The Productivity Plan

Response to the BIS Select Committee by the Campaign for Science and Engineering (CaSE)

Summary of key points

- Overall the Plan identifies many of the correct causes of Britain's low productivity, although there are some nuances to the causes missing, which our response highlights.
- The Plan provides only headline policies without the detail that will be essential to its success. Synergy between Government departments and their policies will also be essential.
- Science and engineering are integral to productivity. The Plan could do more to tackle the Productivity Puzzle by supporting science and engineering through the following means:
    - Providing confidence to researchers, businesses and investors by setting a clear, ambitious, long-term R&D investment strategy that exceeds predicted growth.
    - Investing in education to tackle the STEM skills shortage.
    - Aligning immigration and VAT policies to complement other areas of Government policy to support science and engineering .

Introduction

The Campaign for Science and Engineering (CaSE) is the leading independent advocate for science and engineering in the UK. CaSE works to raise the political profile of science and engineering, and ensure that the UK has world-leading research and education, skilled scientists and engineers, and successful innovative businesses. It is funded by around 800 individual members and over 100 organisations including businesses, universities, learned and professional organisations, and research charities. Collectively our members employ 350,000 people in the UK, and our industry and charity members invest around £19.3 billion a year in R&D globally[1].

Science and engineering are integral to productivity. Taking the analogy below from the Productivity Plan, science and engineering improves the ingredients that we have *and* improves the recipes.

> *"Productivity is a measure of how well resources are converted into goods and services. Raising productivity can be achieved by improving the quality of the resources, and the way that we combine them. There is an analogy to cooking: we can raise living standards by improving the ingredients we have, and by using better recipes."*

However, for the full benefits of UK science and engineering to be realised, policies across all departments must be coordinated to support the overarching mission of nurturing and growing the UK's science and engineering capabilities. Nowhere is this more obvious than in solving the Productivity Puzzle. Synergy is required to ensure that the UK has the most competitive science and engineering environment and workforce in the world to raise productivity and create the UK's future prosperity. The Productivity Plan makes welcome steps to achieve this, but as set out below, there are areas and many details omitted from the plan that will be crucial to its success.

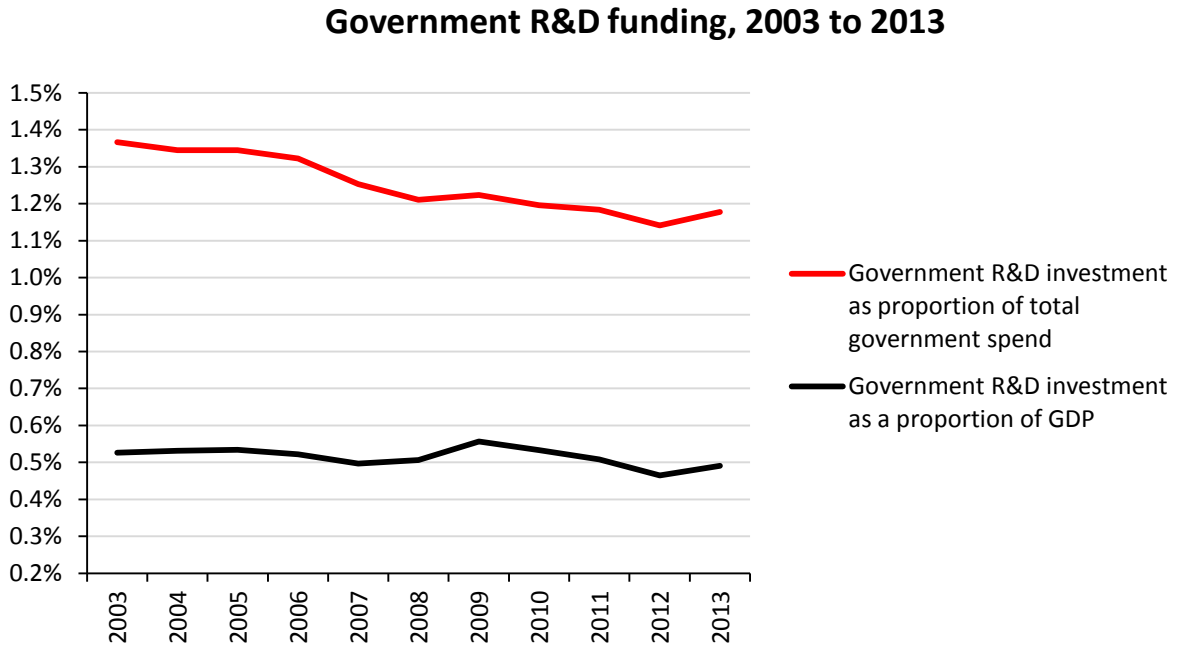
[1] Calculated using data from the latest year available from CaSE members. This is likely to be an under-estimate as data was not available for all members.

