THE ROYAL SOCIETY

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Submission to the Cabinet Office call for evidence to inform the government's Integrated Review of Security, Defence, Development and Foreign Policy

The Royal Society is the national academy of science for the UK. Its Fellows include many of the world's most distinguished scientists working across a broad range of disciplines in academia, industry, charities and the public sector. The Society draws on the expertise of the Fellowship to provide independent and authoritative scientific advice to UK, European and international decision makers.

We have focused our submission on questions 1 and 4 below.

Question 1: What are the key opportunities, challenges, threats and vulnerabilities facing the UK now? (Submissions focusing on rapidly evolving areas such as science, technology, data, cyber, and space are particularly welcome.)

Below are outlined global opportunities that are underpinned by the UK's strength in research and innovation. We also highlight a number of challenges, threats and vulnerabilities that would impact the UK's research and innovation system, potentially limiting its ability to exploit these opportunities. Further information is provided in the bibliography.

Opportunities:

Scientific leadership

The UK is in a strong place scientifically to take a global leadership role on common challenges such as climate change, food and water security and biodiversity loss, and harnessing the benefits of data and machine learning. Having previously led the way on difficult and controversial regulatory issues, it has the opportunity post-Brexit to develop safe and ambitious regulations in areas such as genetic technologies which set the global standard (for example see the recent report of the International Commission on the Clinical Use of Human Germline Genome Editing in the bibliography below).

Taking a global lead in the green recovery

The UK's policy stance to achieve net zero by 2050, and its commitment of money and ambition to become a 'science superpower', provide an opportunity to utilise our substantial global networks to shape and deliver a green recovery. The UK can take a global lead in developing technologies and approaches that will underpin global green growth and help address known drivers of change over the next decade such as the rapid loss of biodiversity. However, it will take serious delivery plans and a much higher level of political commitment and leadership to achieve that ambition; and to do so in a way which ensures that technology-led growth is equitable. There is a real opportunity for the Government to raise its green economy leadership ambition in an international context, and it should draw on an unparalleled UK scientific competence to do so.

Multilateral and bilateral research partnerships around the world

The UK should refresh its international research and innovation strategy with a focus on creating ambitious new deals with leading and established science nations across Europe and further afield as well as with emerging science nations. Particular attention should be given to countries in which the UK is currently underperforming in comparison with other leading scientific nations. This in turn will help nurture and develop our asset base to continue to attract the globally mobile investment that is an essential component of UK R&D intensity (half of all private investment). There is scope for broadening the range of available instruments for international collaboration and to think strategically about how to deploy them alongside existing multilateral, bilateral and national/regional mechanisms. Such a strategy should set out a clear framework for partnership, such as

- Cooperation on basic research (discovery)
- Innovation partnerships (economy, productivity)
- Partnerships on high value infrastructure (e.g. CERN, neutrino labs, fusion research etc)
- Policy challenge partnerships (e.g. climate change, ageing, sustaining the biosphere)
- Research integrity and regulation.

(See a snapshot of UK-international scientific collaboration and R&D investment in the bibliography below)

Increasing the UK's attractiveness to foreign-owned R&D businesses

With foreign direct investment already making up around 50% of UK private R&D expenditure, the UK should focus on becoming the R&D investment capital of the world, with regulation and institutional architecture geared to drive this as effectively as possible. A foreign direct investment strategy should open-up opportunities to UK R&D firms overseas and should also have a regional dimension consistent with the government's 'levelling up' agenda. This would require a thorough assessment of where we have investable strengths and assets, and a targeted campaign to attract the globally mobile R&D investment that we need to generate innovation, growth, and high value jobs.

Maximising the value of UK innovations

There are many dual use technologies that offer roles in a second domain that could be further exploited for either defence/security, or civil economic benefit. There is an opportunity for Government to deploy UK Government Investment's financial expertise to explore creative innovation models that increased the benefits of technologies developed in one domain, to the other.

Challenges, threats and vulnerabilities:

Known and unknown risks

The financial crisis, current pandemic, geo-political changes and climate change all demonstrate the need for better preparedness. It is important to make appropriate preparations for risks on the National Risk Register, as well as ensuring that there is the capacity in the system to rapidly respond to unknown risks and the mechanisms to rapidly access evidence and expertise. A robust economy is central to national resilience and investing in a vibrant and healthy research and innovation system is core to securing a strong economy. The R&D Infrastructure Roadmap is a starting point for the strategic choices that government should make over the next decade on technology investments to strengthen the UK's research and innovation system. Such investment decisions should include consideration of the value of such infrastructure to defence and national security, and its role in key international partnerships.

Global political uncertainty
The UK is exposed to growing turbulence in global politics. The rise of populism and nationalism can undermine scientific endeavour and damage the international collaboration that is essential for increasing resilience and responses to shared global societal threats.

