COUNCIL FOR SCIENCE AND TECHNOLOGY

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Dear Prime Minister

Investing in UK research and development

Sustained investment in research and development (R&D) is critical to achieving the Government's social, economic and security goals. However, UK R&D (1.7% of GDP) is well below the OECD average of 2.4% of GDP and lags behind powerhouses such as China (2.2%), the US (2.8%), Germany (3.0%), Japan (3.2%), Israel (4.5%) and South Korea (4.6%). Raising both public and private sector R&D investment is essential if we are to maintain international competitiveness and deliver sustainability, wellbeing and prosperity for the UK.

The Council for Science and Technology warmly welcomes the Government's reaffirmation in the 2019 Spending Round of its commitment to increasing levels of R&D to at least 2.4% of GDP by 2027, and that it will set out plans in the autumn to significantly boost public R&D funding. The recommendations in this letter focus on how additional public sector investment can be deployed to maximise its impact and, in particular, encourage the private sector to invest in R&D. Evidence from countries that have significantly increased their R&D levels suggests that if we get our approach right, not only in terms of public funding but also the wider policy environment, private sector investment will follow such that the ratio of private to public R&D, summed across the whole economy, reaches approximately 3:1. This must be an objective for the UK.

A key question is on what type of activities additional public funds should be focused in order to drive private sector investment. Innovation is dependent on excellent research and development, from which new ideas and innovations emerge. The Government will always have a critical role in funding for pure research, which is the jewel in the UK crown and forms the base on which all else depends. This funding, which has fallen behind our competitors as a percentage of GDP, should be increased. That said, available information suggests that it is towards the

development end of the R&D spectrum where there is the starkest difference with respect to countries with successful innovation-based economies that have achieved high levels of R&D.

Recommendation 1: The primary focus of increased R&D funding should be applied research, development and implementation, not at the expense of pure research but in addition to it. This will be critical to stimulate private sector investment and to get the most out of our truly excellent science base.

Although there is evidence of insufficient investment in development and implementation, many R&D statistics are not usefully disaggregated into research versus development activities or different Technology Readiness Levels. It is important to understand how much is invested in different types of activities and to benchmark the UK against others. A diverse set of metrics will be required to capture the dynamic translation processes taking place in growing UK sectors, particularly in the service sectors, such as fintech and creative sectors. This is a key step towards ensuring that appropriate funding schemes are developed that are fit for purpose for each type of activity.

Recommendation 2: HMT, UKRI and ONS should investigate the current distribution across research and development activities, monitor it over time, and benchmark internationally. This should be done with minimal additional bureaucracy. An ambition for spending in each category should be set at a national level to ensure that an appropriate balance is maintained.

A commitment to raise funding in the UK for development and implementation would send an important signal to business in the UK and globally. Additional steps are required, however, to encourage private sector investment, which we address in the following recommendations.

Recommendation 3: To allow businesses to invest with greater certainty, Government should identify and communicate which long-term challenges it wants to address in the context of wider government objectives and which sectors or capabilities it is seeking to develop. The Industrial Strategy grand challenges and missions are a good example of this, as are the approaches taken by the Netherlands, with its Top Sectors strategy[1], and by Singapore.

Recommendation 4: To ensure that the UK spots trends early and can act quickly, Government (BEIS) should develop data analysis tools to identify emerging opportunities. This should examine data from grant funding, patents and early venture investment, and also consider issues such as supply chain readiness. Interventions, which evidence[2] suggests may need to be very different for different domains, can then be developed: one area may require basic or applied research

[1] https://www.government.nl/topics/enterprise-and-innovation/encouraging-innovation

[2] https://www.thebritishacademy.ac.uk/publications/research-innovation-evidence-synthesis-conditions-translate-research-drive-innovation

whereas another may need one or more of development and implementation funding, infrastructure, a test-bed or investment in skills.

Success in mission-oriented, translational and applied R&D will also require funding mechanisms that are tailored appropriately to maximise business involvement. The approach needed is different from that used successfully for academic grant allocation.

Recommendation 5: Government should adopt a more business-friendly, "investment portfolio" approach to funding for development and implementation activities. The specific characteristics of this would be:

- Streamlined processes with much faster turnaround to match the speed and agility with which businesses make decisions. This should be benchmarked against international successes. For example, US Air Force's new Small Business Innovation Research (SBIR) programme shows what might be achieved. It makes funding decisions within 90 days and for its "Pitch Days" invites applicants to pitch within 30 days of submission and makes decisions (and allocates some funding) on the day, all based on minimum viable paperwork. It has led to an improvement in the number, breadth and quality of applications[3].
- A greater acceptance of risk so that high-risk, high-reward opportunities can be taken in the knowledge that some projects in the portfolio will fail, failure being part of the learning process. This applies not only to UKRI funding but also R&D by government departments and agencies. Such an approach has been pioneered in the US by the ARPA group of agencies.
- The flexibility to make larger, longer-term investments where that is needed, including for applied research projects.
- Empowering programme leaders so that they "own" the portfolios, are responsible for meeting their objectives and can take funding decisions quickly. The appointment of programme directors for the Industrial Strategy Challenge Fund is a positive step in this regard. US DARPA, France's AI leaders and Japan's Strategic Innovation Programme[4] are also examples from which we can learn.