This response addresses the specific questions of the Committee but is limited to the primary areas of interest for CaSE in the Productivity Plan; these are investment in R&D, education and skills, and a flexible and open workforce. This response is not intended to be an exhaustive assessment of the Plan.

Question 1: Causes of low-productivity

Investment in R&D

The Plan is right to point out that low investment in R&D, which has long been below the levels of our international competitors, is a primary reason for the UK's low productivity. Government investment in R&D has fallen both as a percentage of GDP and as a percentage of total Government spending[2]. Between 2003 and 2013, GDP rose by 44% and public spending by 56% but Government investment in R&D only rose by 34%.



However, the Plan fails to acknowledge that it is not only the level of investment that is important but also stability, which provides long-term confidence to researchers and investors. Both the level and stability of Government investment are crucial to leverage further investment and to support R&D that will lead to productivity gains.

The Plan is also right to highlight short-termism in private investors as a problem. This is acutely true in some areas of science and engineering, where the R&D pipeline means the time from initial investment to financial return can be over ten years. This contrasts markedly with some other sectors and can discourage investment in science and engineering. Government investment and funding stability will go some way to encourage long-term thinking among investors but the Plan is right to look for additional policy levers.

[2] http://blog.sciencecampaign.org.uk/wp-content/uploads/2015/04/CaSE-RD-investment-briefing-April-2015.pdf

Education and skills

Although acknowledged implicitly in some parts of the Plan, there is not enough recognition given to the UK's chronic skills shortage in Science, Technology, Engineering, and Maths (STEM).

Echoing findings of countless past surveys, the 2015 CBI/Pearson skills survey found that among engineering, science, and hi-tech firms, nearly half (44%) report difficulties in finding experienced recruits with the right STEM skills, particularly high-level STEM skills[3]. This is reflected in the Home Office's Shortage Occupation List where 75% of roles are in STEM[4].

The Royal Academy of Engineering and Big Innovation Centre estimate that demand for new workers will average 104,000 STEM graduates and 56,000 STEM technicians with NQF Level 3 and above skills in each year between now and 2020[5]. Based on this prediction, the Social Market Foundation (SMF) estimates that there is an annual shortfall in domestic supply of around 40,000 STEM graduates[6]. To close this shortfall with domestic employees, the number of UK STEM graduates would have to increase by around a half. The SMF also points out that this shortfall does not take into account the expected increases in demand for STEM skills that will arise from the Government's mission to promote science and engineering as a strategy to rebalance the economy. Furthermore, the Government's plans to invest £100 billion in infrastructure over the next five years, a key feature of the Productivity plan, will require specialist engineers and the world's best minds to be delivered efficiently and on time.

The STEM skills shortage is a major impediment to economic growth. Failure to meet demand for engineering skills alone is estimated to cost the UK £27 billion a year from 2022[7]. Furthermore, in its international benchmarking study, the Department for Business Innovation and Skills found that the UK's science and innovation system is hampered by weaknesses in its STEM talent base[8].

