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Campaign for Science and Engineering in the UK

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CaSE Working Paper

RESEARCH FUNDING

INTRODUCTION

Investment in science and engineering research generates a wide range of benefits, from economic growth to enhancing quality of life.[1] Nearly 30% of the UK's Gross Domestic Product (GDP) is produced by sectors intensive in science, engineering and technology.[2]

Given the established importance of research and development (R&D) as the basis of a knowledge economy, the European Union has a target of 3% GDP to be spent on R&D from all sources by 2014. The UK government set a lower target of 2.5%, arguing that the UK has many industries that are typically low investors in R&D. But the situation is not helped by the fact that UK public investment is low with respect to comparable countries.

UNESCO data from 2007 placed the UK 15th for percentage of GDP spent on R&D, with Israel, Sweden, Korea, Finland and Japan all spending above 3%, and Iceland, the USA, Singapore, Denmark, Germany and Austria all spending above 2.5%, with the UK trailing behind at 1.8%. This pattern will change with GDP in response to recent economic events and as different countries invest in R&D to a greater or lesser extent. Unfortunately, the UK government has not seized the opportunity seen by other countries to invest in the research base as part of its response to the current recession, although it has increased invested in later stage R&D via the Strategic Investment Fund. Finland and Korea responded to their economic crises in the 1990s by investing heavily in R&D, and this investment has been judged to have helped drive their strong re-growth through knowledge based economies.[3]

Given that many other countries are investing heavily in research, could the UK not just rely on what they produce? The answer is no. The UK will only be able to benefit fully from other countries R&D, if UK researchers have developed their own skills and knowledge by conducting comparable research themselves. Evidence shows that countries with higher R&D intensity gain more from foreign performed R&D.[4]

What would it take to get 2.5% of UK GDP being spent on R&D?

The UK spent £25 billion on R&D in 2007, equivalent to 1.81% of GDP.[5] In order to achieve the UK goal of 2.5%, an extra £10 billion would need to be spent on R&D (or GDP would have to fall by 28%). Not all of that additional £10 billion would have to come from public funds, but the government should recognise how much scope for additional support and investment there is.

Action: **The UK must pursue policies to increase the knowledge intensity of the economy, maintaining the commitment of at least 2.5% of GDP to be spent on R&D by 2014.**

Without political prioritisation and commitment, the UK risks its standing in international science and engineering and it risks losing internationally mobile researchers and private research investment. Science is a global endeavour and the UK should be perceived to be a desirable partner. Equally, within the UK, researchers, their organisations and non-public funders need to know that public money will provide a stable stream. The current uncertainty of long-term funding, and regular reprioritization of limited funds in experienced in some areas, is destabilizing and hinders long-term research.

Action: **The next government needs to show stability of science funding by:**

- **maintaining the ring-fenced science budget for the current spending period to 2010/11.**
- **seeing through the Science and Innovation Investment Framework 2004-14, which would mean that spending over the next period matches projected economic growth.**

Different Sources of Investment

In 2007, the government invested 30% of the UK's total R&D spend, the private sector funded 47%, with 17% from foreign-owned firms and 6% from the non-profit sector. Evidence shows that public R&D helps generate private R&D, and vice versa, and that both have an independent effect on growth.[6, 7] Ensuring that there are plenty of skilled workers helps to make sure that public and private money are not competing for limited resources. Some studies have shown that the impact on private funding is greater if public money is spent on basic rather than more applied research, although it may take longer to reach its full return; these differences should be considered in generating a balanced portfolio of investment.[8, 9]

Action: **The UK government needs to show its commitment to science and innovation through sustained investment to develop the knowledge and skills critical to attract R&D investment from other sources.**

Distributing Tax Payer Support for Research

As a percentage of GDP, UK government spending on R&D fluctuated from 0.52 to 0.59% over the last decade, and was 0.55% in 2007. Comparing across G7 countries for 2006, UK public spending was only greater than Italy, with Germany at 0.71%, France at 0.81% and the USA at 0.77%.[10]

Public money is spent on R&D through a range of streams, as illustrated in Table 1 and Figure 1. Note that the bulk of the Science Budget is delivered to research councils, but it also includes capital funding (£400m), knowledge transfer (£100m), National Academies (£70m), and for science and society and other programmes (£60m).