Brexit disruption
Failure to remain part of EU schemes such as Horizon Europe will impact negatively on UK science. Although the UK government has committed to provide funding options in all scenarios, the many intangible benefits of full and close cooperation through an association agreement will be difficult to replicate in a domestic context, and we will inevitably see a serious hiatus to the international collaborations that are core to UK science strengths. The Government should be putting substantive plans in place to mitigate this serious capacity loss. In general, the lack of clarity around the UK's future relationship with the EU in areas affecting science, including security cooperation, cross-border data flows, and space and nuclear policy, remains a significant concern.

UK immigration policy and need for reciprocal arrangements with other countries
Ending free movement with the EU will act as barrier to scientists carrying out their research. As a reciprocal arrangement, the existence of visa-free work and study rights was invaluable to the UK's internationally mobile research community and its removal represents a significant loss. Agreeing reciprocal arrangements on international mobility should be a priority focus of the future trade strategy and the UK must also reconsider the upfront costs of work and study visas. The fact that these are up to six times more expensive than in other leading science nations, remain an up-front 'shop window' perception that other nations are more welcoming, and is a poor competitive signal. (see bibliography for a global comparison of UK visa arrangements)

Vulnerabilities in the higher education and research base
The government has recognised that interventions are needed in response to COVID-19 to protect research and innovation in universities and research organisations and move towards more sustainable funding models. A negative outcome for university research will also impact on the UK's higher education student offer which has an export value of more than £13 billion.

Well governed access to data
The UK has an advanced theoretical policy underpinning in well governed access to and use of data. However it currently lacks the basic competences in both public and private sectors to be able to exploit this even at a basic level. This needs a major drive across the public sector – which cannot be effectively led from one small Whitehall department. The UK government also needs to consider what incentives might encourage the private sector to significantly raise its game here, and/or what it would take to attract companies with a high degree of competence to locate here. The COVID-19 pandemic has highlighted the realities of the gaps between theory and practice in this area.

Machinery of government changes
With the planned merger of DfiD into the Foreign and Commonwealth Office, there is currently a lot of uncertainty over the future of existing ODA research funding schemes.

Increasingly entrenched inequality

The recent COVID19 pandemic has brought ongoing inequalities into sharp focus. To maximise innovation and creativity in science for the benefit of all of humanity, we need a truly diverse and inclusive scientific workforce that draws from the widest range of backgrounds, perspectives and experiences. Giving everybody the tools to critically engage with science, including promoting science education, will increase opportunities for people to become researchers and innovators, support a healthy trust in science and engagement with its findings. (the Society is calling for a Royal Commission that can look beyond the immediate disruption and give parents, teachers, employers, civil servants and politicians the opportunity to reshape our education system to give the breadth of knowledge, experience, creativity, resilience and skills that are vital for everyone to thrive in the 21st century – see bibliography)

Question 4: What are the most effective ways for the UK to build alliances and soft power?

The scientific values of rationality, transparency and universality enable science to be used to build constructive international relations and should be considered a key component of the UK's Integrated Review of Security, Defence, Development and Foreign Policy.

Science is essential for UK jobs, health and wellbeing, and improving quality of life for us and people around the world – it also has a role in shaping the UK's relationship with other countries, bringing benefits that flow both ways. While science has always played a role in the development of military and other hard power capabilities, it is also a source of soft power because of its attractiveness both as a national asset and as a universal activity that transcends individual country interests.

Science is inherently international, and science also has the potential to help defuse complex and tense geopolitical situations by providing opportunities to engage with developing and emerging economies. Scientific links have been built and sustained between individual scientists in different countries throughout history, whatever the political situation, thereby providing a strong base for developing future relations.

The UK should take advantage of its leadership in science to build stronger international relations. For example UK science plays a lead role in convening a number of multilateral networks and significant opportunities exist in the coming year to use science as a soft power asset, as well as take steps to drive a global green recovery: the UK will host the UN Framework Convention on Climate Change 26th Conference of the Parties (COP26) and the G7 Summit; the UK will also participate in the upcoming United Nations Convention on Biodiversity 15th Conference of the Parties (COP15) and the G20 Summit; Beyond 2021, UK science is well placed to promote carefully managed collaboration in more challenging political environments.

The UK has an international science base and has been successful in attracting scientific researchers and innovators from around the world because of funding opportunities, a welcoming and supportive environment, and the opportunity to work with other leading scientists based in the UK. Similarly many UK nationals choose to develop their scientific careers overseas, building global networks and sharing knowledge. Overseas nationals comprise two-fifths of our academic workforce in science, technology and engineering and more than half of the postgraduate student population in the UK.

The UK's involvement in the EU Framework Programmes has been essential for international scientific collaboration. Although the UK has various bilateral research agreements in place with countries like the USA and India, there are no existing multilateral arrangements or mechanisms that are comparable to the Framework Programmes in size and scope.

