annex C. These sessions attracted representatives from a wide range of organisations, including universities, small and medium enterprises (SMEs), research intensive businesses, National Academies, professional bodies and charities.

Written responses

A written call for evidence was published at the start of the review. It attracted 137 responses, 13 responses were from individuals and 124 were on behalf of organisations. Of those who responded on behalf of organisations, 49 were from academic or research institutions, 9 were from large business organisations, 14 were from public bodies, 3 were from SMEs and 16 were from Learned Societies and National Academies. In addition, responses were received from charities, intergovernmental organisations and trade associations.

Responses were received from organisations based in many geographic locations of the UK. Responses were also received from organisations outside the UK. Annex F shows a list of respondents.

The valuable and wide-ranging views raised at the evidence gathering sessions and in the call for evidence responses have informed this review. A summary of key themes from the written evidence and discussion groups is provided here.

Working internationally – the importance of European Research and Innovation Funding

The review's focus is on the full international funding landscape, but it is impossible to look at this without acknowledging the role that European funding plays in the UK's international research and innovation activity. Many respondents stated it was their preference that the UK secures associated country status to Horizon Europe. There was widespread recognition of the unique characteristics of EU research and innovation programmes and the benefits the UK has enjoyed from participation in EU Framework Programmes over several decades. The scale and scope of EU funding, the prestige, and the multinational collaborative research enterprises it facilitates were raised as some of the key benefits of association to EU Framework Programmes. Respondents also emphasised the intangible benefits of participation in EU programmes.

Whilst acknowledging the general preference amongst stakeholders for maintaining a strong relationship with Horizon Europe, the discussion that follows is broader in scope. The review

focuses on the design and delivery of potential funding schemes to support international collaboration in its widest sense, which may include activities that would sit alongside full or partial association to Horizon Europe or be needed should association not be a viable option.

Views from outside the UK

UK government has officers working around the world as part of the Science and Innovation Network (SIN). Based on their in-country experience, SIN officers advised the review that:

European views

EU programmes play a critical role in UK engagement with European counterparts. If the UK is not keyed into EU programmes, the UK would need to establish new long-term commitments and mechanisms across areas of shared interests, avoiding duplication with Horizon Europe and addressing the double jeopardy of research funding. Enabling and sustaining student and researcher mobility, continued support for open exchange of data and material, use of research outputs and Intellectual Property would need to be addressed.

Global views

The split between bottom-up, researcher-led relationships versus top-down government-to-government-led agreements was a prominent theme. Bilateral ODA programmes demonstrated this top-down approach – established through agreement of shared thematic priorities and co-ownership of programmes. Several officers noted the need for a sustained and flexible portfolio of funding mechanisms balancing support for both ODA and non-ODA funding routes, particularly to keep pace with the fast-growing economies. The co-design of joint funding programmes would need to accommodate different programme durations and funding cycles in partner countries. Across all regions, the wider international participation in the current European research and innovation programme (Horizon 2020) was indicated as a multilateral route to further cooperation.

Transition and the need for stabilisation

Respondents recognised that an effective transition from historic participation in EU Framework Programmes to any new funding arrangements is essential in ensuring success. Many emphasised the need for short-term stability to protect capabilities built up during previous EU R&D programmes and alleviate the disruption that not associating to Horizon Europe may cause. There was widespread concern that an ineffective transition would lead to the UK becoming a seemingly less attractive place to both researchers and businesses. It was highlighted that this could hinder the UK's ability to attract and retain world leading talent and business investment, vital steps in reaching the 2.4% target. A widely held view was that, as the UK leaves the EU, a long-term programme of regulatory reform will be required. This will require extensive input from the research and innovation community, across a wide range of disciplines and public policy domains.

Blue-skies research

European Research Council (ERC)

Some respondents highlighted the ERC as a highly effective and respected facilitator of excellence driven blue-skies research in the UK. Many of those respondents cited the unique characteristics the ERC offers as underlining its success. The key characteristics highlighted by consultees, which are well aligned with the capabilities and aspirations of world-leading researchers in the UK, are listed in Figure 13.

Figure 13 Highly regarded characteristics of ERC

- Size of the grants
- Length of the grants
- Open to all nationalities
- Over a decade of precedent and familiarity has led to prestige
- Freedom to explore ideas as they emerge
- Freedom to move institute and country
- Covers different career stages
- Prestige due to the rigour of the peer review process
- Excellence as sole criterion for evaluation

UK funding for blue-skies research

It was widely agreed during discussions of both ERC and other EU programmes that, in the absence of association, new arrangements would be needed to support excellence focused blue-skies research in the UK. Current domestic funding schemes, including the overall balance of funding in UKRI, were described as focusing on specific missions and challenges at the expense of blue skies research. Only the public sector will support blue-skies research at a national scale so it is particularly important that UKRI provides such support. There was wide agreement that a domestic blue-skies funding scheme could reflect and improve many of the best features of ERC, including using excellence as the sole criterion for evaluation.

Some suggested a replacement should and could improve on the ERC in terms of the duration and level of funding it offers. New arrangements could be optimised around distinctive UK interests, rather than the collective interests of 28 EU Member States. There was discrepancy between responses as to whether regional disparities in research funding within the UK should be addressed within a new excellence focused funding scheme. In addition, the current split of funding between different disciplines and sectors was raised as a point that needs careful consideration. Similar points were made in relation to other strands of EU funding.

It was universally agreed that grants for the highest quality researchers should be available across all career stages. Some respondents wished to see a larger number of grants available to post-doctorate researchers.

Disciplines and inter-disciplines

Many highlighted the reliance of particular sectors and disciplines, such as Social Sciences and Humanities, on ERC funds and the current shortage of such funding in the UK for these disciplines. The disproportionate negative effect loss of ERC funding would have on these disciplines was a widely raised concern. The need for more multidisciplinary and interdisciplinary funds was frequently emphasised. There was a lack of consensus as to the current effectiveness of EU funding in assessing and funding multi- and inter-disciplinary projects.

Delivery

Administrative arrangements

Where funding administration was discussed, some respondents stated that UKRI were the only body, or best-placed body, to deliver the administrative arrangements for new funding. Some felt that using UKRI to deliver funding represented the best value-for-money for public funds. Many respondents valued the Haldane Principle and the general view was that future funding initiatives for both blue-skies research and international collaboration should usually have independence from Government – not least because the shape and scale of international collaborations will be agreed between researchers in different countries rather than being determined by the UK alone. One frequently raised suggestion was that any alternative funding scheme could be overseen within UKRI and governed by a board consisting of international researchers selected due to their quality, commitment and expertise. National Academies in the UK and elsewhere could play important roles in nominating candidates for the board.

Peer review

The need for quality peer review was emphasised by many. The ERC peer review system, where subject panels consisting of academic experts review applications, was frequently mentioned as a model for internationally recognised peer review. Many respondents highlighted that UKRI have expertise in this area and others pointed to the National Academies as having well developed and highly respected mechanisms for peer review.

Operating principles

There was widespread recognition that the purpose and key principles of new funding arrangements need to be clearly established before the detailed administrative arrangements can be designed.

Frequently suggested principles included support for excellence, independence from Government, supporting and supplementing existing collaborative relationships, establishing long-term stable commitments to funding, and providing grants across the different research career stages. There was widespread concern that new international schemes could be too highly specified by funders rather than challenging researchers to identify the most compelling fields of enquiry.

There was recognition that long-term investment models are required. Some respondents cited the forthcoming UKRI infrastructure roadmap as a welcome step towards a strategic approach to planning and harmonising future funding schemes. In addition, many emphasised that improvements could be made to the design of future frameworks, this included new funding schemes to focus on value and outcome, rather than process, helping to align resources.