Table 1 illustrates the different purposes behind different public funding streams. Public funds are vital for strategic work that would not benefit private investors but does

benefit society, like policy development, and some areas of defence and health. Public money is also needed where private investors are unlikely to spend enough - areas where there is uncertain utility, where large time scales are involved, and large amounts of development work required. A recent OECD paper argues that the importance of public funding for long-term riskier research and research on societal challenges is even greater during a recession.[11]

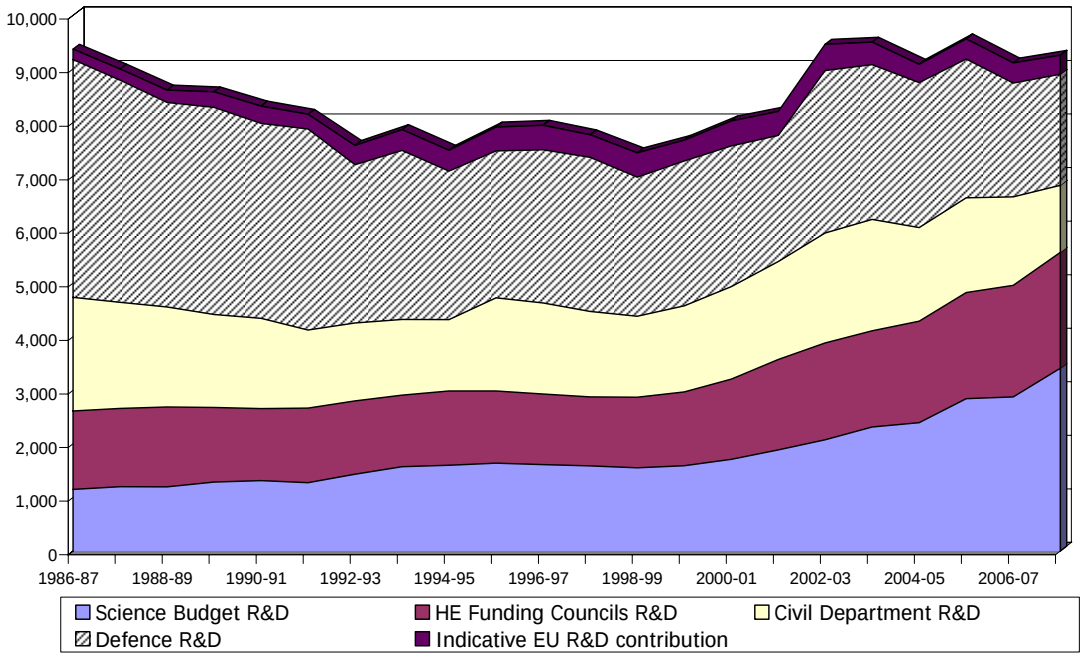
Action: **There needs to be greater consideration given to the portfolio of public funding streams for UK R&D, which exist to deliver different policy objectives. There needs to be better understanding about the trade-offs and synergies between different investment options.**

Table 1. Illustration of the principles behind different funding streams supporting UK R&D, net spend in 2007/08 and %change since 2004[12]

Public funding streams	Millions	%change	Policy Objectives				
			Knowledge & Skills	Policy	Societal Issues	Wealth Creation	Defence
Science Budget[13]	£3,520	+42	***	**	**	**	**
Funding councils	£2,230	+14	***	*	*	*	*
Civil Departments	£1,290	-28	*	***	**	*	-
Ministry of Defence	£2,140	-23	*	*	*	*	***
TSB	£230	-	*	-	**	***	*
RDAs	£440	-	*	-	**	***	-
R&D Tax Credit	£670	-	*	-	*	***	*
European Union R&D[14]	£368	-	**	**	**	**	-

*Note: ***primary purpose of stream, **some funding for this objective, *incidental.*
Tax credit data for 2006-07.
RDAs = Regional Development Agencies.
TSB = Technology Strategy Board, a further £100 million comes from RDAs and research councils but has not been included to avoid double counting.