As the UK redefines its relationship with the European Union, science can be used as a soft power asset to build up European scientific collaboration in areas such as artificial intelligence, climate change and low carbon technologies. Redefining the relationship with the European Union also provides opportunities for a review of the UK's relationship with both European and non-European countries.

Addressing global challenges and trading across borders is increasingly reliant on science and technology, which opens many doors to various forms of soft power for the pursuit of regulatory diplomacy. Seemingly innocuous technical regulations in telecommunications for example can have profound effects on the exploitation of space. Norms in taxonomy underpin environmental impact assessments governing exploitation of new deep-sea mineral resources. Exploiting the UK's world leading outcome focussed better regulation system, is useful for having serious influence with organisations setting international standards in climate environment and the biosphere (mainly UN, including UNEP, UNECE, ISA, WHO, also EEA and WMO), space and international telecommunications, the internet, the sea (IMO and ISA), metrology (BIPM, ISO etc.), human animal and plant disease (including EFSA and ECDC), and data and the internet.

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Current status of UK-international scientific collaboration and R&D investment – a snapshot

- **The UK has a higher level of foreign direct investment in R&D than any other G7 nation,** has seen significant growth in this area over the last two decades and is the top foreign direct investment destination for China in Europe. Between 2007 and 2017, US owned businesses increased R&D expenditure in the UK by 22%, EU owned businesses by 42%, and other internationally owned businesses by more than 300%. [1]
- **Europe is by some distance the UK's largest and fastest growing academic collaborator**. As Table 1 shows, more than a third of UK research papers are co-authored with other EU and associated countries, compared with 17.6% with the USA.[2]

Table 1: The UK's top research collaborators across all fields 2014-2018

Country/bloc	Total number of papers published by country/bloc (2014-2018)	Number of papers co-authored between the UK and the partner country/bloc (2014-2018)	Percentage of UK papers co-authored with the partner country/bloc (2014-2018) UK total = 682,414
Horizon 2020 bloc*	2,783,573	228,773	33.5%
USA	2,225,226	120,406	17.6%
Germany	586,406	64,199	9.4%
France	398,716	45,452	6.7%
China	1,591,646	43,723	6.4%
Italy	367,438	43,474	6.4%
Australia	352,256	42,655	6.3%

[1] Adrian Smith and Graeme Reid (2019), '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', available at: https://www.gov.uk/government/publications/future-frameworks-for-international-collaboration-on-research-and-innovation-independent-advice

[2] Royal Society (2019), 'Submission to the Sir Adrian Smith call for evidence on future frameworks for international collaboration on research and innovation', available at: https://royalsociety.org/topics-policy/publications/2019/consultation-response-sir-adrian-smith-international-collaboration/

Netherlands	219,229	37,286	5.5%
Spain	314,807	35,787	5.2%
Canada	374,297	31,028	4.5%
Switzerland	167,301	27,138	4.0%

Source: Clarivate Analytics data and analysis for the Royal Society (May 2019)

*'Horizon 2020 bloc' is shorthand for European Union Member States and countries associated to the current EU Framework Programme for research and innovation Horizon 2020

- **The UK's involvement in the EU Framework Programmes has been essential for international scientific collaboration.** Although the UK has various bilateral research agreements in place with countries like the USA and India, there are no existing multilateral arrangements or mechanisms that are comparable to the Framework Programmes in size and scope.[3]
- **The UK benefits from a highly international and mobile R&D workforce**. Non-UK nationals comprise two-fifths of the UK's academic workforce in science, technology and engineering and more than half of the postgraduate student population.[4] The ability of researchers to move to and from the UK with minimal barriers is fundamental to increasing the volume of R&D undertaken in the UK and the economic and societal benefits that derive from it.
- **Government funding for UK research activity in low and middle income countries has grown in recent years** with an increasing volume of aid spending on research and knowledge exchange being channelled through departments, agencies and partner organisations outside the Department for International Development (DfID). The Official Development Assistance (ODA) budget distributed by UK Research and Innovation, for example, increased by 52% from 2017/18 to 2019/20.[5]

[3] Royal Society (2019), 'Why the UK must associate to Horizon Europe', available at: https://royalsociety.org/topics-policy/publications/2019/why-the-uk-must-associate-to-horizon-europe/

[4] Royal Society (2019), 'UK science and immigration: why the UK needs an internationally competitive visa offer', available at: https://royalsociety.org/topics-policy/publications/2019/uk-science-and-immigration-why-the-uk-needs-an-internationally-competitive-visa-offer/

[5] Academy of Medical Sciences, British Academy, Royal Academy of Engineering and Royal Society (2019), 'UK Research and Innovation: explainer', available at https://royalsociety.org/topics-policy/publications/2019/ukri-explainer/