Industrial strategy and the 2.4% agenda

Increasing investment levels in the UK

There was wide agreement that the agenda for any new funding arrangements should be set within the context of raising overall investment levels in the UK to 2.4% of GDP by 2027. Many highlighted the strategic role universities could play in this agenda due to the international networks and structures many have already established.

Increasing support for university-business collaborations and match-funding contributions for international businesses looking to invest in UK R&D, were frequently raised as mechanisms to incentivise R&D investment including Foreign Direct Investment.

It was widely recognised that the UK's reputation for outstanding blue-skies research is fundamental in attracting business investment to the UK. It attracts the world-leading talent that businesses want to access. It was suggested that maintaining a balance between blue-skies and innovation-led research is important to continue to attract R&D investment, as well as maintaining the breadth of world-class research the UK has to offer.

Talent

There was wide agreement that attracting and retaining talent in the UK is essential, especially in reaching the UK's 2.4% commitment. The UK would appear less attractive after Brexit and if it does not associate to Horizon Europe unless an effective programme of mitigation is introduced quickly. For example, it was suggested that the UK would need to improve its ability to attract and retain world leading talent. Mechanisms that were frequently suggested included offering fellowships and grants that cover all career stages, including PhDs, offering Full Economic Costs on grants, offering increased salaries and making grants open to all nationalities. Some respondents suggested developing new schemes for international PhD students to attract researchers to the UK.

Blue-skies research and the 2.4% target

It is widely understood that excellence based research attracts investment:

- 'there is a wide variety of positive impact links between the science base and the private sector. Moreover, there appears to be a "crowding in" effect of public sector R&D on domestic and foreign R&D activities in the UK.' (CaSE[21])
- 'Companies come [to the UK] to hire talent (and lots of it). The focus for the UK should be on a ready supply of the skills foreign and domestic businesses need.' (Deloitte[22])
- 'The high quality of UK academic research and the ability to collaborate with universities are key factors in attracting early-stage investment in R&D to the UK…. Collaboration with universities is an important route for early-stage and long-term strategic R&D and can play a crucial role in supporting company growth. However, there is increasing international competition for this collaborative work, with the quality of research in many countries improving rapidly. The UK must work to maintain its leading position in academic excellence.' (Royal Academy of Engineering[23])
- 'Firstly, we must create the opportunity for that first spark of creativity to arise. And this means encouraging a vibrant and diverse research system, with support for world-class, blue-skies research in universities and institutes.' (Minister for Universities, Science, Research and Innovation[24])

International collaboration

Supporting spontaneous international collaboration

One frequently cited issue was the substantial body of international collaboration that takes place 'spontaneously' and 'organically' within the research community. These spontaneous collaborations are widespread, varied and dynamic and occur outside any formal funding mechanisms. Quantifying them is difficult.

Spontaneous collaboration was highlighted as an essential foundation to UK participation in formal schemes such as Global Challenge Research Fund (GCRF) and EU programmes.

[21] 'The Economic Significance of the UK Science Base: a report for the Campaign for Science and Engineering'. April 2014. Jonathan Haskel, Alan Hughes, Elif Bascavusoglu-Moreau

[22] 'Power Up: UK inward investment'. 2019. Deloitte

[23] 'Increasing R&D investment: business perspectives.' 2019. Royal Academy of Engineering

[24] https://www.gov.uk/government/speeches/becoming-an-innovation-nation-driving-up-private-investment-into-research-and-development

Many highlighted Quality-Related (QR) funding as the key facilitator of these collaborations and emphasised that increased investment in UK universities, through QR funding or similar, is needed to continue to support spontaneous international collaboration. It was suggested by several consultees that a QR fund could be developed to incentivise and support international collaboration, similar to the business QR fund and charity QR fund. Other mechanisms highlighted by which spontaneous collaboration can be supported included workshops and conferences, secondments, and university level collaboration. Capturing fast-moving opportunities for business collaboration required the flexibility of QR funding.

Collaborative networks

The was widespread consensus across sectors, from academics through to research-intensive businesses, that access to the collaborative networks the EU facilitates is vital to supporting R&D in the UK. For academics these collaborations allow access to the essential infrastructure, facilities, resources, databases, talent and skills. Businesses and SMEs emphasised that collaborative networks help projects to be scaled-up and, for some businesses, the ability to form partnerships and be involved in projects is more important than the funding.

Pan-European network GÉANT[25]

The UK is currently a member of GÉANT, the pan-European network that interconnects specialised internet service providers across and beyond the EU. It allows researchers to communicate, share high performance computing and transfer large volumes of data. European Research Area members currently contribute towards 50 per cent of the cost of GÉANT, with the remaining costs met by the European Commission.

Clean Sky - A Public-Private Partnership with the European Commission[26]

Clean Sky is a public-private partnership between the European Commission and the European aeronautics industry, including SMEs, research centres and academia. It aims to develop technologies to enable future aircraft to reduce noise levels and cut fuel burn and related CO_2 emissions by 20-30%. The 16 founding members of Clean Sky include Rolls-Royce, Safran and Leonardo Helicopters. The University of Nottingham has the highest level of participation of any university involved.

[25] Case study and text provided by Jisc.

[26] Case study and text provided by University of Nottingham.

Belmont Forum - An international partnership to address global environment change[27]

The Belmont Forum is an international partnership of funding organisations, science councils and regional consortia from over 50 countries. It supports interdisciplinary research in environmental and sustainability issues. Belmont Forum members work collaboratively providing resources to calls for proposals - Collaborative Research Actions - and they also make monetary or in-kind contributions to the secretariat. The Actions allow large-scale international research collaboration on a financial scale comparable to EU Horizon-supported projects.

Official Development Assistance funding

Many respondents recognised that Official Development Assistance (ODA) funds, such as Newton and the Global Challenge Research Fund (GCRF), successfully support international collaboration. Respondents highlighted that these funds are good at supporting multi- and inter-disciplinary projects; they showcase UK R&I internationally; they contribute to the UN Sustainable Development Goals; and provide the UK with opportunities to engage and influence research agendas in ODA eligible countries. However, respondents frequently raised concerns around the restrictions on ODA funds and stated that these restrictions can be inhibitory when it comes to building collaborations. Issues raised included that the overall budget is too small and the lack of funding for building collaborative projects between ODA and non-ODA countries.

Lead agency funding and schemes with non-ODA countries

There was wide recognition that more funding is needed to support collaboration with non-ODA countries. Respondents frequently highlighted the benefit of schemes where two or more international Research Councils form a lead agency agreement to jointly fund research.

The UK Arts and Humanities Research Council (AHRC) with the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) was cited as an example of a successful funding initiative for humanities researchers in the UK and Germany to support joint UK-German research projects. BBSRC-NSF (National Science Foundation, USA) was cited as a successful funding initiative for Biological Sciences.

Lead agency agreement schemes were praised due to the collaboration they facilitate and the avoidance of 'double jeopardy' where applications must be approved by both agencies. However, many respondents highlighted that these schemes are rare and international collaboration would benefit from them being more widely available. It was emphasised by many that, outside of these trans-national lead agency agreements, collaboration with non-European countries is hampered by the lack of available funding schemes. Many respondents agreed that new mechanisms are required to facilitate international collaboration beyond Europe, even if the UK associates to Horizon Europe, and priority funding alliances with key countries should be developed.

[27] Case study and text provided by Robert Gordon University.

Combining funds

A common theme that emerged from the evidence was that researchers combine funds from multiple sources at any given time in order to support international research. Examples of the funds combined include Horizon 2020 funds, UKRI domestic and international programme funds, charity lead international programmes (e.g. the Indian Government's Department of Biotechnology and Cancer Research UK'S India-UK Cancer Research Initiative), and funds from international partners including businesses and international universities. Some respondents stated that combining funds from multiple sources was easy. Others highlighted difficulties around eligibility requirements. It was suggested that new UK funding arrangements should recognise the challenges of harmonising funding and learn from UKRI's experiences of collaborating with funding agencies overseas. It was clear from many responses that the distinctive challenges of creating international collaboration requires distinctive arrangements for managing research and innovation funding.

