House of Commons

Science and Technology Committee

Bridging the valley of death: improving the commercialisation of research

Eighth Report of Session 2012–13

Report, together with formal minutes, oral and written evidence

Additional written evidence is contained in Volume II, available on the Committee website at www.parliament.uk/science

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Science and Technology Committee

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The Reports of the Committee, the formal minutes relating to that report, oral evidence taken and some or all written evidence are available in printed volume(s). Additional written evidence may be published on the internet only.

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Summary

There exists the concept of a valley of death that prevents the progress of science from the laboratory bench to the point where it provides the basis of a commercially successful business or product. The future success of the UK economy has been linked to the success of translating a world class science base to generate new businesses with the consequent generation of UK jobs and wealth. For decades Governments have sought to promote technological innovation and ensure that the UK benefits from its world class science base. The current Government has made several changes to the innovation landscape and therefore we considered this an opportune moment to consider whether government policy was moving in a positive direction.

A troubling feature of technology companies in the UK is how many are acquired by foreign owners where the subsequent jobs and wealth are generated outside the UK. Evidence to the Committee indicated that there are several reasons for this. These businesses take time to develop and to become profitable in an environment where financing is focussing more on quick returns and on less risky investments. We consider it key that the Government ensure that sufficient capital is available and recommend that the proposed bank for business, possibly in partnership with the Business Growth Fund, be used to promote a bond market for medium sized businesses, thus providing growing small businesses with an additional source of funding. We also recommend that the Government investigate the potential to require funds to have a proportion of European SME equities.

We consider it important that investors have a better understanding about technology investments and that the Government ensure that investors have ready access to information that would encourage their interest in technology based investments. The amount of information available would, in our view, be improved by the restoration of both the R&D Scoreboard and Bank of England monitoring on the availability of finance to SMEs.

The broader fiscal context is extremely important, especially for smaller companies. We considered that there needs to be a mechanism to support SME's who do disproportionately badly from the current R&D tax credit scheme. Indeed the Government needs to distinguish in its innovation policy between small and medium enterprises: a single SME category is too broad. We had some concerns that VAT might in some cases hinder commercialisation activity and urge the Government to iron out any such issues.

The Technology Strategy Board is becoming the focus for government innovation policy and we considered the portfolio of funding mechanisms and facilities available for them to support innovation and growth. We were concerned about the access of small firms to large scale test and experimental production facilities. We considered that the Technology Strategy Board and other commercialisation activities needed to ensure projects were properly supported in issues of manufacturing capability. We recommended that Government consider how they can resource the TSB to provide local level advice to technology businesses. The Small Business Research Initiative (SBRI) and the SMART Award scheme would appear to be successful initiatives but lack sufficient funds to meet

the demand from companies. We consider it vital that the Catapults are made to work but have concerns that they may be pushed to become self-financing too quickly.

We recommend that that TSB produce a review of regulatory burdens on technological innovation in the UK that includes a roadmap of how that regulatory reform might be used to drive innovation and which institutions should take the lead.

While our academic research is the jewel in the crown of UK innovation activity, we have some concerns about how universities interact with the commercialisation of research. We would like to see how well changes to the Higher Education Innovation Fund improve commercialisation activity; whether there is a need for greater amounts of proof of concept funding in the sector; and challenge the institutions to become more accommodating to non-traditional backgrounds among their academic staff. We have concerns that driving an innovation agenda too aggressively through universities may have diminishing returns with regard to commercialisation and risk damaging the academic research that is working well. It is crucial that the Government has a coherent plan on how to engage the research base (people, facilities and intellectual property) with the innovation agenda. The Government's objective should be to create a commercial demand for university engagement to which they are already primed to respond.

The Government's ambition to increase innovation activity will depend on its willingness to engage and speculate in that activity. A key feature of that speculation should be leading the way by investing in small technology businesses through its procurement policy. The Government will need to upskill its staff on how to better exploit government procurement for this purpose; better utilise the NHS in driving biomedical advances and ensure centres of excellence, such as the Crick Institute, proactively engage with business. We also recommend a Minister in HM Treasury be given responsibility for the delivery of procurement-driven benefits identified by the Department for Business, Innovation and Skills.

Finally there is a need for a clear vision from the Government to provide businesses confidence to make R&D investments. Without a definite commitment from Government about which sectors it intends to fund, business is more reticent about making its own financial commitment. A clear strategy for the future should aid the higher levels of business related research and development from businesses in the UK.