Figure 1. Government expenditure on R&D in real terms, 1986-2008 (base year 2006-07) £ millions.



GOVERNMENT DEPARTMENTAL R&D BUDGETS

Funding of government departmental R&D has fallen quite dramatically – by about a quarter since 2004 alone (although some of this change might be due to changes to how departments classify R&D)[15]. Departments should recognise their responsibility to secure the evidence-base for their policies, investing in research to develop and evaluate new ideas and to evaluate policies already in place. The Sainsbury Review recommended better identification of and protection for departmental R&D budgets. The government had accepted this recommended, but has only. R&D budgets may be vulnerable to cuts, such as those seen in the 2009 budget, because they do not directly deliver public services.[16]

Action: **Government departmental R&D budgets need to be maintained to provide the evidence-base for policy development and the effective delivery of public services.**

Action: **Government departmental R&D budgets should be published in advance and protected from other spending priorities.**

THE RESEARCH BASE

Direct funding for the base of research in universities and research institutes has doubled over the last ten years. It is delivered by a dual support system. First, the Science Budget allocates money to seven different research councils who fund research

projects, studentships, and national research facilities. Second, universities receive general research money via the regional Higher Education Funding Councils depending on a number of factors but mostly their prior research performance.

UK performance

- Four out of the top thirty universities for research in the world were judged to be in the UK in 2009.[17]
- The UK produces 12% of all citations and 14% of the most highly cited papers. Increasing competition from other countries means that we cannot be complacent and the UK's share of world publications has been slowly falling over the last decade to 8%, reflecting the growth of other countries like China (whose share quadrupled in a decade), Brazil and South Korea.[18]
- Investment in UK research is very efficient, 3rd in the world in terms of citations per researcher and top of the G8 for papers as a proportion of GDP.[19]

Ring-fenced the Science Budget

The Science Budget has been ring-fenced to protect it from the short-term needs of whatever department is administering it.[20] A ring-fenced means that for the spending review period, currently three years, there is security in the level of funding available. This is beneficial as it:

- Ensures a proportion of the government's overall spending on research is protected in order to deliver long-term benefits to the country.
- Protects the Science Budget from raids from its host department – this may become even more important as departmental budgets are squeezed.
- Enables funders to make medium-term plans and commitments with a greater degree of confidence that the funding for it will be there.
- Is necessary, given that £98 million was taken from it for industrial support by the DTI in 2007, it seems likely that many more raids would have occurred without the ring-fence.

Action: **The Science Budget must continue to be agreed separately and ring-fenced from departmental spending.**

Shaping the Research Base

Research councils distribute their funds according to a number of principles:

- Focus on excellent research as judged by peer review.
- Maintain a broad base of investment in pure, fundamental as well as in applied research.
- Follow the Haldane principle that the Government may guide overall strategic direction, but research councils decide which projects are to be funded.

There have been recent concerns about the level of government influence over the direction of research. Notably, the government has refused freedom of information requests to publish its guidance on the division of funds between the research councils.[21]

Action: **Any guidance from government to research councils, particularly the Allocation Letters, should be done transparently.**

In addition, the government has encouraged both of the dual funding streams to distribute money on the basis of the impacts of research as well as its excellence. Research councils ask that grant-writers consider how to enhance the impact of their projects, although it can be hard to anticipate what these might be. Funding councils plan to distribute a proportion of their funds on the basis of the impacts of prior research, although these are very hard to capture, attribute appropriately and compare.