MOF Technologies: SME in Northern Ireland[28]

MOF Technologies are an SME based in Belfast specialising in the manufacturing, testing and commercialisation of metal organic frameworks (MOFs), a type of adsorbent nanomaterial that has applications in gas storage, filtration and heat transformation.

Over its lifetime, the company has received funding from different sources to support its growth including ERDF funding via Invest NI, Horizon 2020 funding via a consortium project, and a grant from Innovate UK. Currently, the company is part of three ongoing Horizon 2020 collaborative research projects.

Regional and Devolved Issues within the UK

The unique characteristics of R&D in Scotland, Northern Ireland, Wales and of many regions of England were emphasised by respondents. It was highlighted that the types of R&D funding received, how funds are spent, and the nature of R&D carried out were distinct for these regions. Addressing regional differences needs to be balanced against benefits of coherent UK policy when developing policy and funding instruments.

Structural and Regional Development Funds

There was recognition of the vital role EU structural funds, for example the European Research Development Fund (ERDF), play in many parts of the UK. These funds often lie at the interface between business and research. They support R&D infrastructure and enable R&D activities. Their importance is often place specific, for example reliance on these funds was highlighted in Lancaster, Wales, the South West of England and Northern Ireland among

[28] Case study and text provided by MOF Technologies.

others. Some respondents stated that these funds are vital to the contribution of research to the place agenda and can be a mechanism by which devolved administrations, city regions and local authorities are engaged in research and innovation. A pressing need to include similar support under any new funding arrangements was emphasised.

Cardiff-Takeda - Drug Discovery Partnership[29]

The European Research Development Fund contributed to the creation of Cardiff University's Medicines Discovery Institute and the Cardiff University Brain Research Imaging Centre. Academic expertise in these institutes, alongside UKRI-funded research in neuropsychiatric genetics and neuroscience, attracted the pharmaceutical company. Takeda – the largest pharmaceutical company in Japan - to invest £4m in a partnership with Cardiff University.

CAPSE[30]

The Centre for Automotive & Power Systems Engineering (CAPSE) was part sponsored by a Welsh Government flagship programme under the European Regional Development Fund. It is a knowledge transfer centre with expertise in the area of low carbon automotive and renewable energy research. The University of South Wales subsequently invested £1.5M on new purpose-built labs and offices to house the Centre and in the last year has invested a further £4m in equipment and created more than a dozen new highly skilled jobs.

Regional disparities

While not raised by all respondents, many highlighted that regional disparities are an issue that needs to be addressed. Some respondents argued in favour of investing in R&D in less prosperous regions of the UK. Suggestions to combat regional disparities included investing in facilities and infrastructure in particular regions, overcoming geographical bias by funding innovative industries and removing the industry specificity of some funding, and developing more 'clusters of excellence'.

Northern Ireland and Irish border

Northern Ireland respondents emphasised the extensive collaborative relationships across the Irish border. They highlighted that 'North-South' collaboration has helped build highly valued networks across all disciplines and has helped advance areas of common interests such as manufacturing, AI and climate change. The strong cross-border collaborative relationship is a complex issue that needs to be recognised and addressed. Respondents highlighted the need for future funding arrangements to continue to facilitate, incentivise and build on North-South research collaborations as they play a critical role in adding scientific value as well as community building.

[29] Case study and text provided by Cardiff University.

[30] Case study and text provided by University of South Wales.

UK Immigration policy and more

Policy decisions on research and innovation have strong connections with policy in other government departments. More effective coordination of policy across Government would be welcomed widely. Many interdependencies were raised throughout the evidence that, although not within scope of this review, would support the UK's position as a world-leading research country, and ultimately the 2.4% agenda.

There was wide agreement that an open, supportive immigration system is vital to support R&D in the UK. The transparency of immigration policy, the visa application process, cost of visas and regulations regarding dependencies were all raised as policy areas that need to be conducive to researchers. Respondents emphasised the need for a visa route that supports any new funding arrangements, particularly when looking to attract global talent to the UK. In addition, many highlighted the need for streamlined mobility regulations that allows researchers to easily attend conferences, network events, and carry out research and other research related activities both in the UK and overseas.

Additional interdependencies frequently highlighted included higher education and the need to attract overseas students to the UK, ISO-standards, taxation, and intellectual property strategies.

CONCLUSIONS

Research and innovation are towering strengths of the United Kingdom.[31] As we gathered evidence for this review from across the United Kingdom, we found countless examples of the impact of research and innovation on individuals, communities and businesses. These benefits include improvements in public health, transport, communications, our understanding of the natural environment, the quality and security of food chains and the competitiveness of new and established businesses across the economy.

This country's reputation for outstanding research is respected around the world. The UK's broad span of research excellence (including humanities, social sciences, natural sciences, life sciences and engineering) and diverse relationships between research and business are particular strengths.[32]

Those strengths persuade some of the world's most talented researchers to pursue careers in this country. Many of the world's most research-intensive companies invest here and collaborate with our outstanding universities and research institutes. However this country now faces unprecedented levels of international competition for research talent and business investment. This adds up to a time of challenge and opportunity as described in a recent speech by Minister for Universities, Science, Research and Innovation, Chris Skidmore.[33]

Research and innovation are fundamentally international endeavors. The research and innovation community operates in cosmopolitan international networks, bringing together knowledge and expertise from across the planet to address problems and explore the frontiers of knowledge at global, national and local levels. Participation in EU research and innovation programmes has been a prominent and successful part of UK research and innovation for several decades.

The UK Government has been consistent in its wish to have the option to associate with Horizon Europe. That position reflects a clear consensus in the academic, business and charity communities that the UK should associate with Horizon Europe. That consensus has remained steady since before the referendum.[34] It is a rational response to the widely documented benefits – scientific, financial and intangible – that the UK has derived from participation in earlier EU R&D programmes.

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[31] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/815400/International_comparison_of_the_UK_research_base__2019._Accompanying_note.pdf

[32] http://ncub.co.uk/reports/state-of-the-relationship-report-2019

[33] https://www.gov.uk/government/speeches/becoming-an-innovation-nation-driving-up-private-investment-into-research-and-development

[34] http://www.sciencecampaign.org.uk/asset/F0AA2106-2B7F-4A3E-B345A332F877043B/

[35] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/795227/Terms_of_reference.pdf

However, wider factors may bear on the ultimate decision on association and it is therefore prudent to explore alternatives. The Government therefore commissioned this report "to explore credible and ambitious alternatives to deliver positive outcomes for science, research and innovation in the event that the UK does not associate."[35]

In preparing our findings, we have drawn extensively on informative written submissions to this review and the many valuable meetings in locations ranging from Belfast to Brussels and from Exeter to Edinburgh. We have also benefitted from earlier investigations, including those by the House of Lords Science and Technology Committee[36], The Royal Society,[3738] the Royal Academy of Engineering[39], Wellcome[40] and the Horizon Europe Alternatives Board convened by BEIS.

Brexit and UK public spending on EU R&D

In 2018, Government published 'UK participation in Horizon 2020' on arrangements for continued participation in Horizon 2020.[41] At the time of writing, the design of future EU research and innovation programmes and options for UK association beyond the Horizon 2020 programmes have not been finalised.

The UK's previous association in successive EU research programmes has been underpinned by several arguments.

- Association is a highly efficient way of creating pan-European partnerships, accessing shared infrastructure, sustaining existing collaborations and pursuing high quality research. Furthermore, EU money adds diversity to the funding ecosystem, sometimes supporting research topics – archeology, law and software engineering, for example - that are lower priorities for UK funders.

- The cost of association has been included in the UK's overall subscription to the EU: that cost is incurred whether or not UK researchers participate. EU research funding does not come at the expense of UK research budgets.