1 Introduction

Background

1. Victorian England has been portrayed as a golden age of science and engineering.[1] The nineteenth century saw huge leaps in the application of science and resulted in science-driven industrial and agrarian revolutions. Major cities grew on the back of industrial clusters which traded throughout the British Empire: Glasgow (steam locomotives); Manchester (cotton); Bradford (wool); and Newcastle (ship building).[2]

2. But it was not all smooth sailing. The financially innovative discount house, Overend and Gurney, collapsed in 1866, triggering a wave of company insolvencies.[3] A decade later Lewis Carroll's 'Snark' had its life threatened by a railway share.[4] Ultimately, the heavily skewed distribution of wealth and the extension of the franchise (the second Reform Act was introduced in 1867) made the system unsustainable.[5]

3. The material destruction and social turmoil of the first World War was followed by the financial destruction of the 1929 stock market crash and the Committee on Finance and Industry (chaired by Hugh Macmillan but reportedly dominated by John Maynard Keynes) was formed by the government to examine what could be done.[6] Its report noted the problems faced by small companies seeking investment and in 1945, at the end of the second World War, the Industrial and Commercial Finance Corporation (ICFC) was established to finance small businesses.

4. Since 1945 and the formation of the ICFC, there have been various efforts by Government to build on the UK science base. In the early 1990's renewed attention was paid to the potential use of the research base for economic and social development. The research councils[7] were reorganised and the national technology foresight initiative established, under the aegis of an Office of Science and Technology. This began an on-going dialogue between public and private research establishments and end-users to promote wealth creation and technology transfer. Later in that decade the Regional Development Agencies (RDAs) were created; a key part of their role being to further economic development. The RDAs introduced a variety of programmes and incentives to encourage research commercialisation and dialogue between industry and the research

[1] For example, "Age of Wonder", Richard Holmes, HarperPress, September 2009

[2] For example, "The First Industrial Nation: The Economic History of Britain 1700-1914", Peter Mathias, October 2001

[3] "The Mystery of Overend & Gurney: A Financial Scandal in Victorian London", Geoffrey Elliott, Methuen Publishing Ltd, June 2007

[4] http://etext.virginia.edu/etcbin/toccer-new2?id=CarSnar.sgm&images=images/modeng&data=/texts/english/modeng/parsed&tag=public&part=all p64

[5] For example, "The Penguin Social History of Britain: English Society in the Eighteenth Century", Roy Porter, Penguin, April 1990

[6] http://www.nationalarchives.gov.uk/cabinetpapers/themes/policy-protectionism-imperial-preference.htm and "John Maynard Keynes 1883-1946 by Robert Skidelsky 2003 ISBN 0333903129 – pp 419-427

[7] The first research council, the Medical Research Council, was established in 1920 following a recommendation of the 1918 Haldane Report. This was followed by the establishment of the Agricultural Research Council in 1931 and the Science Research Council, the Natural Environment Research Council and the Social Science Research Council in 1965.

base. More recently we have seen the advent of the TSB and the Innovation centres (Catapults) being established with cross party agreement.

5. In this report we describe how, in the early years of the 21st century major fiscal incentives were introduced to encourage businesses to increase their expenditure on research and development.[8] We focus particularly on the role of the current Government in maintaining and developing these and other policies intended to encourage the commercialisation of innovation.

6. The UK has a world class science base but there remains a need to attach world class exploitation mechanisms to leverage that research to gain economic benefits. This report considers the issue of the exploitation of research by looking first at the overall framework for innovation in the UK and some of the broad issues that affect the development of policies in this area, then at how government might further encourage the engagement of business with research activity and finally at how general government spending might be used to deliver wider innovation policy objectives.

The inquiry

7. We announced our inquiry into *Bridging the "valley of death", improving the commercialisation of research* on 14 December 2011 and issued a call for evidence based on the following terms of reference:

i. What are the difficulties of funding the commercialisation of research, and how can they be overcome?

ii. Are there specific science and engineering sectors where it is particularly difficult to commercialise research? Are there common difficulties and common solutions across sectors?

iii. What, if any, examples are there of UK-based research having to be transferred outside the UK for commercialisation? Why did this occur?

iv. What evidence is there that Government and Technology Strategy Board initiatives to date have improved the commercialisation of research?

v. What impact will the Government's innovation, research and growth strategies have on bridging the valley of death?

vi. Should the UK seek to encourage more private equity investment (including venture capital and angel investment) into science and engineering sectors and if so, how can this be achieved?

vii. What other types of investment or support should the Government develop?

