COUNCIL FOR SCIENCE AND TECHNOLOGY

1 Victoria Street
London SW1H 0ET

Prime Minister
10 Downing Street
London SW1A 2AA

July 2017

Dear Prime Minister

Harnessing science and technology for economic benefit across the UK

We are writing to provide further advice about "what more Government could do to harness the role of science and technology to deliver economic benefits that are shared across the UK"[1], as you and the Secretary of State for BEIS have requested. This follows our contributions to the Government's Industrial Strategy Green Paper, through discussions with the BEIS Secretary of State and our letter to you in October 2016.[2]

We now offer our views on the particular questions raised in the Green Paper on science, technology and place, specifically how to "maximise and develop the particular strengths of different areas", and "improve knowledge transfer between research and business communities to better improve their productivity".

The innovation, research and technology sector contributed an estimated £32-36 billion to the UK economy in 2012-13.[3] In the decade or so before the economic crisis around half of the UK's growth in productivity was driven by innovation – new ideas, science and technology[4]. However, not all areas are harnessing the potential of their science and technology assets and creating the conditions for innovation.

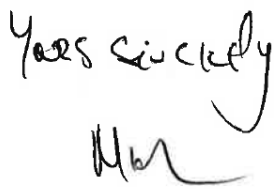
Evidence shows that innovation thrives when there is sustained engagement between research institutions, business and other organisations, and when the right infrastructure and skills are available. Physical and digital Infrastructure is necessary for local growth and to boost investment prospects. Continued investment in skills at all levels is fundamental to boosting local competitiveness and equality of opportunity across the UK. Other factors like good housing and support for arts and culture are also important to keep those benefits local by attracting and retaining talent. When capital, ideas and labour are increasingly mobile, the attractiveness of places and the agglomeration of ability and expertise matter more than the physical connections to raw materials.

[1] 7 October 2016
[2] CST letter on the Industrial Strategy, 20 October 2016
[3] The impact of the innovation, research and technology sector on the UK economy, Oxford Economics, November 2014
[4] Department for Business, Innovation and Skills, Our Plan for Growth: Science and Innovation – Evidence Paper, 2014

Our attached paper outlines seven proposals to deliver the economic benefits of science, technology and innovation throughout the UK. In particular, it suggests how the government and others can encourage local economies to:

(a) *Identify the range of science and technology related assets they already have* (research institutions, business, skills etc.) and the potential comparative advantage this might present[5];
(b) *Maximise their existing assets*, by creating incentives for local organisations to identify relevant links, and to fully utilise assets in the local area;
(c) *Create the right conditions for further investment*, through governance that can coordinate local planning, investment and skills.
(d) *Encourage greater innovation in businesses* across the UK's sectors and regions.

We would be pleased to discuss this issue and our recommendations with you or your ministerial colleagues. We are copying this letter to the Chancellor, Secretary of State at BEIS, Secretary of State at DCLG, Minister of State for Universities, Science, Research and Innovation, Cabinet Secretary, Permanent Secretary at the Treasury, Permanent Secretary at BEIS and Permanent Secretary at DCLG.



Sir Mark Walport
Co-Chair

Professor Dame Nancy Rothwell
Co-Chair

[5] Where they can produce goods and services at a lower opportunity cost than others. An opportunity cost is the loss of other alternatives when one alternative is chosen.

Identifying science and technology related assets

The economic benefits of science and technology are often delivered through their translation, commercialisation and contribution to innovation. These in turn rely on dynamic, reciprocal engagements between universities, businesses and financial and industry organisations, to generate new ideas and solutions, find partners and develop products. When these organisations are clustered around a particular sector – like advanced manufacturing in Sheffield for instance – agglomerations of research, skills and specific financial products help to sustain and develop the innovation ecosystem.

Pittsburgh's economic re-emergence for instance, has been driven by the confluence between its local universities, strong support from regional industries (e.g. in precision manufacturing), and local government's willingness to use its policy levers to stimulate opportunities (e.g. by amending its regulatory framework to allow driverless cars) [6]. Singapore's emergence as a regional hub for smart infrastructure similarly grew from a combination of its strong research base, highly skilled workforce and government policy interventions and investment. Closer to home, South Wales is developing a hub for compound semiconductors, to tap into a global market with an expected value of £75-125 billion by 2025.[7] This has been driven by regional industry, investments in a Compound Semiconductor Applications Catapult and Cardiff University's role in training and research.