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[36] https://publications.parliament.uk/pa/ld201516/ldselect/ldsctech/127/127.pdf

[37] https://royalsociety.org/topics-policy/publications/2019/uk-science-and-immigration-why-the-uk-needs-an-internationally-competitive-visa-offer/

[38] https://royalsociety.org/-/media/policy/Publications/2018/royal-society-brexit-no-deal-factsheet.pdf?la=en-GB&hash=03BC02270D6BFDC28C5D268A8F12199C

[39] https://www.raeng.org.uk/policy/engineering-policy-areas/research-and-innovation-policy/investing-in-engineering-research-and-innovation/increasing-engineering-business-r-d-investment-the

[40] https://wellcome.ac.uk/reports/building-strong-future-european-science-brexit-and-beyond

[41] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/766510/horizon-2020-government-overview-december-2018-update.pdf

- Furthermore, EU programmes have reflected the UK view that funding should follow excellence, rather than being spread more evenly across member states. The high performing research base in the UK has enabled this country to secure substantially more R&D funding from the EU than it contributes. That has added further to the appeal of participation.

Whatever the final arrangements beyond Horizon 2020, continued participation in EU programmes may require additional financial justification within the UK.[42] Once existing membership commitments between the UK and the EU are overtaken by the terms of Brexit, the UK will no longer pay a 'membership subscription' to the EU. Until now, that subscription has automatically included the UK's financial contribution to EU research programmes.

In future, any financial contribution to EU research programmes may be tensioned against other options for domestic UK budgets. This tensioning should not be on financial grounds alone. Intangible benefits are a major part of the rewards from EU research collaboration and these benefits would need to be part of any overall assessment of costs and benefits. [43]

In simplistic binary terms, one option is to make payments directly to Brussels to participate in EU research programmes. Alternatively, the UK could spend the same amount of money on research and innovation activities, optimised around the interests of the UK rather than the collective interests of EU programme participants. In practice, more nuanced options may be available, perhaps including degrees of participation in EU programmes as a so-called 'third country' (ie a country outside the EU).

Key foundations of strong research and innovation

During this review, we have heard numerous accounts of how EU structural funds have contributed to the development of research and innovation in the UK.[44]

These funds are concentrated in areas of economic need and often contribute to the interface between research and the economy, diversifying the sources of funding and providing resources under terms that are that are difficult to replicate under existing UK arrangements.

[42] https://www.timeshighereducation.com/opinion/uk-researchers-free-money-will-come-price-after-brexit

[43] http://www.sciencecampaign.org.uk/news-media/press-releases/case-letter-science-minister-intangible-benefits.html

We also heard from many sources across the country about the large scale of spontaneous collaboration that takes place internationally. This spontaneous activity is not supported by specific grant awards or funding schemes whose headline purpose is 'international collaboration'. It is driven by the exchange of ideas and exploration of new challenges by researchers working in international peer groups. That is how research works. Spontaneous collaborations make vital – but often unrecognised – contributions to the research base. They are often the source of new ideas and new research programmes. In universities, much of that activity appears to be supported by QR funding. But we heard that QR funding has not risen at the rate of other funding streams over the last decade and now faces many competing pressures.

We also heard about the challenge of reacting to fast-moving opportunities for international collaboration in a competitive world. We heard that fast-moving opportunities – whether at the level of Government Ministers, universities or research institutions – are often accessible only if the UK has readily available resources with which to reach a rapid agreement. If the UK side has to embark on a lengthy process of grant application to find resources then the opportunity may well be lost and the benefits go elsewhere.

We were told frequently about the pressing influence of immigration policy on the ability of the UK to attract and retain talented researchers, technicians, PhD students and others from around the world while facing international competition for such talent. Visa arrangements that not only allow but actively encourage PhD graduates to pursue at least the early stages of their careers in the UK would be particularly welcome. We heard that variations in salary levels across the UK mean that visa regulations based on minimum salary thresholds can be less than optimal in some parts of the country where such thresholds sit above the market rate for the relevant employees. The relationship between immigration policy and science was the subject of a recent inquiry by the House of Commons Science and Technology Committee.[45]

Alternatives to association with EU programmes

If the UK Government chooses not to associate in substantial areas of Horizon Europe for which it is eligible, then that decision may well have diplomatic and economic implications beyond research and innovation. Any such implications would presumably have been taken into account in reaching the decision on association.

Under our terms of reference, this review is focused specifically on the UK agenda in the event of a decision not to associate. After such a decision, it seems unlikely that Government would support proposals to recreate similar funding arrangements on a permanent basis inside the UK. In other words, we are not convinced that a persuasive case

[44] https://ec.europa.eu/regional_policy/EN/funding/

[45] https://publications.parliament.uk/pa/cm201719/cmselect/cmsctech/1061/1061.pdf

can be made for sizeable levels of public spending on activities that replicate, line by line, EU research and innovation arrangements in the UK soon after Government has decided not to associate.

A decision not to associate would presumably be on the basis that arrangements optimised around the interests and ambitions of the UK would make better use of public funding than the same level of expenditure on arrangements that are optimised around the collective interests of EU programme participants.

Such new arrangements would therefore include support for international collaboration in research and innovation on a global scale. These collaborations could reflect the capabilities, ambitions and longer term vision of the UK. They would reflect our strong and growing R&D relationships around the world, described in the recent International Research and Innovation Strategy.[46]

The UK has participated in EU research and innovation programmes for several decades. Sizeable numbers of researchers in the UK have built their careers on funding, research networks and facilities within the EU. We have heard from many authoritative sources during the course of this review that abrupt and unmitigated change to the level of access to EU programmes is likely to destabilise some of the research capability of the UK.

Furthermore, we have heard repeatedly that a decision not to associate would, in the absence of a convincing alternative agenda for international collaboration, undermine the attractiveness of the UK to academic researchers and business investors in R&D.

[46] https://www.gov.uk/government/publications/uk-international-research-and-innovation-strategy

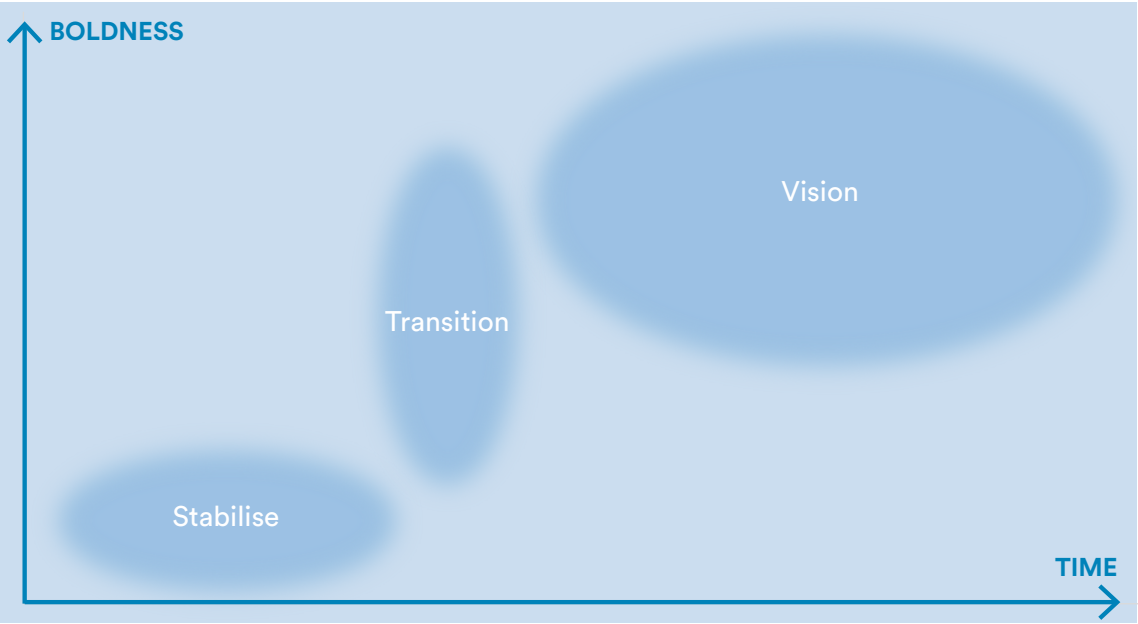
RECOMMENDATIONS

The Government now has an unprecedented opportunity to promote an exciting, well-resourced vision for international collaboration in research and innovation over the longer term. Specific components of that vision are described below. Should they be adopted, many of these components would require detailed development in partnership with the academic, business and charity communities.