8. We received 94 written submissions and took oral evidence from a range of witnesses and organisations; we are grateful to all those who contributed. In the course of our inquiry, we met a range of academics and industrialists engaged in the business of

[8] These we describe in the report

commercialising research. We visited both the Warwick Manufacturing Group within Warwick University and the Advanced Manufacturing Research Centre in Sheffield where we were able to speak with those involved in meeting business needs and tackling fundamental research challenges. We are extremely grateful to both of these institutions for hosting us and providing an invaluable insight into the business of bringing commercial success from academic research.

2 Innovation and the "valley of death"

9. The valley of death describes the point where a business, often a technology based business, has a working prototype for a product or service that has not yet been developed enough to earn money through commercial sales. The company needs to find sufficient money to develop the prototype until it can generate sufficient cash, through sales to customers, that would allow it to be self sufficient and grow. Growing companies will generate both jobs and wealth, a key objective for any government.

10. The Government recently published an Innovation and Research Strategy for Growth, which sets out how it plans to work with business and the knowledge base to underpin private sector led growth.[9] In the same week, the Government published its strategy for the life sciences, outlining how the Government will take action to make the UK a world-leading place for life sciences investment.[10]

11. Our predecessor Committee's 2010 *The impact of spending cuts on science and scientific research* concluded that the UK had an excellent research base but was still failing to maximise its potential by translating research into wealth and health. It recommended that the Government should consider increasing funding for the translation process to at least the same order of magnitude as that provided for basic research.[11] The 2009 inquiry *Engineering: turning ideas into reality* concluded that the UK was likely to miss out on the economic return associated with translating the findings of research into commercialised technologies, and called for a serious revision of the structures used to support the growth of fledgling industries.[12]

12. This Committee's 2011 inquiry into the Technology and Innovation Centres (now known as Catapults) cautioned that the limited funds available for innovation should not be monopolised by the TICs and noted that there was a lack of knowledge in the business world regarding existing UK research and development capabilities. The report recommended that the Technology Strategy Board (TSB) maintain a public list in the form of an online catalogue of centres that are ready and willing to work with business, in particular SMEs (small and medium enterprises), in specific technology areas.[13] A key feature of these centres was to follow the example of the Fraunhofer institutes in Germany in delivering long-term capital in an institution bringing together university expertise with private capital to produce industrial demand driven research and development.[14]

[9] BIS, "Innovation and Research Strategy for Growth", December 2011, Cm 8239 http://www.bis.gov.uk/assets/biscore/innovation/docs/i/11-1387-innovation-and-research-strategy-for-growth

[10] BIS, "Strategy for UK Life Sciences", December 2011 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/32457/11-1429-strategy-for-uk-life-sciences.pdf

[11] Science and Technology Select Committee, "The impact of spending cuts on science and scientific research", Sixth report of 2009-10, HC 335, 23 March 2010

[12] Innovation, Universities, Science and Skills Select Committee, "Engineering: turning ideas into reality", Fourth Report of 2008-09, HC 50, 27 March 2009

[13] Science and Technology Select Committee, "Technology and Innovation Centres", 2nd Report of 2010-2012, HC 619, 17 February 2011 http://www.publications.parliament.uk/pa/cm201011/cmselect/cmsctech/619/61902.htm

[14] Science and Technology Select Committee, "Technology and Innovation Centres", 2nd Report of 2010-2012, HC 619, 17 February 2011 , Chapter 3 http://www.publications.parliament.uk/pa/cm201011/cmselect/cmsctech/619/61902.htm

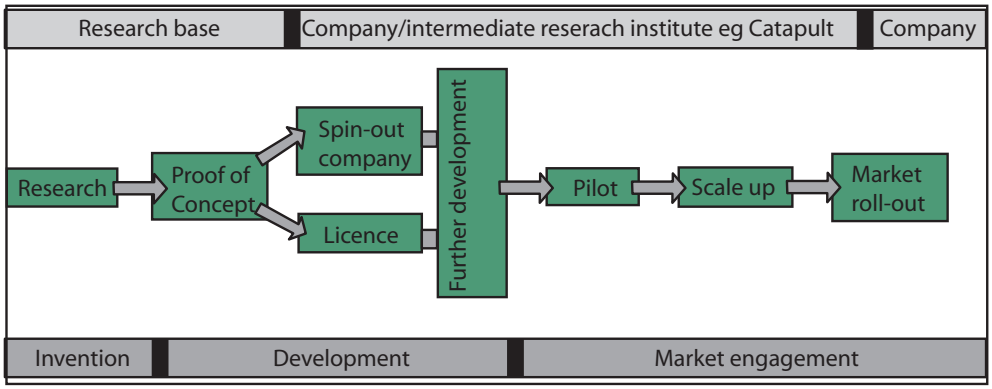
13. Evidence submitted by the Department for Business, Innovation and Skills (BIS) outlined the portfolio of policies that have been developed for the practical support for innovation which includes:

- Initiatives managed by the Technology Strategy Board (TSB), including the Catapult centres, the Small Business Research Initiative (SBRI), Smart awards, and Knowledge Transfer Partnerships (KTPs)
- R&D tax credits - provide tax relief for technological R&D
- UK Innovation Investment Fund (UKIIF) - funding for venture capital
- Patent Box – reduced tax on patents from 2013
- Higher Education Innovation Fund – funding available to universities for knowledge transfer, provided through the Higher Education Funding Council for England (HEFCE).[15]

The Linear Model of Innovation

14. The Science and Technology Policy Research Unit (SPRU) at the University of Sussex, and Exeter Business School (EBS) expressed concern that the Government's strategy for growth[16] "still retains an implicit discredited linear model in many places" mentioning specifically the Knowledge Transfer Partnerships (KTPs).[17] Others who criticised the idea that there was a single 'valley of death' tended to argue that the concept encouraged people to think that innovation was linear, and that financial obstacles were only found in one place.[18]

15. The linear idea of innovation may be described in the following way:



16. The Higher Education Funding Council for England (HEFCE) highlighted to us that the role of universities may be less instrumental in the commercialisation process than is assumed:

[15] Ev 101-102, paras 41–58

[16] BIS, "Innovation and Research Strategy for Growth", December 2011, Cm 8239

[17] Ev143, paragraphs 19, 27

[18] For example, Ev 174, para 4; Ev 122, para 5; Ev w108; Ev 145; and Ev w42-43, paras 1.1, 4.1; 5.1

> The vast majority of new technologies in the world that become commercially adopted will be devised and developed in the business world, by entrepreneurs, technology consultants, large and small businesses and in supply chains (albeit, we believe, infused and informed by university ideas and human capital development). [...]we estimate that only 19% of patent application filings from [the] UK [originate in] universities[19]

17. SPRU & EBS[20] expanded on the contribution of the linear model to high technology manufacturing:

> Much thinking about the commercialisation of research adopts an inappropriate and misleading 'linear model of innovation' in which university research generates innovations, that are then transferred and commercialised. Only 3% of the economy is in high tech manufacturing that draws on research in this way[21]

18. Written evidence from the Government noted that relatively little innovation was commercialised in this manner. Rather, the main route by which knowledge generated by the research base is commercialised is through "collaborative and contract research, consultancy, and the provision of professional training".[2223]

19. The University of Manchester also criticised the linear model:

> We have some discomfort with the phrase "valley of death" which implies that it is only necessary to get through this particular stage. In fact successful innovation is an interactive process in which commercialisation plans have to be effective in all stages and sometimes simultaneously.[24]

The Innovation ecosystem

20. The four resources essential for economic activity are knowledge, finance, services and people. The challenge for government policy is to define how it provides an environment where those four resources can be accessed effectively by businesses that already exist and those that may start up and grow. This is as true of technology sectors as of the wider economy but the way in which the resources are made available and the particular kinds of knowledge, capital and people required (or the balance between them) may differ from the business community as a whole.

21. The organisations, relationships and flows of money and knowledge by which innovation can be translated into jobs and wealth, often termed the innovation ecosystem, is a complex one. Professor Georghiou of the University of Manchester provided us with a diagram that we reproduce below:

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[19] Ev 140, para 27

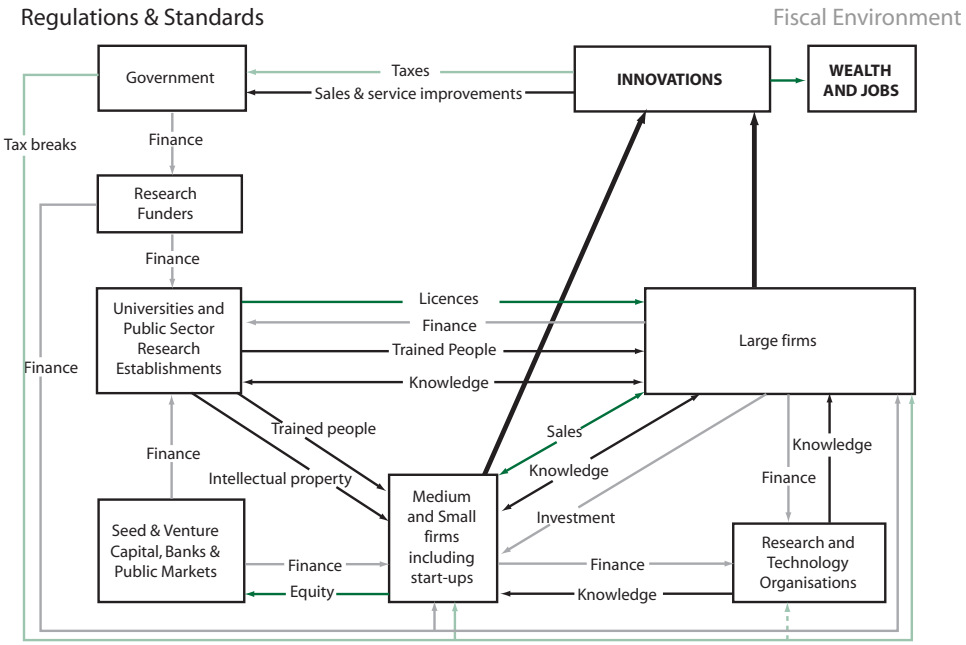
[20] Science Policy Research Unit at the University of Sussex and the Exeter Business School