A flexible and open workforce

The Plan correctly highlights a number of labour issues that contribute to low productivity, including skills mismatch. This mismatch can involve both people working in roles for which they are over-qualified, and people working in roles for which they are under-qualified. The STEM skills shortage described above means that this cannot be solved simply by moving current members of the workforce around to achieve perfect skills match in all roles. The chronic STEM skills shortage means there will be roles left over for which people are not qualified or best-suited to.

The Plan is therefore wrong not to acknowledge the role of immigration in addressing this skills demand, nor the role of highly-skilled foreign scientists and engineers in raising productivity through innovation and up-skilling our current workforce. Immigration policies that improve the level and breadth of skills in the workforce must be part of any plan to raise productivity.

[3] http://news.cbi.org.uk/reports/education-and-skills-survey-2015/education-and-skills-survey-2015/
[4] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/423800/shortage_occupation_list_april_2015.pdf
[5] http://smf.jynk.net/wp-content/uploads/2013/03/Publication-In-The-Balance-The-STEM-human-capital-crunch.pdf
[6] http://smf.jynk.net/wp-content/uploads/2013/03/Publication-In-The-Balance-The-STEM-human-capital-crunch.pdf
[7] http://www.engineeringuk.com/Research/Engineering_UK_Report_2015/
[8] https://www.gov.uk/government/publications/science-and-innovation-system-international-benchmarking

Question 2: Long-term investment

Investment in R&D

The Chancellor has made clear his intent to prioritise spending in areas that drive productivity and growth. As stated in the Productivity Plan, investment is an essential part of raising productivity and there is clear and robust evidence of a link between R&D spending and national productivity. Despite this, the Plan does not set out a clear investment strategy for science or innovation funding, nor for departmental R&D spending, which currently accounts for 40% of total Government investment in R&D[9]. Departmental R&D funding is the intelligence budget of Government, supporting the efficient and effective delivery of public services. This investment is therefore crucial for productivity.

Government investment in R&D boosts productivity in a number of ways through generating new knowledge and processes, up-skilling the workforce, and catalysing further R&D by leveraging investment from private industry and charity.

- Every £1 of public investment in R&D raises private sector output by 20p each year in perpetuity[10].
- £1 of public investment gives rise to an increase in private funding of between £1.13 and £1.60[11], and firms that persistently invest in R&D have 13% higher productivity than those with no R&D spending[12].The productivity-boosting effect of public sector R&D investment is greater the higher private sector R&D investment is.
- Evaluation studies have specifically shown that firms in receipt of innovation grants from UK government are 41% more likely than other similar firms to introduce new products to market, with product innovation linked to raising a firm's labour productivity[13]. This effect is boosted by collaboration with the research base.
- The outcomes of R&D also contribute to productivity of the UK workforce by developing treatments and technologies that enable people to live longer, healthier lives.

The UK research base is the most efficient in the world. With only 3% of global R&D funding and 4% of the world's researchers, the UK research base is responsible for 11% of citations in patents worldwide and 16% of the most highly-cited academic papers[14]. The UK is also ranked 2nd globally for the quality of its scientific institutions[15]. However, this should not be seen as an excuse to continue to starve the sector of funds.

The UK's declining public R&D investment is a lost opportunity, risking the breadth and depth of UK science excellence with implications for the absorptive capacity of firms and our ability to benefit

[9] http://blog.sciencecampaign.org.uk/wp-content/uploads/2015/04/CaSE-RD-investment-briefing-April-2015.pdf
[10] http://sciencecampaign.org.uk/?page_id=14040
[11] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/438763/bis-15-340-relationship-between-public-and-private-investment-in-R-D.pdf
[12] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/293635/bis-14-p188-innovation-report-2014-revised.pdf
[13] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/369650/bis-14-1168-estimating-the-effect-of-uk-direct-public-support-for-innovation-bis-analysis-paper-number-04.pdf
[14] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/263729/bis-13-1297-international-comparative-performance-of-the-UK-research-base-2013.pdf
[15] http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2014-15.pdf

from global investment in science and innovation[16]. Further reducing the UK's public investment in R&D would also send a very damaging signal to investors.