The UK is fortunate to have deep seams of science and technology expertise across the country, but their local economic impact varies considerably. Lowestoft's Centre for Environment, Fisheries and Aquaculture Science, Derbyshire's ceramics industry, Leamington Spa's creative industries and Northamptonshire's Motorsport Valley are a few examples of expertise that has grown out of an area's history and traditions and now provide their area with the potential for comparative advantage. We explore below how the government and others can help regions to identify, expand and leverage these for further economic benefit.

To start this activity, local economies first need to understand their organisations and assets.[8] A clear and accessible map of research, industrial and innovation ecosystems would help local government, institutions and businesses know what exists in their local area. This can help them identify opportunities for collaboration, both locally and nationally, and highlight how to foster or develop a comparative advantage.

A number of government departments and agencies hold useful data, including BEIS, DCLG, HMRC, DfE, Companies House and the Intellectual Property Office. UK Research and Innovation (UKRI) may be well placed to coordinate a single accessible map of local science, technology and innovation assets. Although a number of data sets identify where scientific expertise and activities are based, they are currently fragmented and difficult to bring together. Science and Innovation Audits (SIAs) go a long way towards addressing the need for clearer mapping of local industrial, research and innovation ecosystems. There is

[6] http://www.cmu.edu/cmnews/extra/060828_savior.html
[7] Kaustubha Parkhi, Global Markets and Technologies for Compound Semiconductors, BCC Research, 2012; Compound Semiconductor Market Worth $104.55 billion by 2020, MarketAndMarkets, 2014
[8] See for example Nishimura, J. & H. Okamuro, Subsidy and networking: The effects of direct and indirect support programs of the cluster policy. – Research Policy 40/5: 714-727, 2011.

more to do to understand industrial activities and map skills however, and to get a clear picture across the country (as SIAs do not cover the whole of the UK). Many datasets emphasise scientific expertise, but unique industry clusters and training also provide comparative advantage. Incorporating additional analysis – such as cluster analysis or patent analysis – will provide greater insight into an area's potential economic niche. We build upon a Nurse Review recommendation, which proposed that Research Councils should collectively map the UK research landscape and take responsibility for making the data widely available[9].

Recommendation 1: The Government should work with UK Research and Innovation to create and promote a single accessible map of local science, technology and innovation assets. This should include expertise, activities and skills, to help local economies understand their areas of comparative advantage and drive productive interactions between businesses, universities and research institutions.

- **Local and national government should use the mapping exercise to develop a compelling narrative that highlights local and national strengths and helps to drive investment.**

- **Following on from the Science Innovation Audits, the Government should highlight how areas' assets, expertise and activity compare at a national level.**

The success of policy interventions also depends on more intangible factors: local ambition, leadership and support. Interventions are more successful where they build on an existing foundation. Without kindling it is difficult to start a fire. An evaluation of research and development programmes in Germany, which aimed to rebalance the economy at a regional level and included a competition element, found that public funding was most successful where it strengthened the existing or emerging strengths of a region.[10] The beneficial effects on the economy were also permanent, maintaining benefits after funding had stopped[11].

We propose that the Government introduce an innovation and growth competition that encourages local areas to identify how they can advance their economic development, based on genuine pockets of scientific excellence. It should encourage leadership, reciprocity and trust – all factors that the innovation economy depends on – by requiring collaboration between a mix of sectors in the area (business, universities, local government etc.). While the Government should be clear about the outcomes it hopes to achieve, it should allow competitors to be creative in how they deliver them. It should be similarly flexible in considering what constitutes an "area" or "region", as places of expertise may not fit neatly within the boundaries of a Local Enterprise Partnership (LEP), local authority or even a nation.

The competition will need to work alongside other local growth initiatives – including City Deals, Strategic Economic Plans, Local Growth Plans and the Shared Prosperity Fund – to form part of a coherent package for the region. Those running the competition should use

[9] Paul Nurse, Ensuring a successful UK research endeavour: A Review of the UK Research Councils, 2015, recommendation 2

[10] Also see Karlsruhe Koschatzky, K., The Regionalisation of Innovation Policy in Germany: Theoretical Foundations and Recent Experience, Working Papers Firms and Region R1, 2000

[11] Thomas Brenner, Carsten Emmrich and Charlotte Schlump, Regional effects of a cluster-oriented policy measure – The Case of the InnoRegio program in Germany, 2013

the mapping proposed in Recommendation 1 to provide national coordination of activities supported at a regional or local level[12].