[21] Ev w130, para 7

[22] Ev 95, para 5

[23] Ev 98, para 24

[24] Ev 122, paragraph 5.



22. The context for the whole ecosystem is determined by the regulations, standards and the fiscal environment set by Government. Universities and Public Sector Research Establishments attract finance and produce trained people, knowledge and intellectual property. Research and Technology Organisations (RTOs) perform a similar but more commercially oriented function. Finance flows from Government, larger firms, seed and venture capital organisations, banks and public markets. Ultimately the innovations that generate jobs and wealth are developed by businesses large and small and depend on a complex web of finance and knowledge transfer between these public and private organisations. The purpose of innovation policy is to ensure that both knowledge and finance flow efficiently to support the commercialisation of innovative products and services.

23. Insurance companies and pension funds have been major investors in this area but, in recent years, have become more cautious in their investment portfolio.[25] It was with some concern that we heard that a venture capitalist who made an investment in ARM[26] in the 1990s gauged that ARM would not, in today's financial environment, have received that funding[27] without which it might have failed to become one of the world's leading computer chip manufacturers. The issue of institutional investment will be considered in more depth later in the report.

24. Rolls Royce pointed out in their evidence that a common misconception was that innovation happened in smaller companies when a significant amount of innovation came from within large companies.[28] They highlighted their participation in networks alongside universities and small and medium sized businesses.[29] In October 2011, the Confederation of British Industry (CBI) published the Future Champions report which highlighted the

[25] Q 56

[26] ARM Holdings plc is a British multinational semiconductor and software design company headquartered in Cambridge. It is a key player in the field of mobile phone chips based on the ARM architecture and possibly the most widely known of the 'Silicon Fen' companies.

[27] Q 53 [Katie Potts]

[28] Ev 186, para 5.5.1

[29] Q 209

relative value of medium sized businesses to the economy. The report pointed out that firms with a turnover of between £10 million and £100 million represent less than 1% of businesses but generated 22% of economic revenue and 16% of all jobs, suggesting that growing this size of company would have a disproportionately beneficial impact on wealth and jobs creation. [30]

25. Having outlined the innovation system in the UK we next consider where that system may not be functioning and how it might be improved.

Access to money and equipment

26. For a business to be successful it must, over time, generate more money than it spends. However, the timescale for achieving a positive cash position can be lengthy; Amazon famously operated successfully, for seven years, spending more money than it was making.[31] Technology companies are similar in that they often need to invest heavily before they can demonstrate the potential to be profitable.[32] If they cannot find patient investors, then they may go out of business or be forced to sell out cheaply before they realise their potential.[33]

Picking winners

The challenge is to ensure that appropriate types of finance are available at all stages of a company's development and, as resources are always limited, that they go to the companies that will use them to best effect. It is widely accepted that Government is unable to "pick winners" (though we learned that resources available to the TSB means that it has to do so in allocating grants such as SMART awards). Recent reports on patents relating to graphene suggest that despite the £50m commitment from the government, China is taking a lead in this field. The University of Oxford had "concerns about strategies that rely on predicting technology futures and 'winners'".[34] The SME Innovation Alliance also warned against the Government "picking winners" or allowing "the 'Great and Good' to judge or select winners: such panels will always pick the well presented, apparently 'safe', project and miss the exciting and good".[35] However, we were told that Government does need to make choices in terms of which sectors to prioritise when assisting R&D investment and may, on occasion, need to go further.[36]

27. Sir Peter Williams, Vice President of the Royal Society and Chairman of the National Physical Laboratory, told us that there might be times when the Government needed to be brave and back good companies but that when it does, such as in the case of graphene,[37]

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[30] "Future Champions", CBI, October 2011

[31] Amazon was incorporated in 1994 and reported its first profitable quarter in 2001.

