COUNCIL FOR SCIENCE AND TECHNOLOGY

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Prime Minister
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09 August 2019

Dear Prime Minister

Diffusion of technology for productivity

The UK's productivity gap is well known. We produce less per hour worked than our competitors and productivity growth has stalled since the 2008-9 financial crisis. The problem is not that the UK lacks companies at the cutting edge – indeed we score well in this regard – but rather that the tail of less productive firms is larger and longer than in other countries and growing.

Technology is the key to productivity – technology in this context is not just devices and equipment but also business processes, management techniques and analytical methods. Firms in the "long tail" are those that have not implemented existing technologies. We see, for example, that the UK's productivity gap between the top- and bottom-performing companies in the services and manufacturing sectors is larger than our international competitors[1]. The issue in this context is a lack of technology diffusion (the spread of existing technologies) rather than a shortage of innovation (the creation or new and better tools or methods). It is not sufficient for a small number of individuals in a handful of companies in a few sectors in one region to be using technology. Ideally, all people in all firms would use both new and existing technologies more, and this is where more focused effort is needed.

There are several external factors that influence a firm's ability to implement new technologies, including the availability of finance and the quality of infrastructure such as broadband and 4G (soon to be 5G) networks. These are of course important, but there are additional barriers to technology diffusion on the demand side that urgently need to be addressed and which are the focus of this letter. We identify two deficiencies in human capital that affect many firms in all sectors and regions:

    a. **Management and leadership**: Research suggests that more than half the UK's productivity gap with the USA could be attributed to deficiencies in management[2]. Leadership and management are critical in driving

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[1] Andy Haldane (2018) The UK's Productivity Problem: Hub No Spokes (speech)
[2] Bloom, Sadun and van Reenen 2017: Management as Technology.

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improvement. Managers frequently overestimate their own performance, lack the know-how to diagnose their firm's deficiencies, are unaware of how technology could improve performance, or lack the skills to drive implementation[3]. Even among competent firms who see the value in implementing the best production methods, there are further challenges in raising productivity to higher levels. They may not know what solutions would work best, how to adopt them, or where to get help. In some cases, there is little practical help available.

b. **Widespread skills and knowledge gaps**: a large proportion of the UK workforce lack the necessary literacy and numeracy skills. There is a scarcity of workers with general STEM qualifications and more specialised expertise at all qualification levels relevant to the adoption and utilisation of new technologies. In a recent survey[4], more than half of UK employers expressed concern that the UK could fall behind other countries in terms of technological advancement due to STEM skills shortages. At the same time, two thirds of workplaces with a reported basic skills gap do not provide basic skills training[5].

We believe, therefore, that the UK government should focus on two key areas. The first is **improving the UK's technology diffusion architecture** to overcome the information failures and accelerate the uptake of technology. The term "diffusion" may be taken to imply a passive process, but in fact it should be pursued actively. The second is **to address the deficiencies in general and specialised skills and training** that limit the UK's technological capability.

We offer five recommendations to help address these areas:

1. **Establish a business-facing National Centre for Productivity to support firms that have implemented the basics and have the ambition to take the next steps towards high performance.** This would aim to improve their command of technologies whilst promoting the use of methods for identifying the right solutions.

2. **BEIS should work with UKRI, the Industrial Strategy Council (ISC) and LEPs to review current business support programmes and consider how to create a more comprehensive system with local impact to deliver technology penetration.** We propose a hub & spoke model branching from the proposed National Centre for Productivity.

3. In support of recommendation 2, **consider how universities and public laboratories could play a wider role in technology diffusion and engaging more with local businesses than they currently do.**

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[3] Be the business: https://www.bethebusiness.com/2018/05/productivity-overconfidence-hampering-british-performance/

[4] https://www.stem.org.uk/news-and-views/news/skills-shortage-costing-stem-sector-15bn

[5] https://www.gov.uk/government/publications/poor-basic-literacy-and-numeracy-effect-on-employers

4. **Incentivise businesses (especially those in receipt of public sector support for innovation) to actively promote knowledge, know-how and technology adoption in their sector or across the supply chain.**

5. **HM Treasury, BEIS and the Department for Education should explore how to use policy and regulation to encourage employers to invest in training their staff to support the use of new technologies.**

We trust you will find these recommendations useful. We have attached more detail in each area and would be pleased to discuss this with you and your Ministerial colleagues.

We are copying this letter to the Chancellor and the Exchequer Secretary to the Treasury, the Secretary of State for Business, Energy and Industrial Strategy, the Secretary of State for Education, the Minister of State for Universities, Science, Research and Innovation, the Cabinet Secretary, the Permanent Secretary for BEIS and the Chief Executive of UKRI. The Council for Science and Technology is grateful to all those who participated in the discussions held to inform this work.