Recommendation 2: The Government should establish a competitive Innovation and Growth Place Fund to encourage regional economic development based on genuine pockets of scientific excellence. This should involve both universities and business, in areas of the country that are not otherwise economically prosperous. Bids should identify how funds will deliver quantifiable economic and social benefits to the area over a defined period of time (5, 10, 20 years). UK Research and Innovation may be well placed to deliver such a Fund.

Maximising existing assets

Areas should think creatively about how their existing local assets can support science and innovation in potentially pioneering and profitable ways. Airfields can test drones, hospitals can trial innovative approaches to data-driven services, and factories can implement novel approaches to automation. Tangible assets might also include ports, farms or mines, while intangible assets could include an adaptable local regulatory framework or an innovation-friendly local public service. Some local economies are already thinking imaginatively: testing autonomous vehicles on Milton Keynes' road network for instance, or trialling predictive policing approaches in Kent's police-forces. Some existing schemes encourage innovation support in specific sectors or areas, including the NHS Tests Beds and Future City Demonstrators Programme.

Areas can go even further. Public and private sector owners should be encouraged to recognise the value of their physical and virtual assets and to consider how they can form part of an offer to inward investors. Innovation is one of top reasons for attracting foreign direct investment to the UK[13]. Technological innovations need to be tested extensively and demonstrated in real-world environments if they are to succeed on the market. Testing also allows regulations and standards to be developed in parallel, which determine the commercial success of technological innovations[14]. The UK could improve its innovation performance by expanding the range of test-beds available and promoting them more effectively[15]. The Government should explore how to better use publicly owned assets as test-beds and how to encourage private-owners of relevant assets to utilise them for science and innovation purposes.

Recommendation 3: The Government and local areas should identify what incentives can encourage publicly and privately owned assets (airports, hospital, factories, police-forces etc.) to be used more productively to support science and innovation capability and attract innovation investment.

[12] Also see The Dowling Review of Business-University Research Collaborations, 2015, p63
[13] U. T. &. Investment, Performance & Impact Monitoring Survey (PIMS) Inward Investment Wave 10 - 2014/15 Investments
[14] Also see the Royal Academy of Engineering's submission to the Industrial Strategy and RAS2020 Robotics and Autonomous Systems Strategy, 2014
[15] Also see the Royal Academy of Engineering's response to the Industrial Strategy Green Paper

Creating the right conditions for further investment

Innovation thrives where the conditions are fertile. These might include:

- a mix of economic, physical and networking assets, including universities and research institutes;
- a physically compact area with good transport and digital infrastructure;
- mixed-use housing, office and retail, with arrangements for knowledge exchange and collaboration.[16]

Bringing together the institutions, development and infrastructure to create the right conditions requires long-term local vision and investment. This in turn needs local leadership, ambition and powers as well as private sector finance and expertise. In many areas, combined authorities or Local Economic Partnerships successfully bring these together. The Greater Manchester Combined Authority for instance includes the ten Greater Manchester councils and the Mayor. They work with other local services, businesses, communities and other partners to improve the city-region and address cross-region issues like transport, regeneration, and attracting investment.

Such governance arrangements can establish the conditions to attract inward investment and create a credible focus for investment. This might include for instance:

- Land with planning permission for business, and the opportunity and infrastructure for future expansion;
- Property developers who share the overall goal;
- Infrastructure that may be planned or built by local authorities;
- A skilled workforce and opportunities for professional training in work;
- Investors who are already lined-up, to provide access to long-term, patient capital.

Other parts of the country lack these regional public and private collaborations however. This is particularly problematic for areas where sector clusters exist or are starting to emerge, but need additional infrastructure, development or funding to thrive.

Recommendation 4: Local regions should develop appropriate regional governance and collaboration mechanisms that can help create the best conditions for innovation and economic growth. DCLG, BEIS and local authorities should help regions learn from each other by highlighting different regional governance models.