This vision could be pursued only with significant additional public funding. If the UK does not associate with Horizon Europe then we see a powerful case for replacing the level of funding that the UK currently receives from EU R&D activities – around £1.5bn per annum – with public investment from the UK. Our recommendations are based on the availability of that funding.

This vision would be part of a larger framework that begins with the protection and stabilisation of existing capabilities. The framework should be structured along the lines of Figure 14.

Figure 14 *The concept of a global vision for UK research and innovation, building first on the protection and stabilisation of capabilities built through participation in EU programmes.*



Stabilising and protecting research capabilities

Recommendation 1

We recommend that any decision not to associate should be accompanied by an immediate programme to protect and stabilise capabilities built up in the UK through participation in EU research and innovation programmes over recent decades.

This programme of stabilisation and protection is an essential first step towards a new vision. Without the adoption of this recommendation, the UK would be discarding the benefits of public investment in EU programmes over several decades and the resulting stock of reputation, capability and talent that have been amassed during that time.

In this report, we cannot specify the precise mechanisms of stabilisation and protection. However stabilisation and protection might begin by expanding the scope and extending the duration of the Government's existing funding guarantees.[47] This might include facilitating and funding participation on a third country basis in Horizon Europe, as appropriate.

Many existing holders of EU grants for research and innovation have a history of winning competitions for EU funding and, until recently, had a reasonable expectation of winning future competitions. That expectation could be undermined at relatively short notice if the UK does not associate with Horizon Europe.

Protection and stabilisation could include extension of the duration of the Government's guarantee to include a readily accessible funding extension of one or two years to UK researchers whose expectations have been changed abruptly. This could provide a period of transition for individual researchers to adjust their funding ambitions away from EU programmes and towards new activities such as those outlined elsewhere in this report.

Participation in EU programmes has also provided access to databases, research facilities and long-standing networks of expertise. Abrupt loss of access to these assets cannot be mitigated directly but financial support from UK Government could be made available by expanding the scope of the Government's guarantee to provide resources with which the research base could transition to alternative arrangements.

[47] https://www.gov.uk/government/news/funding-from-eu-programmes-guaranteed-until-the-end-of-2020

A new vision for international collaboration

A new vision for research and innovation might build on the extraordinary breadth of existing collaborations and relationships, some of which was set out in the recent International Research and Innovation Strategy.[48] Many of those we consulted, asked for an outline of this new vision to be published quickly and promoted widely. They called for a sense of direction for the UK research base, helping to mitigate the inevitable uncertainty that would follow the end of decades of participation in EU programmes.

Sizeable levels of support for basic research have come from the European Research Council and other EU programmes under Horizon 2020. Meanwhile, the balance of funding from UKRI is perceived by many of our consultees to have shifted towards mission-oriented and challenge-led programmes. A longer vision for the UK provides opportunities to re-balance UK funding to ensure that vital capabilities in basic research are maintained outside EU programmes.

There was also recognition that the vision provides an opportunity to align the UK's international collaboration more effectively with major growth in India, China, the Asia Pacific and many other parts of the world, not least in countries with which we participate in Official Development Assistance. And of course it provides opportunities for even greater emphasis on our major research relationships with the USA and Commonwealth countries.

Recommendation 2

We recommend that this vision includes three headline themes, each of which requires, and builds upon, this country's outstanding strength in basic research and the diverse relationships between universities and businesses in the UK. The headline themes are:

- **major new strides towards higher levels of overall R&D investment in the UK;**
- **greater contributions of research and innovation to addressing long-standing regional disparities in wealth and opportunity; and**
- **increasing the agility of UK research and innovation to capture fast-moving opportunities.**

Taking these in turn:

Strides towards 2.4%

The Government's commitment to raise R&D investment to 2.4% of national wealth by 2027 is welcomed widely. It is a major challenge for the UK which would place great demands on the availability of high performing researchers. It is recognised widely that the strength of

[48] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/801513/International-research-innovation-strategy-single-page.pdf

the UK research base is a magnet for international investment in R&D and increasing such investment is key to meeting the 2.4% commitment. We recommend the introduction of:

- An international version of the UK Research Partnership Investment Fund (RPIF): a competition for universities and institutes to attract sizeable investment into UK R&D by companies headquartered in other countries, thereby making a substantial commitment to the Government's manifesto commitment to raise overall R&D investment to 2.4% of GDP by 2027. The existing UK RPIF provides £10m - £35m to winning bids that attract at least twice that amount from other investors.[49]

- A coherent Global Talent Strategy, combining reforms to immigration policy with a suite of fellowship programmes to attract and retain many of the world's most talented researchers and research students in the UK. Immigration policy should be about attracting talent to the UK as well as regulating entry to our country.

- Substantial additional funding for basic research, recognising that significant levels of support for this important work currently come from EU programmes. That additional funding can be delivered through existing administrative arrangements.

- A flagship programme of research fellowships, offering large awards over long periods of time for exceptional researchers in all disciplines to expand the frontiers of knowledge in areas they have identified. For example, funding for two – or even three - successive four year terms on a scale that is at least as great as that from funders in other countries. Funding should be available at all career stages. Awards should be overseen by a prestigious international faculty of peer reviewers, recruited through national academies across the countries of the UK, Ireland and beyond.

Opportunities for all regions of the UK

Throughout this review, we have been struck by the widespread use of EU structural and regional development funds to support research and innovation. These resources add diversity to the funding landscape, providing support for activities that are not clearly covered by UK funding streams. Many of the activities supported by structural funds lie at the interface between research and local economies. We recommend:

- Integration of the forthcoming Shared Prosperity Fund with the Innovate UK agenda. This should take full advantage of Innovate UK's potential to guide and shape sizeable parts of the Shared Prosperity Fund, in partnership with the Ministry of Housing, Communities and Local Government. Innovate UK also has the potential to manage distinctive new investment streams, responding to any reduction in support for UK SMEs under Horizon 2020.

[49] https://re.ukri.org/research/uk-research-partnership-investment-fund/

- Major new centres of research and innovation – each on the scale of a medium-sized university - that would embark on missions to address the world's most pressing challenges while signaling the scale and ambition of the UK's agenda. These could be concentrated into entirely new campuses, each of which would have the potential to attract major new investment to its regional economy. Alternatively they could be created as networks of new institutes, spreading their activities more widely across the UK. For example, a new Zero Carbon Institute could bring together expertise in engineering, climate sciences, law, social science and economics from around the world to address the worst effects of climate change and build industries for a zero carbon economy of the future. Another centre could focus on the medical, social and economic challenges of ageing populations in many countries.

Greater agility to seize fast-moving opportunities

Distinctive new funding is required to enable researchers in universities, institutes and, sometimes, businesses to grab fast-moving opportunities for international collaboration. We heard that, all too often under current arrangements, new opportunities cannot be pursed without first going through lengthy processes of grant applications. Those grant application processes are well suited to most research and innovation activities but break down when the UK is presented with attractive - but fleeting – opportunities, for example during meetings at political, funding agency or institutional levels. Meanwhile, support for spontaneous collaborations between researchers in the UK and their international peers seems modest compared to the opportunities and benefits of this work.