The UK Research Base has great capacity to yield significant returns from greater investment by this Government and thus contribute to the long-term health and productivity of the UK economy. Yet, public spending cuts put at risk innovation and future growth, a point recently made by the Chief Economist of the Bank of England[17].

As recognised in the 2014 Science and Innovation Strategy, departmental R&D spending is currently poorly protected from short-term budget cuts despite its importance to the everyday effectiveness of Government. Knowledge and insight gained through department-funded R&D will be essential to the efficient delivery of the productivity-raising measures outlined in the Productivity Plan. Measures such as future-proofing transport systems, developing reliable, low carbon energy, and creating world-class digital infrastructure across the UK will all rely on sound evidence and improved technology gained through science and engineering. They will also be largely delivered by scientists and engineers.

Despite the Plan making the clear link between R&D investment and productivity, the only R&D investment commitment made in the Productivity Plan is repeating the Government's long-term capital commitment of investing £1.1 billion per year in real terms up to 2020/21[18]. This is welcome medium-term stability and recognises the enormous long-term growth potential that comes from investing in scientific infrastructure. However, it must be met with sufficient resource funding through the "Science Budget" to ensure efficient use of capital resources, and it must be complemented by increases in all areas of Government R&D investment.

For science and engineering to play its full part in addressing the UK's low productivity, the Government must set an ambitious upward trajectory for investment in R&D over the long term, at a rate that exceeds predicted growth. This investment strategy must provide confidence by setting clear investment levels and stability.

Investment in education and skills

Apprenticeships- STEM apprenticeships can offer great employment and progression routes for young people, allowing them to become productive workers. In general however, those taking apprenticeships experience lower funding, greater complexity, and more variability in quality than university students[19]. Despite the focus on improving apprenticeships in recent years, STEM apprenticeships have become less popular since 2011 and too few young people are choosing the vocational route into a STEM career[20]. Of the 440,400 apprenticeships started in 2013/14, 65,190 (14.8%) were in STEM. And in overall numbers, there has been a decrease in people taking STEM apprenticeships, down from 70,100 in 2011/12.

[16] Insights from International Benchmarking, BIS analysis paper, 2014
[17] http://www.bankofengland.co.uk/publications/Documents/speeches/2015/speech797.pdf
[18] Science and Research funding allocations 2015/16, BIS, 2014
[19] https://www.gov.uk/government/publications/state-of-the-nation-2013
[20] Analysis by CaSE. Data sourced from the Further Education data library, Skills Funding Agency and Department for Business Innovation and Skills (accessed July 2015): https://www.gov.uk/government/statistical-data-sets/fe-data-library-apprenticeships

These apprenticeships are also not offering training at sufficiently high levels to maximise employer or worker benefits. In 2013/14, only 270 higher level engineering, science or maths apprenticeships were started. The numbers of people going on to finish and qualify with a higher apprenticeship is much lower again, with only 30 in 2013/14. The reality is this route is not yet a viable alternative for young people finishing school and looking for a route into a high quality science and engineering career. There is the opportunity to change that with the Government's commitment to creating more apprenticeships but there needs to be a step change in prioritising the creation of quality higher level STEM apprenticeships.

It is not currently clear how the Government's commitment to create 3 million apprenticeships will achieve this nor how the apprenticeship levy will be targeted to meet the STEM skills needs of employers. This detail will be crucial to the success of the Plan.

Universities **-** The provision of science and engineering undergraduate courses comes with additional costs associated with equipping laboratories and providing materials for practical work. They therefore cost more to deliver than many others and certainly more than the current cap on undergraduate fees of £9,000. The Government, and wider UK, has much to gain from an increased pool of skilled scientists and engineers, as demonstrated by our chronic STEM skills shortage. Alongside the increased uptake of science and engineering it is therefore absolutely right that Government meets the additional costs that come with teaching these subjects.