There are risks involved in such a strategy if it rewards highly predictable short-term research over other areas that could bring significant long-term scientific, economic and other societal gains. The other functions of the research base, including training and the security to respond to unexpected future challenges, must be sustained and underpinning disciplines like mathematics must be maintained.[22] The breadth of research across science and engineering is one of the UK's competitive advantages; it ranks in the top three in seven out of nine research fields, as judged by citations per publication.[23] Breadth enhances innovation and enlarges the sectors that can attract internationally mobile industry investment, students, and researchers and enables the UK to gain more from research done overseas.[24]

Rather than trying to shape the research done, the various impacts of research may be best strengthened by ensuring that new knowledge is fully communicated and developed into innovations and new products where appropriate and by enhancing framework conditions down-stream of the research base.

Action: **Research councils should continue to fund the highest quality research; the impacts of this work could be enhanced by ensuring the flow of skills and knowledge out from the research base rather than influencing what research is done.**

SUPPORTING INDUSTRY INVESTMENT IN R&D

It is estimated that the gains that private companies reap from their investment in R&D are about half of the gains that "spillover" to other private companies and the wider society.[25] Direct support, regulation and incentives to enhance private R&D investment are thus well justified.

The government has argued that it is hard for the UK to achieve high levels of private R&D investment because of the profile of the economy. More than four fifths of UK industry sales occur in sectors that are low of very low investors in R&D, like oil and gas, and 75% of GDP comes from the service sector. One of the goals of the Science and Innovation Investment Framework 2004-14 was to create new R&D intensive sectors. The goals of any focused industrial activism should be clearly articulated and should support specific industries with policy aims in addition to economic growth (e.g., support of green technologies).[26] Efforts to encourage industry investment and innovation should not focus simply on sectors that already have a large presence here, but expand to

diversify the portfolio to increase the breadth of excellence and the potential for interdisciplinary collaborations.

The Technology Strategy Board promotes innovation through various collaborative projects and knowledge transfer activities, working as a hub linking business, universities and government in strategic areas. Some of these roles are shared with the research and innovation spending of the Regional Development Agencies (RDAs), although the RDAs obviously have a regional element. The TSB budget is modest given that it should be a key driver of collaborative research between industry and university.

Action: **The Technology Strategy Board's work should be evaluated and further support should be given if it is effective as a means to develop emerging technologies and industries.**

Public sector procurement is worth £220 billion. It should be used to stimulate but not micro-manage innovation, providing a guaranteed market for the most successful work. The Small Business Research Initiative (SBRI), funded by government departments, is a good model, in which companies compete to come up with innovative solutions to public challenges. The first stage funds a group of companies for feasibility studies followed by a final contract for product development. Providing additional financing for the SBRI another stream, like an increased TSB budget, would encourage departments to spend more through this route.

Action: **Government departments should be encouraged to spend part of their procurement budget to spur innovation.**

R&D Tax Relief

In the aggressive competition to attract industrial R&D investment, in 2008, 21 countries offered industry R&D tax relief. In the UK, overall subsidies to industry mean that it needs to invest nearly 90p to achieve a £1 investment in R&D (taking into account all tax incentives and deductions). The UK is ranked 19th in terms of how generously the tax system treats R&D, down from 13th in 2004. The UK is more favourable for industry than the US, but far less attractive than Brazil, India, and China.[27]

According to a recent survey, 37% of companies said they had increased R&D as a result of the credit and three quarters said that it had helped to maintain their R&D investment in the UK. Notably, a fifth of companies said that they would actively relocate R&D overseas if the R&D tax credit ceased.[28] In 2006/07, the UK spent £670 of public funds on R&D tax credits, in addition, companies can offset capital investment in research infrastructure against their taxable income.[29]

It is not clear whether these tax reliefs do indeed increase absolute levels of R&D investment or just influence where companies chose to locate their R&D. Either way, given the international consistency of these incentives, it would be a gamble to reduce them without a thorough evaluation of the possible consequences of such an action.