[32] For example, Ev 132, intro & Ev 153, para 6

[33] Ev 165, para 1.2

[34] Ev w139, para 21

[35] Ev 128, para 33

[36] Q 9

[37] On 3 October 2011, the Chancellor of the Exchequer pledged a £50m investment to create a graphene global research and technology hub and build a national capability to support the commercialisation of applications for graphene

"you are going to have to try to pick two or three winners and give them not sub-critical but super-critical financing, so that you do enable them to be a leader in the facilitation and deployment of this remarkable substance in new applications".[38]

Finding the cash to do business

Equity capital and public market finance

28. A traditional route for start-up companies is to seek capital from personal sources then look for business angels and venture capitalists. Capital of this nature is usually acquired by exchanging part ownership of the company (equity) meaning that the original entrepreneurs see their interest in the company diminish over time:

> The key point is that, if you are an entrepreneur and you have to go and get money, you virtually sell 95% of your idea very quickly either to venture capital, AIM[39] or whatever. You are left with 5%. That literally leaves the vast majority of people emotionally drained of the energy to take their idea forward.[40]

The SME Innovation Alliance were also concerned about how the need to seek venture capital increases the chance of control of the company and its technology moving overseas:

> The VC funding model is also a systematic means to export UK technology. The vast majority of funds come from overseas. If a company has three funding rounds, and if 80% of funds are non-UK, then mathematically the chances of control remaining in the UK after three rounds is 0.8%[41]

29. Anne Glover, co-founder and Chief Executive of Amadeus Capital Partners Ltd, explained one reason for the short term nature of equity investment:

> The reason that our time scales are short is that at the moment, historically, until [the Business Growth Fund] came along, the availability of the next stage of capital was too weak. Basically, we had to assume that we could work only with our own and that made us much more risk averse. If there was a ladder of financing that worked, we would take the long-term risks and be happy about it.[42]

We heard that the short timescales of venture capital investment means that small companies are often developed for the sole purpose of being sold[43] and that, as most buyers are overseas, many of these companies and their technology end up being developed

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and ensure the UK remains at the forefront of graphene work. BIS Press Release, "£50 million hub to commercialise Nobel Prize winning material", 3 October 2011

[38] Q 116 [Sir Peter Williams]

[39] AIM is the London Stock Exchange's international market for smaller growing companies. A wide range of businesses including early stage, venture capital backed as well as more established companies join AIM seeking access to growth capital. http://www.londonstockexchange.com/companies-and-advisors/aim/aim/aim.htm

[40] Q 95 [Dr Francis]

[41] Ev 129, para 27

[42] Q 53

[43] Q 53 [Stephen Welton]

overseas.[44] An example of this is referred to in our previous report on Technology Innovation Centres, see paragraph 5.

30. We have been told that the UK needs to change the financial environment to incentivise more smaller companies to grow further independently rather than sell out to a larger, and probably foreign, competitor.[45]

31. The issue of long term capital has been the subject of a recent report to the Department of Business Innovation and Skills. That report noted a failure in the marketplace to provide significant sums of patient capital to enable companies to develop and grow.[46] We were also told that many UK institutional investors had withdrawn from the UK stock markets, Katie Potts of Herald Investment Management Ltd, stated:

> pension fund and insurance companies at their peak in 1994 owned about 60% of the UK stock market. They have now withered to less than 20%, and they have been replaced by overseas investors, who do not look at smaller companies and do not care about early stage companies. That degree of shrinkage means cash outflow. [...] It makes me weep having gone through the risk phase and then finding that foreign companies buy them too cheaply.[47]

32. In her written evidence she had explained the reasons for this change:

> These institutions were professional long-term stable investors, with good corporate governance skills who controlled executive remuneration etc. It is a tragic and devastating unintended consequence of the abolition of ACT relief, combined with the rising liabilities for defined benefit pension schemes as life expectancy has grown, and investment returns have diminished. The accounting requirement to disclose these liabilities with valuation methodologies which discourages equity investing has been the final death knell, which has led to the disappearance of institutional investors on the registers of our investee companies.[48]

33. The CBI, *Future Champions*, report highlighted the difficulty of medium sized companies in the UK accessing a functioning bond market such as those found in Germany and the US, which further accentuates the lack of capital to technology companies. The report stated:

> Many large firms have found that issuing debt either through a private placement or through public bond markets, has a number of advantages; they can make a return on investment over long time periods and choose investors that share in their objectives, all without reducing the equity stake of existing shareholders.[49]