Yours sincerely,

Sir Patrick Vallance　　　　　　　　　**Professor Dame Nancy Rothwell**
(co-Chair)　　　　　　　　　　　　　　**(co-Chair)**

Promoting diffusion of technology for productivity

1. Weak leadership and management, alongside widespread skills and knowledge gaps are holding back UK productivity.
2. Stronger technology diffusion architecture will help overcome the information failures, accelerate the uptake of technology and give an active push to processes and practices that support better business management.
3. Improving general and specialised skills and training would provide a significant boost to the UK's technological capability.

Improving the UK technology diffusion architecture

4. The UK already has several structures and initiatives in place or in development that play a valuable role in innovation and the adoption of new technologies:
   - Innovate UK's Catapult and Knowledge Transfer Networks increase innovation capability and reach;
   - the Be the Business programme[6] is using local networks to bring best practice to smaller firms;
   - Business Basics[7] is trialling methods to encourage SMEs to adopt new methods;
   - the Made Smarter[8] scheme in Manchester offers advice, support and funding for the take-up of digital technologies;
   - the Growth Hub Network[9] led by Local Enterprise Partnerships helps businesses understand and access the support they need;
   - "living labs" bring university research skills to bear on real-life business problems.

5. Despite these initiatives, the UK is behind other countries in terms of the scale, reach and coordination of support for technology diffusion. Our Catapult network is an order of magnitude smaller than Germany's Fraunhofer system that inspired it, and its focus is primarily innovation rather than diffusion. Nor do we have anything to rival Japan's *Kosetsushi* or Germany's network of *Steinbeis* Transfer Centres and Institutes, which offer sectoral know-how, technological expertise, consultancy, training and other facilities to solve business problems. There is a shortage of support for British firms to understand the potential of technologies to improve their business; to diagnose their needs; to identify solutions and to support implementation.

   Recommendation 1 - Establish a business-facing National Centre for Productivity to support firms that have implemented the basics and have the ambition to take the next steps towards high performance. This would

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[6] https://www.bethebusiness.com/
[7] https://www.gov.uk/government/collections/business-basics-programme
[8] https://www.madesmarter.uk/
[9] https://www.lepnetwork.net/growth-hubs/

aim to improve their command of technologies whilst promoting the use of methods for identifying the right solutions, building on the Council's previous recommendations to government on computational modelling[10].

6. The mission of the National Centre for Productivity would not be innovation, in its strictest sense, but *the adoption of those technologies*, both new and existing, that will allow firms to close the gap with those at the cutting edge. We suggest that the National Centre should be a true centre of excellence for the application and diffusion of technologies, particularly those with the broadest potential for impact, such as Digital Twinning[11].

7. Low-productivity businesses need to start their journey by the adoption of tried and tested, basic technology, for example: accountancy software, cloud computing and customer relationship management (CRM) software. Some existing initiatives seek to increase penetration of such approaches. The National Centre would aim to help businesses build on this foundation. Continuing the example, cloud computing and CRM software can collect and better manage business and customer data; this in turn supports increasingly sophisticated data analytics and decision-making algorithms; and ultimately more sophisticated artificial intelligence (AI) applications with the potential to deliver greater returns. Adoption of these technologies also plays to UK strengths in R&D.

8. As well as a source of direct expertise (to advise and train businesses, and to demonstrate and pilot technologies and approaches), the National Centre should also act as a trusted intermediary between firms and technology suppliers, researchers and innovators with a clear focus on adoption of appropriate technologies. We suggest that the government consider the potential of partnership models for the centre with the private sector and academia.

Recommendation 2 – BEIS should work with UKRI, the Industrial Strategy Council (ISC) and LEPs to review current business support programmes and consider how to create a more comprehensive system with local impact to deliver technology penetration. We propose a hub & model branching from the proposed National Centre for Productivity.

9. To complement a National Centre, a network of regional centres is needed to drive change regionally further into the long tail, a hub & spoke model. Most businesses are based in a single area and seek help locally; long distances are a barrier to uptake, and managers need confidence that the support they get is going to be relevant to them. Local centres would link to the National Centre but also be the point of access to a strong and easily navigable support offer tailored to the needs of local businesses, whose requirements, at least initially, may be further from the cutting edge.

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[10] https://www.gov.uk/government/publications/computational-modelling-blackett-review

[11] Digital twinning is the computer modelling of business processes, production lines and physical assets that allows the monitoring of performance and identification and testing of improvements through computer simulation.