We recommend two new funding streams to capture fast-moving and unexpected opportunities:

- The first of these should provide additional financial support through QR funding – and its devolved equivalents – for the spontaneous international collaborations that are woven into the fabric of research and innovation but can so easily be inhibited by funding models that are tied to specific projects.

- The second should be an 'Agility Fund' with two distinct strands. The first should enable the UK to invest in emerging international programmes of significant potential benefit to UK research. The second to capture opportunities that arise unexpectedly, including during interactions with other countries at Ministerial levels.

Recommendation 3

We advise strongly against the disruption of existing research and innovation activities to release resources for our recommendations. Such disruption would destabilise the UK's highly successful research and innovation ecosystem just at a time when it faces uncertainty and change. This in turn would have unpredictable effects on businesses and charities contemplating new investments in the UK.

Administrative arrangements

Only a small proportion of stakeholders contributed detailed views on the administrative arrangements. But those contributions, most of which were in discussion rather than in writing, were well-informed.

The implementation of Sir Paul Nurse's 2015 Review of Research Councils gives an indication of the scale and complexity of apparently straightforward reforms to the administration of research funding.[50] We urge caution before embarking on reforms outside the scope of the 2017 Higher Education and Research Act while UKRI is still at such an early stage of its existence. The 2017 Act already provides powers to modify the structure of UKRI.

We found a clear consensus among well-informed stakeholders that the scale and complexity of the alternative funding arrangements discussed in this review would stretch the capacity of UKRI in its current scale and form. Substantial additional capacity would be required for administration and to provide more people with expertise in international research collaboration, the attraction of business investment in R&D from other countries and liaison with immigration authorities in the UK.

Furthermore, the substantial additional UK public spending – some £1.5bn pa – combined with the distinctive objectives for the funding would add significantly to the number and diversity of funding awards being made in the UK. Effective leadership and oversight of these new arrangements would require strong governance with distinctive characteristics to reflect the international nature of the new work.

[50] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/478125/BIS-15-625-ensuring-a-successful-UK-research-endeavour.pdf

Recommendation 4

Against that background, we recommend the following principles for the administration of alternative funding:

- **Robust governance to ensure effective stewardship of public funds and maintain the confidence of BEIS and HM Treasury.**
- **Independence and transparency to maintain the confidence of investors and research collaborators from other countries and from the research community in the UK.**
- **Expertise in the distinctive nature of international collaborations as well as easy access to existing UK expertise and administrative support on research and innovation funding.**
- **Maintain or enhance the diversity of funding sources for research and innovation in the UK.**
- **Introduce the lowest extra costs of administration consistent with the four principles above.**

It is beyond the scope – and authority - of this review to design detailed arrangements for management and governance. On the basis of discussions with well-informed stakeholders, we identified many options for the management of new funding streams. These include:

(i) Creating a new, stand-alone public body that would manage most or all of the new funds, becoming a 'champion' for international collaboration.

(ii) Allocate the funding across the existing nine councils of UKRI so that several Councils each led appropriate parts of the international agenda.

(iii) Create a new cross-cutting funding stream at the UKRI centre alongside Industrial Strategy Challenge Fund and Global Challenges Research Fund that work in collaboration with existing UKRI Councils where appropriate.

(iv) Create a new, independent, science and humanities Council within UKRI that would be a champion for international collaboration, manage much of the new funding itself and work in collaboration with existing Councils where appropriate.

We offer the following preliminary observations on the four options. Clearly more investigation and business planning would be required before a choice between them could be exercised.

Option (i) has arguably the greatest potential for independence and funding diversity. But that would come at a high cost of administration and a long period of gestation compared with other options. It may well require legislative changes. The relationship between UKRI and a new body would inevitably be complicated, given their many overlapping interests and responsibilities.

Option (ii) would arguably be the least expensive and most rapid to introduce, albeit with significant risk of disrupting existing UKRI programmes by introducing many new responsibilities over a short period. It may reduce the existing level of funding diversity. Coherent funding spanning all research disciplines would be difficult to accommodate within this model.

Option (iii) may also reduce the existing level of funding diversity. Furthermore, it may present the Board of UKRI with unmanageable conflicts of interest between their oversight of new funding streams (where the UKRI Board would, in effect, be the governing council) and their oversight of the remaining nine Councils of UKRI.

Option (iv) An independent Council within UKRI could offer robust governance and greater diversity of research funding than the other options. For example, it could rely on administrative services from UKRI while ensuring independence by engaging National Academies across the UK and beyond to inform funding strategy and recruit a prestigious new faculty of peer reviewers. It could be created within the powers of the 2017 Act at significantly lower cost and greater speed than a new body.

NEXT STEPS

Our findings are presented at a high level. We present an overall framework for the funding of international collaboration in the event that the UK does not associate with Horizon Europe.

Significant levels of detailed business planning and administrative planning would be required before our recommendations are ready for implementation.

We suggest that early consideration be given to setting up a group to oversee further, more detailed, preparations.

ACKNOWLEDGEMENTS

Every stage of this work relied on wise advice and enthusiastic assistance from government officials, UKRI staff and colleagues in the research and innovation community across the UK. The authors are indebted to the many organisations who convened meetings, submitted written evidence and otherwise supported the review.

In particular, we wish to thank BEIS officials Masuma Ahmed, Graham Allardice, Zoë Bond, Laura Eden, Raegan Hiles, Steph Hurst, Benjamin Marriott, Alice Roycroft and Harriet Wallace and HM Treasury official Jo Johnson. This review could not have been done without them.

ANNEXES

A. Ministerial Written Statement with Terms of Reference

B. Call for evidence

C. Organisations who responded to the call for evidence

D. Evidence gathering sessions

E. Letter from the chair of CaSE to the Minister of State for Universities, Science, Research and Innovation on intangible benefits of participation in EU research

F. Public expenditure on research and innovation international collaboration

Annex A Written Ministerial Statement with Terms of Reference

Laid by Minister of State for Universities, Science, Research and Innovation on 26 March 2019.

Adrian Smith Review

I am pleased to announce that I have commissioned Professor Sir Adrian Smith, Director and Chief Executive of the Alan Turing Institute, to provide independent advice on the design of UK funding schemes for international collaboration, innovation and curiosity-driven blue-skies research.

The UK is a world-leading research nation with a globally connected research base. Collaboration with European and wider international partners is key to our strength in science and research: more than half of the UK's research output involves such collaboration. The UK is in the top four of global innovation nations and we draw in more internationally mobile Research and Development (R&D) than other large countries, with a total of 16 per cent of UK R&D investment financed from abroad.

This Government is bringing forward the largest investment in R&D on record. As outlined in our modern Industrial Strategy, we are committed to reaching 2.4% of GDP invested in R&D by 2027, and 3 per cent in the longer term. International partnerships and collaboration will play an important part in helping to achieve our ambitions, including in supporting the Industrial Strategy's Grand Challenges to put the UK at the forefront of the industries of the future. Professor Sir Adrian Smith's advice will help set the direction for the implementation of the Government's ambition to ensure the UK continues to be a global leader in science, research and innovation, and an attractive country for individuals to study and work. Furthermore, Sir Adrian's advice will help inform the upcoming Spending Review.

The Terms of Reference, outlining the scope, timescale and reporting of this work are below.

Terms of Reference for the Commission of Professor Sir Adrian Smith

1. General

I. The Secretary of State for BEIS has commissioned Professor Sir Adrian Smith to provide independent advice on the design of potential future UK funding schemes for international, innovation and curiosity-driven blue-skies research, in the context of the UK's future ambitions for international collaboration on research and innovation. This document outlines the terms of reference for this work.