A further issue that can hinder private sector investment in R&D is the shortage of scale-up support including funding for growing business. The UK venture capital market is strong, but weakness remain at subsequent stages compared to the US, particularly for investments around and above £400m. This can hold back high-R&D tech and science companies, with the further risk that if they cannot find scale-up funding they are bought by foreign firms that relocate R&D activities elsewhere. Institutional investors tend to focus on larger, mature firms, while the lack of specialist investors and funds, particularly those with a challenge focus (of which the McArthur Foundation's Catalytic Capital Consortium[5] is an example), is a key part of the problem.

[3] https://www.afsbirsttr.af.mil/News/
[4] https://www.jst.go.jp/sip/k03/sm4i/en/outline/about.html
[5] https://www.macfound.org/programs/catalytic-capital-consortium/

Recommendation 6: HMT, BEIS and the British Business Bank should consider how to further increase the availability of scale-up funding, while HMT should also consider whether UK pension funds could be encouraged or required to invest in emerging UK science and tech companies. This should be in addition to redoubling efforts to implement the findings of the Patient Capital Review[6]. The aim should be for the UK to generate a strong cadre of specialist investors with a focus on areas of key national interest backed by significant funds.

Commercial and entrepreneurial skills and a mindset of enterprise and innovation are important across all academic disciples to effectively leverage R&D investments. Productive interaction between the business and academic communities is, however, often impeded by a shortage of the relevant knowledge and skills in research translation and entrepreneurship.

Recommendation 7: The Government should address the shortage of skills and capability among academic researchers for translating basic research into economic, social and mission outcomes. To achieve this, we suggest the following:

- Evidence shows that training programmes for scientists and engineers centred around developing commercial and entrepreneurial skills, such as the US National Science Foundation's (NSF) I-Corps programme[7], are effective at increasing start-up activities and leveraging private capital. The UK should develop programmes of this type. UKRI's ICURe programme is based on I-Corps and should be scaled up to support more academics in commercialising their research outputs.
- Relevant centres for doctoral training should be aligned with key challenge areas, such as Industrial Strategy Grand Challenges, and important sectors including service sector and creative industries. This is the approach taken, for example, in Singapore.
- Improve interchange between business and academia at all career stages by designing and implementing programmes to facilitate sabbaticals and exchanges with business, and mid-career fellowships spanning industry and academia.

These actions to address shortage of skills and capability should be reinforced by additional support for implementation of the Knowledge Exchange Framework and expansion of schemes such as the Higher Education Innovation Fund and the UK Research Partnership Investment Fund to enable universities to develop the infrastructure for effective business partnerships.

Finally, we should recognise that our Public Sector Research Establishments are, like our HEIs, valuable sources of infrastructure, IP and specialist expertise. They could play a more significant role in fostering private sector R&D investment if better able to form partnerships with businesses or with academic researchers who are

[6] https://www.gov.uk/government/publications/patient-capital-review
[7] https://www.nsf.gov/news/special_reports/i-corps/

commercialising their work. Cyclotron Road[8] at the Lawrence Berkeley National Laboratory in the US is an example of how a successful programme could operate.

Recommendation 8: The Government Office for Science should lead a review into PSREs' economic objectives and how they can widen their business and academic partnerships.

We would be pleased to discuss our recommendations with you or your Ministerial colleagues and to help with further analysis or proposals for implementation of the recommendations. Work on this topic has been led within the Council for Science and Technology by Professor Fiona Murray (MIT Sloan School of Management) supported by Suranga Chandratillake (Balderton Capital), Colin Smith (Aerospace Growth Partnership), Professor Dame Ann Dowling (Royal Academy of Engineering), Anne Glover (Amadeus Capital), and Lord Stern (London School of Economics).

We are copying this letter to the Chancellor, the Secretary of State for Business, the Minister of State for Universities, Science, Research and Innovation, the Cabinet Secretary and the Chief Executive of UKRI.

Your sincerely,

Sir Patrick Vallance

(co-Chair)

Professor Dame Nancy Rothwell

(co-Chair)

[8] https://www.cyclotronroad.org/