10. There are several schemes already active in this space, but there is an opportunity to use these more effectively. Any new initiative must work with the grain of existing efforts. We therefore recommend that BEIS work with UKRI, the Industrial Strategy Council (ISC) and LEPs to review current business support programmes, consider how to create a more comprehensive system to deliver technology penetration, and evaluate what works best for whom.

11. The review should also examine the models operated in other countries including the *Kosetsushi* and *Steinbeis.* The activities of the national and regional centres should be established in such a way as to allow proper monitoring and evaluation of impact. Proposals for a separate productivity research centre are under development at the ESRC and developing effective monitoring evaluation mechanisms could fit within its remit and contribute usefully to the work of the proposed National Centre for Productivity.

Recommendation 3 - Consider how universities and public laboratories could play a wider role in technology diffusion and engaging more with local businesses than they currently do.

12. Creating a UK-wide network from scratch would not be straightforward. However, our universities have wide geographical reach, already have strong links to local business communities and are major employers. Universities, local business, local government and communities should be encouraged to deepen their collaboration. Our diversity of public laboratories across the country also represents a tremendous depth of expertise and are closer to applied research. The review of the Knowledge Exchange Framework (KEF) may provide useful insights into how universities can extend and strengthen their role in technology diffusion (rather than just technology invention), and we recommend that this work should be completed as soon as possible.

Recommendation 4 - Incentivise businesses (especially those in receipt of public sector support for innovation) to promote knowledge and know-how in their sector or across the supply chain.

13. Government should also consider the range of mechanisms at its disposal to promote technology diffusion. Businesses (especially those in receipt of public sector support for innovation) should be incentivised to promote knowledge and know-how in their sector or across the supply chain. For example, businesses that receive public funding to support innovation could be encouraged to share knowledge and know-how to promote the take-up of this technology. This is a requirement of Fraunhofer innovation funding, and a toolkit is provided to help grant recipients with this. This will require a shift from a focus only on innovation to a clear focus on adoption and use.

Addressing the shortage of skills needed to support technology adoption

14. An array of skills is needed across the economy to make the most of new technology. They range from the very basic – even low-level technological skills could be transformative for some firms in the long tail – to advanced and highly specialised. In some firms, the enduring shortage of engineers is problematic and the growing need for data scientists and experts in machine learning and artificial intelligence needs to be addressed[12]. Specialist skills at all academic levels are important, but there has been a reduction in government funding for adult skills since 2010[13]. Reinvigoration of the further education system would support building these skills.

15. This is all underpinned by basic numeracy and literacy skills (the position that the UK occupies in the OECD tables for both is deeply concerning) and, in the context of using technology, STEM qualifications. It is vital that we increase the numbers of people emerging from our schools and universities with the knowledge, skills and enthusiasm to make the most of new technology. This needs to go hand in hand with the improvements in management.

16. Government policy and funding for the education system is extremely important. UK government expenditure on training is below the OECD average[14]. Employer investment per employee has fallen and the number of employees in job-related training is in long-term decline[15]. Employers underestimate the extent of their skills gaps and need to be encouraged to invest in human capital.

17. Apprenticeships are an important part of the picture but only a partial solution: only 1.3% of employers are expected to pay the apprenticeship levy, and the forms of training involved will not suit all firms' needs in adopting new technology[16].

   Recommendation 5 - HM Treasury, BEIS and the Department for Education should explore how to use policy and regulation to encourage more employers to invest in training their staff in ways that support the use of new technologies.

18. This should consider potential employer incentives, including tax credits, as used in some other countries, notwithstanding the potential deadweight costs. It should also reflect on the wider impacts of the UK's tax and labour market framework:

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[12] Skilled experts are needed to develop AI, and they are in short supply. To develop more AI, the UK will need a larger workforce with deep AI expertise, and more development of lower level skills to work with AI. *Growing the AI industry in the UK, 2017* https://www.gov.uk/government/publications/growing-the-artificial-intelligence-industry-in-the-uk/executive-summary

[13] https://researchbriefings.parliament.uk/ResearchBriefing/Summary/CBP-7708#fullreport

[14] https://data.oecd.org/socialexp/public-spending-on-labour-markets.htm

[15]
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/746493/ESS_2017_UK_Report_Controlled_v06.00.pdf

[16] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/545145/Apprenticeships_-expected_levy_and_total_spend_-_Aug_2016.pdf

firm size, self-employment, staff turnover, and industrial relations have a bearing on staff training decisions and are influenced by government policy.

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