II. The global landscape for science and innovation is changing, and access to knowledge, markets, skills and partners now takes place on a global basis. Global Research and Development (R&D) capacity is expanding and non-Organisation for Economic Cooperation and Development (OECD) countries account for a growing share of global R&D, both in terms of researchers and investment. Better understanding is needed on whether the UK's current funding mechanisms, resources and bilateral and multilateral partnerships will be fit for purpose when set against the projected trends in international research and innovation, and against new technology and industry roadmaps and the forecast social, economic and environmental trends.

III. The UK's participation in Horizon 2020, the current European Union (EU) Framework Programme for Research and Innovation, has benefited the UK's science, research and innovation landscape. It provides opportunities for UK entities to collaborate with EU and international counterparts and funding for multiple elements including innovation, international collaborations and partnerships, and curiosity-driven 'excellence' based research. Horizon Europe is the successor to Horizon 2020 and will run from 2021 to 2027. The UK remains committed to ongoing collaboration in research and innovation with partners across Europe. To this end the UK would like the option to associate to Horizon Europe and is continuing to actively shape the development of that programme. However, we are also exploring in parallel credible and ambitious alternatives to deliver positive outcomes for science, research and innovation in the event that the UK chooses not to associate.

2. Purpose

IV. Professor Sir Adrian Smith has been invited to provide independent advice on how funding future international collaboration, from curiosity-driven 'discovery' funding through to innovation, can best be designed to positively impact science, research and innovation in the UK, and to support the Government's strategic objectives, including the Industrial Strategy and its commitment to 2.4% of GDP invested in R&D by 2027.

V. In the immediate term, Professor Sir Adrian will be asked to advise on the design and delivery of elements of the potential alternatives to Horizon Europe association. This will include the Discovery Fund, which aims to provide a UK alternative to the curiosity-driven and excellence-focused elements of Horizon Europe.

VI. On the Discovery Fund Professor Sir Adrian Smith will be asked to consider:

i. The design of UK alternative funds i.e. the scale, scope and any international elements of proposed funds, and how they could complement the current UK funding landscape;

ii. The delivery of UK alternative funds i.e. how strategic direction could be determined, how proposals could be reviewed.

VII. On international collaboration, Professor Sir Adrian Smith will be asked to consider:

i. How funding mechanisms, resources, and international partnerships can remain fit for purpose for our global ambition to support the International Research and Innovation Strategy, which will be published in the coming months.

ii. How international collaboration can best support the Government's Industrial Strategy and 2.4% target.

VIII. Professor Sir Adrian's advice will help inform the upcoming spending review (as announced in the Spring Statement) and longer-term value-for-money considerations on international collaboration for research and innovation.

IX. Professor Sir Adrian will have the independence to engage with relevant stakeholders and seek expert advice as he sees fit.

3. Time Scale

X. It is anticipated interim findings will be presented to BEIS ministers in the Summer of 2019.

4. Reporting

XI. Professor Sir Adrian Smith will report to the Minister of State for Universities, Science, Research and Innovation. Professor Sir Adrian will provide an update on progress on a regular (monthly) basis, to BEIS officials. A summary of his interim findings will be published by BEIS.

Annex B Call for evidence

The call for evidence was open from 12 April 2019 to 26 May 2019.

Future frameworks for international collaboration on research and innovation: call for evidence

Overview

Professor Sir Adrian Smith has been commissioned by BEIS to provide independent advice on the design of future UK funding schemes for international collaboration, innovation and curiosity-driven blue-skies research.

We welcome written contributions on a wide of issues relating to potential funding schemes. Please keep your submissions to less than 2500 words if possible.

The advice team will also hold evidence gathering meetings across the UK.

See the Terms of Reference for this work.

About you

1. What is your name?

2. What is your email address?

3. Are you responding as an individual or on behalf of an organisation?

4. If responding on behalf of an organisation:
   a. What is your organisation?
   b. What type of organisation are you?

5. What region of the UK are you predominantly based in?

6. Are you happy for your response to be published?

Areas of interest

We welcome written contributions on a wide range of issues relating to potential funding schemes. Areas of interest are:

1. Methods by which new funding arrangements can:
   - support research discovery of outstanding quality in all disciplines through international partnerships;

- attract to the UK researchers of outstanding capability from around the world; and
- attract further R&D investment to the UK, thereby contributing to the Government's 2.4% agenda.

2. The optimum balance of emphasis for any new funding arrangements in each of the following dimensions:
   - European collaboration, Official Development Assistance and global collaboration;
   - support for: outstanding individuals; blue-skies research; business innovation and research impact; and research facilities and infrastructure; and
   - research and innovation domains (research disciplines, business sectors etc).

3. Methods and timescales for introducing any new funding arrangements for international collaboration, including those that
   - reflect the ambitions of small and large businesses
   - foster new systems of international peer review and funding.

4. The roles of Government, UKRI, National Academies and other organisations in defining the agenda for European and international collaboration and administering any new funding arrangements for such activities.

5. Existing evidence on the efficiency and effectiveness of funding for international collaborations.

6. Any other issues relating to this work that you wish to bring to our attention.

Annex C Organisations who responded to the call for evidence

- Academy of Medical Sciences
- ADS Group
- Aerospace Technology Institute
- Airbus
- The Alan Turing Institute
- Arts Council England
- Association of Innovation, Research and Technology Organisations
- Association of Medical Research Charities
- Association of the British Pharmaceutical Industry
- Babraham Institute
- BAE Systems
- Biochemical Society
- BioIndustry Association
- BMA Medical Academic Staff Committee
- British Academy
- British Academy of Management
- British Council
- British Geological Survey
- British Heart Foundation
- British Pharmacological Society
- British Society for Immunology
- British Standards Institution
- Brunel University London
- Cancer Research UK
- Cardiff Metropolitan University
- Cardiff University
- CaSE
- Catapult Network
- Centre for Connected and Autonomous Vehicles (CCAV) and Zenzic
- Coventry University
- DEFRA
- Durham University
- ELIXIR
- EMBL-European Bioinformatics Institute
- Engineering Professors' Council
- European Centre for Medium-Range Weather Forecasts
- Francis Crick Institute
- FSB, The Federation of Small Businesses
- GARNet
- Glasgow Caledonian University
- GuildHE
- Heads of University Centres of Biomedical Sciences
- Institute of Development Studies
- Institute of Physics
- Jisc
- Johnson Matthey PLC
- Kingston University
- Leonardo MW Ltd
- Lilly UK
- London South Bank University
- Lontra
- Loughborough University
- Manchester Metropolitan University
- Merck Sharp & Dohme (MSD)
- Met Office
- Middlesex University
- MillionPlus
- Mondi
- N8 AgriFood Resilience Programme
- National Centre for Universities and Business
- National Heritage Science Forum
- National Institute for Health Research
- National Oceanography Centre
- National Physical Laboratory
- Natural History Museum
- NERC National Centre for Earth Observation
- Network Rail
- Newcastle University
- NHS Highland
- NIHR UCLH Biomedical Research Centre Deafness and Hearing Loss Theme
- Northern Health Science Alliance
- Office for Strategic Coordination of Health Research

- Oxford University
- Photonics Leadership Group
- Plymouth Marine Laboratory
- Queen's University Belfast
- Rolls-Royce plc
- Royal Academy of Engineering
- Royal Astronomical Society
- Royal Botanic Gardens, Kew
- Royal Irish Academy
- Royal Society
- Royal Society of Biology
- Royal Society of Chemistry
- Royal Statistical Society
- Russell Group
- Scottish Funding Council
- STFC Particle Physics Advisory Panel
- STFC Science Board
- Strathclyde University
- Teesside University
- TWEFDA, Ltd
- UK Collaborative on Development Research
- UK Hydrogen and Fuel Cell Association
- UK Quality Infrastructure
- UKRI
- Ulster University
- Unconventional Connections Ltd
- University of Nottingham
- Universities Scotland
- Universities Wales
- University Alliance
- University College London
- University College London STEaPP, University of Pretoria Department of Engineering and Technology, African Centre for Technology Studies
- University of Aberdeen
- University of Birmingham
- University of Bristol
- University of Cambridge
- University of Central Lancashire
- University of East Anglia
- University of Edinburgh
- University of Exeter
- University of Hull
- University of Leeds
- University of Leicester
- University of Liverpool
- University of Southampton
- University of St Andrews
- University of the Highlands and Islands
- University of the West of Scotland
- University of Warwick
- Universities UK
- Wellcome
- Welsh Government
- Wood Nuclear Limited