While “place” can be a helpful factor in determining how translation or commercialisation is funded, “excellence” should remain the basis for funding basic research. The UK’s international strengths in basic science are founded in supporting “excellence”, as determined by peer review.

“Excellence” in basic research acts as a magnet for R&D activity, foreign direct investment, and economic growth[17]. Businesses tend to conduct their own R&D closer to where

[16] Bruce Katz and Julie Wagner, The Rise of Innovation Districts: A New Geography of Innovation in America, Brookings Institute, 2014
[17] Abramovsky and Simpson, Geographic proximity and firm--university innovation linkages: evidence from Great Britain, 2011; also see The Dowling Review of Business-University Research Collaborations, 2015, p63

excellent research takes place, with pharmaceutical firms often locating their R&D within 10 km of world-class rated chemistry departments[18]. In 2016, AstraZeneca relocated its £300m R&D facility to Cambridge, doubling the number of collaborations with the university in one year. Strathclyde University's excellence in innovation laser manufacture led Thales Optronics to relocate their laser manufacturing to Glasgow.[19] Research shows that sectors that align to their local universities' strengths, local growth and regional productivity improve the most[20].

We recognise that excellence in different activities has varied definitions and features. A move away from excellence creates a real risk of undermining the UK's international science, technology and innovation reputation and its associated economic benefits.

Recommendation 5: The UK's international strengths in basic science are founded in its support for "excellent" activities, as determined by international peer review. Excellence should remain the basis for funding research in the UK.

Encouraging greater innovation in businesses

A contributing factor to low productivity overall is the extent to which businesses are using innovation in their business practices and tools.[21] Research suggests that every region has companies that are leading in innovation practices and those that are lagging behind.[22] While regional differences do not explain the UK's overall long tail of unproductive companies, improving the picture overall may give an additional boost to those areas with the lowest productivity.

The productivity of British industry varies considerably by region and by sector. London is around 75% more productive than the North East[23]. In the manufacturing sector, frontier firms have an average productivity growth of 2.8%, compared to laggard firms that average just 0.6%[24]. In the services sector, the gap in productivity growth is even larger, at 3.6% for frontier firms and 0.4% for laggard firms[25]. The gap between leading edge businesses and others has been widening since the early 2000s[26].

Identifying the best performing companies in specific areas and sharing their expertise with other local businesses is important to create higher levels of excellence within a region, and to build regional community and identity. Scottish Enterprise for example has undertaken a programme to share excellence in business practice across a range of companies to encourage more regional cooperation. They have identified specific issues such as business scale-up and exporting and focussed on more remote places, such as the Highlands and

[18] Institute for Fiscal Studies, University Research and the Location of Business R&D, 2006
[19] Universities UK, The Economic Role of UK universities, 2015
[20] Hausman, "University Innovation, Local Economic Growth, and Entrepreneurship," 2012; Kantor, S and Whalley, A - 'Knowledge Spillovers from Research Universities: Evidence from Endowment Value Shocks', University of California, Merced, and NBER, March 2012.
[21] OECD Policy Brief, How Regions Grow, 2009
[22] Billett, I and Schneider, P (2016), 'Bitesize: Exploring UK sectoral productivity'
[23] ONS, Regional and sub-regional productivity in the UK, Jan 2017
[24] Frontier firms are defined as the top 5% of firms in terms of productivity levels within each industry and year, whilst laggard firms are defined as all other firms.
[25] OECD, The Best Versus the Rest: The Global Productivity Slowdown, Divergence Across Firms and the Role of Public Policy, 2016
[26] OECD, The Future of Productivity, 2015; OECD, Frontier Firms, Technology Diffusion and Public Policy, 2015; OECD, The Walking Dead? Zombie Firms and Productivity Performance in OECD Countries, 2017

Islands. South-West Norway is building a strong ocean cluster, based on collaboration among large corporations, universities and start-ups across four linked cities. This brings together a diverse range of skills and focusses on upgrading business practices.

Recommendation 6: The Industrial Strategy should send a strong signal to UK businesses about the value of innovation. The Government should explore with business organisations – including the Federation of Small Businesses, British Chambers of Commerce and Institute for Directors – how the routine channels for normal business activity (e.g. trade bodies, health and safety regulators, banks, accountants and HMRC) can "cross-promote" innovation support products and services.