Currently, universities find it difficult to make a business case for expanding undergraduate science and engineering degree provision because the high cost of delivery is not covered by tuition fees and attracts a lower subject premium provided by HEFCE than medicine and dentistry.[21] Universities UK has launched a review of the costs of STEM courses, which we hope will shed light on the exact level of extra investment needed.

Postgraduate courses, particularly PhDs are also critical in meeting the higher-level STEM skills demand. Greater investment is needed through the well-developed systems of the Government research funding bodies, primarily the Research Councils. This can be used to leverage private and charity funds whilst ensuring that postgraduate research is aligned with the UK's wider research priorities and industrial needs (the Nurse Review is currently looking at how this can best be achieved[22]). Greater investment delivered in this way should result in a better alignment of the number of PhD-qualified individuals with the workforce needs of industry and academia. This is an important and necessary target to raise productivity and strengthen the economy.

[21] Science and engineering courses are provided a 'Group B' laboratory based funding top up of £1,500 per student. By comparison, Medicine and Dentistry are provided 'Group A' funding top up of £9,900 per student (2013/14): https://www.shef.ac.uk/finance/staff-information/howfinanceworks/higher_education/calculate_grants

[22] BIS, Nurse review of Research Councils, 2015: https://www.gov.uk/government/consultations/nurse-review-of-research-councils-call-for-evidence

Question 3: A dynamic economy

A flexible and open workforce

To maximise the productivity-gains potential of science and engineering the UK must be able to attract the world's best talent. This means ensuring immigration policies complement wider Government policy to support science and engineering.

The majority of researchers in the UK have been internationally mobile during their career. Almost 72% of UK-based researchers (including those that are not UK citizens) spent time at non-UK institutions between 1996 and 2012, publishing research papers whilst affiliated to those institutions[23]. Furthermore, almost a third (29.8%) of academic staff in UK universities are not UK nationals[24]. This mobility is not because scientists and engineers are particularly fickle about where they live. It is because it is integral to their line of work; internationalism brings huge benefits to their own research and the productivity of science and engineering as a whole[25,26].

Almost half of UK publications are co-authored with international collaborators and such papers are on average more scientifically significant, receiving a greater number of citations by other authors[27,28,29]. UK papers with international co-authorship are associated with 61% greater citation impact when compared to institutional co-authorship[30]. Other benefits of immigration include the greater sharing of knowledge and new approaches to problem solving, both of which are essential to research and innovation, and thus productivity. Many of CaSE's industry members also tell us that foreign members of their workforce open up new international markets due to their connections back home and allow them to deliver complex science and engineering projects in countries where English is not the first language. This raises the productivity of those companies.

International migration is therefore an integral part of science and engineering due to the benefits it brings for research and the delivery of projects. Regardless of skills shortages, immigration of skilled scientists and engineers to the UK is inheriantly necessary if the UK is to remain a world-leader in research and innovation and benefit from the economic and societal advantage that science and engineering delivers.

Despite this, current Government policy is to restrict the number of skilled workers that can come to the UK. Although CaSE is not aware of any scientists and engineers being prevented from obtaining a visa due to the annual cap of 20,700 Tier 2 (General) Certificates of Sponsorship, there is a strong

[23] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/263729/bis-13-1297-international-comparative-performance-of-the-UK-research-base-2013.pdf. Researchers are defined as in the Frascati manual: *"Researchers are professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems and also in the management of the projects concerned."* In the study cited, only published researchers were able to be analysed.
[24] Engineering Professors' Council analysis of HESA data from the Higher Education Database for Institutions (HEIDI), September 2015
[25] http://www.nber.org/chapters/c13405
[26] http://www.nature.com/nature/journal/v497/n7451/full/497557a.html
[27] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/310544/bis-performance-indicators-uk-share-highly-cited-academic-articles-april-2014.pdf
[28] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/263729/bis-13-1297-international-comparative-performance-of-the-UK-research-base-2013.pdf
[29] http://www.pnas.org/content/early/2015/08/05/1501444112
[30] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/263729/bis-13-1297-international-comparative-performance-of-the-UK-research-base-2013.pdf

belief within the science and engineering community that the existence of the cap, and the publicity of its breach in June, is putting-off talented scientists and engineers from coming to the UK to work and contribute to our research base and economy. There is also the real danger that as demand for work visas continues to rise, impact on the science and engineering community will become inevitable.