Action: **The tax credits and relief given to companies for their investment in R&D help to maintain the UK's international competitiveness. Cutting them could risk industrial relocation overseas.**

Financing

In 2006, the UK had a massive venture capital investment of 0.5% GDP, much larger than its nearest competitor, Israel at 0.3% GDP.[30] However, because of the relatively high cost of both starting up a business and of failure through bankruptcy, the UK typically invested in safer start-ups - only 4% of venture capital investment was in start up and early stage companies in 2007, compared with 30% of such investment in the USA. [31] In contrast, the USA had viewed failure as part of the learning process.[32] Funders are now trying to save their current investments rather than funding new ventures. OECD analysts suggest that the role for government in the recession is not to prop-up failing ventures but to enable new ones to seize the opportunities opened up.[33]

Action: **The UK needs to change its approach to start-ups by reducing the initial costs and the price of failure, developing alternatives for bankruptcy and fewer penalties resulting from it.**

Investment from Abroad

In international comparisons, the UK receives the highest proportion of R&D funds from foreign owned firms. The attractiveness of the UK derives from its strong research base and framework conditions such as macro-economic stability, light-touch regulation, and a favourable tax regime. At the same time, UK firms are outsourcing more R&D overseas; extramural R&D performed abroad has nearly trebled from 1996 to 2005 reaching £1,750 million.[34]

Action: **It is essential to maintain a strong research base to continue to attract foreign investment. Levels of outward R&D investment must be closely monitored.**

SUPPORTING RESEARCH CHARITIES

Charitable funding of UK R&D has been rising in real terms since 2004 and reached around £950 million in 2008/09. Most research charities do not consider the funding of university infrastructure their responsibility, although many contribute substantially to it. In order to support charity-funded research, which would otherwise be less competitive to universities and research institutes, funding councils give additional support. For example, England provided the Charities Research Support Fund with £180 million in 2007/08. It is vital that the necessary level of 'top-up' funding is carefully calculated prior to the next Comprehensive Spending Review and that universities are made more aware of it.[35] If charities have difficulty funding high-quality research they may spend their money elsewhere, like on patient support, or even funding work overseas.

Action: **There should be an ongoing commitment to support charitable investment in research.**

EVIDENCE-BASED SCIENCE POLICY

The UK does not have a large capacity for looking at the "science of science policy" – that is, how government funding and organisational decisions affect the UK's performance in science and engineering. Although it is often possible to draw on large scale international analyses, the applicability of their results will vary across countries. The writing of this paper has revealed many questions for which there is insufficient evidence to fully develop policy recommendations, particularly with respect to the tradeoffs and effectiveness of different policy interventions to support science and innovation. The Treasury decides how the spending on R&D is split up across the different streams illustrated in Table 1. It is currently the only government department without a Chief Scientific Adviser.

Action: **The Treasury needs to appoint a Chief Scientific Adviser to commission research in order to assess the implications of different funding strategies.**

Action: **The Science and Innovation Framework should be seen through until 2014, but the process to develop a new comprehensive strategy for investment in science and engineering research and innovation should be started following the election.**

FURTHER INFORMATION

This is one of three CaSE working papers developed with input from CaSE members and other collaborators in the run-up to the general election 2010. The others cover *Science & Engineering in Government & Parliament* and *Education and Skills*.

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[12] Data from BIS websites November 2009 and *SET Statistics,* Department of Business Innovation and Skills, November, 2009.

[13] This line also includes the Government Office for Science funding, although this is not always considered part of the Science Budget.

[14] Indicative contribution to the EU R&D budget

[15] *SET Statistics,* BIS, November, 2009.

[16] *he Race to the Top A Review of Government's Science and Innovation Policies*. Lord Sainsbury, October 2007.

[17] Academic Ranking of World Universities, Shanghai Jiao Tong university 2009

[18] *Performance of the UK Research Base,* EvidenceLtd, for BIS, 2009

[19] *Performance of the UK Research Base*, EvidenceLtd, for BIS, 2009

[20] In February 2007, £68 million was pulled back from this budget by the Department of Trade and Industry, violating the ring fence but at the same time highlighting the importance of the concept.

[21] FOI requests were refused to CaSE and also the Innovation, Universities, Science and Skills Select Committee.

[22] In 2006/07 mathematical sciences received £21 million but this has dropped to a planned £14 million in 2009/10.

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