The tax environment is an important factor in businesses' decisions about whether to invest in R&D in the UK. R&D tax credits are a tax relief designed to encourage greater R&D spending, leading in turn to greater investment in innovation. Studies show that the current scheme is an effective policy for stimulating R&D investment[27] and that the spillover benefits from R&D are strongest in their local and regional areas[28]. R&D tax credits could be better deployed to improve its take-up by certain sectors, regions and business however. The offer delivered via tax credits can also send a strong international message that the UK remains open to science and engineering activity and investment.

The definition of R&D for tax purposes was last substantively revised in 2004 following consultation with business in 2003. They currently use a definition of science that excludes arts, humanities and social sciences. Mathematics is excluded unless it relates to advances in representing the nature and behaviour of the physical and material universe.[29]

The definition is struggling to keeping pace with developments in technology-driven areas of the economy such as artificial intelligence, digital, cyber and Fintech, or with the use of social sciences in services. Currently, R&D involving mathematical modelling of fluids and waves may be eligible for tax credits, while R&D involving mathematics embedded in artificial intelligence programmes may not.

Global R&D trends show that companies are shifting their R&D resources away from physical products to software and services, in order to stay competitive[30]. Between 2010 and 2015 the average allocation of R&D spending for software and services increased from 54% to 59% and is expected to grow to 63% by 2020. The average allocation of R&D spending of product-based offerings fell from 46% to 41% during the same period, and is expected to fall to 37% by 2020. Updating the definition is important for the UK to keep pace with technological developments, to encourage its businesses to stay competitive and to provide incentives for inward investment.

UK R&D tax credits are currently geographically neutral. Both France and Japan have employed their R&D tax credits to increase R&D investment in specific regions, sectors or

[27] Van Reenen, J. & Nyguyen, K., Credit where (R&D tax) Credit's Due, 2016

[28] Branstetter, L. 2001, Are Knowledge Spillovers International or International in Scope? Microeconometric Evidence from Japan and the United States, Journal of International Economics, 53 (February): 53-79; Hausman, N., "University Innovation, Local Economic Growth, and Entrepreneurship", 2012; US Census Bureau Center for Economic Studies Paper No. CES-WP-12-10.

[29] https://www.gov.uk/government/publications/guidelines-on-the-meaning-of-research-and-development-for-tax-purposes

[30] https://www.strategyand.pwc.com/media/file/2016-Global-Innovation-1000-Fact-Pack.pdf

types of approach. [31] In France, companies located in competitiveness clusters can benefit from a full exemption of corporate income tax (CIT) for the first three fiscal years and a 50% exemption the two following fiscal years. An additional innovation tax credit for SMEs allowed them to offset a tax credit against CIT equal to 20% of innovation expenses.[32] Japan's 2017 Tax Reform Act broadened the scope of R&D activities to reward investment in the development of service-focussed business.[33]

HMRC have recently improved guidance on R&D tax credits for SMEs[34]. More could be done to improve the access to tax credits for SMEs and to raise awareness about what they can be used for: to overcome difficult technological problems in the production of products, as well as for 'pure' laboratory research. R&D tax claims tend to be concentrated in London, South East, and the East of England, so it would be particularly valuable to encourage all regions take advantage of R&D incentives[35].

Recommendation 7: R&D tax credits are a powerful incentive for domestic and international businesses to invest in R&D in the UK. The Treasury, HMRC and BEIS should take the following action on R&D tax credits:

- **Review the R&D tax credit definition to make sure it addresses technological developments and the shift towards R&D for software and services. This should include consultation with businesses.**

- **Consider how the tax credits can be employed to improve R&D investment in specific regions.**

- **Further simplify the process for accessing R&D credits and raise awareness across the country.**

[31] The Information Technology and Innovation Foundation, Creating a collaborative R&D tax credit, 2011
[32] https://www.twobirds.com/en/news/articles/2014/global/tax-july-2014/france-r-and-d-tax-incentives
[33] http://taxsummaries.pwc.com/ID/Japan-Corporate-Tax-credits-and-incentives
[34] http://www.hmrc.gov.uk/gds/cird/attachments/rdsimpleguide.pdf
[35] HMRC, Research and Development Tax Credits Statistics, September 2016