The science and engineering community relies on immigration not only to fill skills shortages but also to bring together people with different perspectives, new ideas, and different skills. Bringing in foreign skilled workers also allows the native workforce to gain those skills – which can be especially unique in science and engineering – thus immigration will always be part of the solution to the skills shortage. Current immigration policy predicated on skills shortages therefore does not reflect the reality of science and engineering working and education practises, nor the needs of UK employers keen to raise productivity. The system of identifying skills shortages through an exclusive list also creates vulnerabilities for science and engineering sectors as to an extent it involves "picking winners" and is open to political mood.

Due to the reasons presented in this response, CaSE does not support the annual limit of 20,700 in the Tier 2 (General) route. We believe that the UK should welcome skilled workers who will raise productivity by contributing to UK science and engineering excellence and thus supporting economic growth. Improving immigration policy to support science and engineering should be part of the Productivity Plan.

A dynamic and collaborative research base

Collaboration between universities, charities, and industry is at the heart of the UK's success in science and engineering and is a highly attractive feature for public and private researchers and companies when deciding where to base their research and investment. It is also increasingly recognised that future scientific and technological breakthroughs will come from the collaboration of specialists from a range of disciplines and sectors. Collaborations facilitate the sharing of cost and risk, providing a platform for innovation and raising productivity. It is therefore vital that government policy promotes collaboration and creates an attractive environment for private and third sector investment and innovation. The system isn't broken but more could be done to make it efficient and effective. In line with recommendations in the recent Dowling Review[31], CaSE believes there are further steps that Government can take promote and facilitate research collaboration between academia and industry to drive productivity gains.

Academic and industry CaSE members have highlighted the UK's VAT system as a current and significant barrier to research collaboration, particularly co-location within research institutes. In a recent CaSE briefing, the key issues and solutions to explore are set out in detail[32]. The primary issue is that publicly-funded research institutes are restricted to 5% commercial activity if they opt not to pay VAT or face costly tax bills to co-locate their researchers with industry colleagues. The

[31] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/440927/bis_15_352_The_dowling_review_of_business-university_rearch_collaborations_2.pdf

[32] http://sciencecampaign.org.uk/CaSEVATbriefing2015.pdf

complicated nature of the UK tax system and inflexible interpretation by HMRC is creating unnecessary cost and bureaucracy, and stifling research collaboration and productivity that the Government is seeking to grow. It is important that policies are aligned across government to ensure the efficient use of public funds within the higher education sector and that public investment is optimised to promote productivity. CaSE echoes the recommendation in the Dowling Review that the government needs to address the issue of VAT on shared facilities as a matter of urgency.

Question 4: Effectiveness of the Productivity Plan

Ultimately the effectiveness in the Productivity Plan will depend on the detail of the policy headlines its presents. Many of the themes and ideas are welcome and if followed through will help to address the Productivity Puzzle.

As we have outlined, the policies will need to be backed up with investment and be targeted to areas where they will have the greatest effect, such as science and engineering. The Plan also requires a whole-Government approach, with synergy between departments and their policies. If this is achieved, the Productivity Plan will be delivered in the most efficient manner possible, saving the tax-payer money. However, if policies contrast rather than complement, such as is the case with immigration and VAT policy, the effectiveness of the Plan will be stymied.

CaSE would be happy to provide more detailed information on any of the issues raised in this submission.

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