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[44] Q 56 [Katie Potts]

[45] Q 218 [Tim Crocker]

[46] BIS, "The Kay review of UK equity markets and long-term decision making", July 2012 http://www.bis.gov.uk/assets/biscore/business-law/docs/k/12-917-kay-review-of-equity-markets-final-report.pdf

[47] Q 56 [Katie Potts]

[48] Ev 201, para 1(i)

[49] "Future Champions", CBI, October 2011

34. Stephen Welton of the Business Growth Fund also highlighted the importance of medium sized businesses:

> I think the fact you can raise money for businesses that are more mature in and of itself is not a bad thing. What we want to do is expand the number of growing medium-size companies. Based on the research we have done, there are 5,000 companies currently in the UK turning over between 2.5 million and 100 million, growing in excess of 10% per annum.[50]
>
> They are not growing at 50% compound per annum, but they have grown well. These are the businesses which can go from 2.5 million, 5 million, 10 million to 20 million. The economic effects of that are dramatic in terms of employment, tax revenues and everything else, but that market needs funding from investors and banks.[51]

Non-equity based capital

35. Not least because of the concerns over ownership which are noted above, public sector grant funding (UK and EU), which does not require any loss of equity, is an enticing prospect for small technology companies. Its disadvantage is that it is often highly bureaucratic to apply for[52] and, in some cases, highly competitive and only enough to "get an idea off the ground".[53]

36. Another non-equity option could be a loan from a bank. The Government has schemes to encourage bank lending to business, for example the 'Enterprise Finance Guarantee' scheme[54] and, under the Merlin agreement,[55] banks have pledged to proactively support, and invest in, small businesses. Early in 2012 Government provided banks with £20 billion at low rates of interest for the National Loan Guarantee Scheme[56] so that they could provide small businesses with loans up to one percent cheaper[57] than they might otherwise be offered.[58] However we heard that banks were requiring entrepreneurs to provide security to obtain these loans. For example Dr Worswick, Chairman, Cobalt Light Systems, stated that:

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[50] The witness later stated that there are 4,000 companies currently in the UK turning over between 2.5 million and 100 million, growing in excess of 10% per annum.

[51] Q 59 [Stephen Welton]

[52] Qq 81-2

[53] Ev 173, para 37

[54] A bank loan where the government guarantees 75% to the bank. http://www.bis.gov.uk/efg

[55] An accord between the UK Government and the major UK banks – specifically Barclays, HSBC, LBG and RBS, and Santander – in which the banks explicitly recognised their responsibility to support economic recovery, not least in providing finance to small and medium sized enterprises through the creation of the Business Growth Fund and other direct lending.
http://www.hm-treasury.gov.uk/d/bank_agreement_090211.pdf

[56] HM Treasury website, "National Loan Guarantee Scheme", http://www.hm-treasury.gov.uk/nlgs

[57] The delivery of the 1 percentage point discount may also vary between banks as some offer a reduced interest rate over a number of years, whereas others may offer the discount as an up-front cash payment.

[58] "Chancellor launches scheme to boost small business lending" HM Treasury press notice, 19 March 2012

> We approached HSBC, with whom I had had a very long and excellent relationship, under the Government loan guarantee scheme. We wanted to borrow £400,000 for working capital on a specific project. It took a fair amount of time but that is okay; they had due diligence and so on. Remember that 75% of that—£300,000—was covered by Government guarantees. They then turned round and said, "Well, the directors of the company will have to warrant the other £100,000."[59]

In some cases, the only security available may be a family home. The Minister recognised that banks had become bad at lending where there were no assets such as a house to guarantee a loan. He did point out however that under the Enterprise Finance Guarantee Scheme conditions "lenders must not take a charge on the principal private property".[60]

37. Matthew Bullock was head of Barclay's technology financing team in Cambridge for ten years. He told us it was possible for banks to fund technology innovation:

> We provided bank finance in Barclays for the kind of venture I am talking about, not the one that was running very quickly towards product development and going down through the negative loop. We lent very consistently. We had a loss rate of one sixth of the bank's average over a 10-year period, and basically it was a very good business. We rotated our finance because basically we were providing working capital finance against contract payments from creditworthy customers who we were satisfied would be very sound debtors. We had to monitor things very closely, which we did, but it was basically quite good business for banking.[61]

38. We were encouraged that there might be a remedy for some of these problems in the near future. While we were inquiring into this issue, Rt Hon Vince Cable MP, the Secretary of State for Business, Innovation and Skills, announced that a bank for business will be established within the next 18 months. This was confirmed by the Chancellor of the Exchequer in the Autumn Statement[62] but details of how this bank will be constituted or operate are not expected until spring 2013.