Annex D Evidence gathering sessions

Host organisation	Participants
National Academies	National Academies Presidents/Vice Presidents
EUREKA Summit in Manchester	SMEs and stakeholders with interest in innovation in the UK
Russell Group	Russell Group Vice-Chancellors, Pro-Vice-Chancellors of Research
Chief Scientific Advisors	Chief Scientific Advisors for Government Departments
Royal Society of Edinburgh	Young Academy, RSE Fellows and institutions
Chief Scientific Advisor for Wales	Devolved interests including government, industry and academia
UKRI	UKRI Executive Chairs UKRI Board and Executive Chairs
Academy of Medical Sciences	Charitable research funders from several sectors
Royal Academy of Engineering (on behalf of National Academies)	SMEs Big businesses
University of Leeds & N8 research	North of England businesses and universities
Coventry University	Midlands businesses and universities
UKRep	Brussels-based UK research offices and organisations; countries who have association or third country relationships with European R&I funding
CaSE	CaSE organisational members and other organisations with research and innovation interests
Ulster University & Queens University Belfast	Northern Ireland businesses, universities and government
University of Exeter	South West businesses and universities
High-Level Group, convened by Minister of State for Universities, Science, Research and Innovation at BEIS with the Parliamentary Under Secretary of State at the Department for Exiting the European Union	Research and innovation sector representatives and senior officials

Annex E Letter from the chair of CaSE to the Minister of State for Universities, Science, Research and Innovation on intangible benefits of participation in EU research

19th September 2018

Dear Universities and Science Minister,

Intangible benefits of participation in EU research

We discussed the intangible benefits of UK participation in EU research programmes during a meeting last week. I mentioned that Wellcome and CaSE convened a workshop on 12 September at which we explored these issues and I promised to send you a note of that workshop and the thinking behind it.

Wellcome attracted an outstanding range of workshop participants, a list of whom is attached. We heard important insights from Norway and Switzerland about the costs and benefits of their participation in EU research. We received many valuable contributions from UK organisations, not least from The Arts Council, The National Trust and the Medical Research Council each of whom have expertise in assessing intangible benefits.

This issue is coming into sharp focus as we reach pivotal stages of the Brexit process. There was unanimous support for continued participation in EU R&D. Clearly it is vital that the UK secures associate status for future programmes. There was also wide agreement at the workshop that the costs and benefits of EU programmes can be better assessed if we have a good understanding of both the nature and scale of their intangible benefits to the United Kingdom alongside direct financial returns. Only then can the value to the UK of future participation in EU programmes be compared with that from alternative options within the UK.

Until now, UK participation in successive EU research programmes has been underpinned by three arguments. The one most commonly cited by researchers is that participation is a highly efficient way of creating pan-European partnerships, sustaining existing collaborations and pursuing high quality research.

Secondly, the cost of participation has been included in the UK's overall subscription to the EU. That cost is incurred whether or not UK researchers participate. EU research funding does not appear to come at the expense of UK research budgets.

Third, UK influence has contributed to an EU focus on excellence rather than, say, regional economic development or an even spread of funding across member states. The emphasis on excellence is one factor that has allowed the UK to win more money from participation in EU R&D than the UK's notional contribution to these programmes.

The popularity of EU initiatives in the UK research community will doubtless continue. But with no overall UK subscription to the EU, the cost of participation will become transparent.

Moreover, with less UK influence on their design, policymakers in Brussels may divert more funds towards regional development, problem-solving missions and global challenges. Early signs of those changes are already visible in European Commission proposals. The financial profit from participation in EU research programmes may not continue.

If the UK no longer profits financially from participation in EU research then the rationale for participation will largely rest on demonstrating an array of non-financial, intangible, benefits. If the value of these benefits is sufficient then participation in Horizon Europe remains a viable option.

The following were among the many intangible benefits of EU programmes identified by workshop participants:

- Competition for EU funding raises standards and accelerates research progress.
- EU funding increases the diversity of the UK research base by complementing domestic spending.
- Participation in EU programmes provides access to advanced facilities and access to large data sets unavailable in the UK alone.
- Participation in EU programmes helps attract talented researchers to the UK. The pool of top quality researchers in the EU is clearly larger than that in the UK alone.
- Many research-intensive businesses operate across several EU member states and are attracted to EU research programmes with similar geographic coverage. Business participation in these collaborative programmes may improve access to markets elsewhere in the EU.
- Participants in EU programmes have opportunities to influence the future shape of EU research and innovation and sometimes have opportunities to influence technical standards that shape future regulation.

It will take time to develop robust techniques and data sets to support the valuation of intangible benefits so, in the short term, UK interests would be best served by continued participation in EU programmes. Extensive evaluations and illustrations of the intangible benefits of scientific and scholarly activities have already been carried out and provide strong starting points for the longer term assessment of costs and benefits.

For example, the Arts Council has quantified many intangible benefits to people and society from investment in the arts. The Medical Research Council, Wellcome and the Academy of Medical Sciences published a study on economic benefits of medical research. The UK National Ecosystem Assessment puts a financial valuation on the natural environment in the UK. The Campaign for Science and Engineering published a seminal analysis by Johnathan Haskel and Alan Hughes of the economic significance of the UK research base a few years ago. And of course UKRI and BEIS already have substantial expertise and experience in assessing the value of public spending on research and innovation and unique insights into the handling of these issues within Government.

I hope this summary is helpful. I remain in touch with officials from both BEIS and UKRI and stand ready to help progress this thinking along with colleagues from many of the organisations that took part in the workshop. Meanwhile, I am circulating this letter to workshop participants.

Yours Sincerely,

Professor Graeme Reid

Chair
Campaign for Science and Engineering

Annex F Public expenditure on research and innovation international collaboration

BEIS provided data to the review on the scale of funding they allocate, directly and through partner organisations, for international research and innovation. Other parts of government may also fund international research and innovation, but in the timescale of the review, a decision was made to focus on funding within the BEIS umbrella.

Figure 15 shows the public expenditure R&I programmes by BEIS and its delivery partners[51], including the 'UK contribution' to EU programmes.

Figure 15 Approximate annual R&D expenditure by BEIS and its delivery partners, and 'UK contribution' to EU R&I Programmes[51]

Public expenditure	£millions	Period
European Union programmes[52]	1,470	2014-2020 annual average
ODA Programmes[53]	440	2017
Non-ODA international[54]	230	2018/19

Figures rounded to nearest £10m. Note, the data do not cover R&I programmes for which the 'international' element of funding was not readily available.

Source: BEIS

[51] Note, the table presents the latest available data available from a wider range of disparate sources and covers different time periods.

[52] European Programmes include Horizon 2020, Euratom RT, ITER, Galileo and Copernicus. Note, the budget for these programmes comes out of the overall European Commission budget (plus small contributions from associated countries, sometimes in-kind).The £1.5bn is an illustration of the costs accruing to the UK from these programmes as an EU Member State, based on the UK's share of own resource (more than 95% of the EU budget) multiplied by the programme budgets. The programme budgets and UK share of own resource also varies (increasing and decreasing) from year to year.

[53] ODA Programmes include the Global Challenges Research Fund, Newton and ODA-qualifying spend on research and innovation in other BEIS programmes.

[54] Non-ODA international expenditure includes EUREKA, JET, international spend by Academies and UKRI.