39. **We are concerned that our small companies are too often bought up by larger overseas companies before they can develop into the medium sized enterprises that would produce substantial jobs and wealth in the UK. We are convinced that while equity investments have a place, too many companies are forced into over-reliance on this route because other types of funding are unavailable. *We recommend that the proposed bank for business, possibly in partnership with the Business Growth Fund, be used to promote a bond market for medium sized businesses, thus providing growing small businesses with an additional source of funding.***

40. **We have concerns that regulation to de-risk pension and insurance funds has had the effect of starving technology companies of a source of long term patient capital. There is a need to deploy these funds more usefully. *We recommend that the***

[59] Q 84 [Dr Worswick]

[60] Q 308

[61] Q 53 [Matthew Bullock]

[62] HC Deb, 5 December 2012, c880

Government investigate the potential to require funds to have a proportion of European SME equities.

41. Lloyds Banking Group run a scheme where senior staff attend a Warwick based engineering course designed to help them make better decisions on financial risk by giving them a better understanding of some emerging technologies.[63] ***We recommend that the bank for business adopts such an approach for its staff from the outset.***

42. **The bank for business announced by the Government may provide a useful go-between for institutional investors and technology businesses.** ***We urge the Government proactively to seek to develop not only the market in technology equities but to ensure that the market has ready access to information that may change the perception of these equities and their relative risk and create mechanisms, such as the Lloyds scheme, to help fund managers understand evolving technologies. However, reporting requirements and other costly regulatory burdens on UK-based listed companies, especially in the AIM market, should be kept to a 'fit for purpose' minimum.***

43. The development of companies may not be linear but it is important that, at whatever stage a company finds itself, there is an obvious next investment step to take. If the investment ladder is not complete then companies may take development steps at inappropriate times. For example, Birmingham University pointed out that without access to proof of concept funds, universities may establish companies too early in order to qualify for SMART.[64]

44. The Wellcome Trust was concerned that

> the Government's ambition for university knowledge exchange income from external sources to grow by 10 per cent over the next three years [...] will encourage universities to see their interactions with businesses within a context of short-term revenue generation, rather than sharing knowledge for longer-term public benefit. It may dissuade them from seeking out local partnerships that will create jobs and see intellectual property retained within the UK, if greater profit can be made from licensing technology internationally.

45. ***We recommend that the Government re-examine their portfolio of interventions to determine where gaps may lie and to ensure there is a consistent spread of funding across the spectrum of business need. It is important that government funding fits the needs of growing companies rather than company growth having to adapt to gain government funding. It is also important to ensure that the incentives from Government tend towards greater growth and retention of jobs and wealth creation in the UK.***

Getting access to the necessary technology

46. The successful commercialisation of research requires parallel efforts to develop manufacturing technologies. Professor Bill O'Neill, University of Cambridge, stated:

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[63] Personal communication, Head Office, Lloyds Baking Group.

[64] Ev w49, para 1.4

> Translational research and development has been widely recognised as of vital importance to ensuring that the UK gains a wealth creation dividend from investment in science. However, the importance of parallel research and development in the supportive manufacturing sphere has, until recently, received less attention.
>
> [...]
>
> For some inventions, for instance in the material sciences, manufacturability has remained a constraining challenge for years after the invention's market potential has been recognised. These, wasteful, fallow years could have been foreshortened if the manufacturing research and development effort had been mobilised sooner.[65]

47. Rolls Royce identified a need for national manufacturing infrastructure that could support pre-production R&D:

> Our overseas competitors benefit significantly from access to rigs and facilities in National research centres which are funded and maintained at the state-of-the art out of the public purse (e.g. NASA in the USA, DLR in Germany, ONERA in France). In the UK, such facilities have largely been privatised. It is no surprise then that many of these facilities have been, or are being closed as they cannot be maintained as a commercial operation, or else face under-investment so that they become uncompetitive. Such facilities are essential to take technology through the TRLs 4, 5 and 6. [66]

As example, Rolls Royce pointed to the lack of a UK engine altitude test facility, the repeated threat of closure of the Noise Research Centre in QinetiQ and the difficulty the Aircraft Research Centre in Bedford has faced in seeking to modernise facilities. [67]

48. Dr Eoin Sullivan of the Centre for Science, Technology and Innovation Policy at the University of Cambridge wrote of the importance of manufacturing requirements:

> Public science and engineering research programmes typically focus on building one technology artefact to demonstrate innovation/technology; but lack resources to address risks in maturing manufacturing processes. [68]

The following graphic was produced, by Dr O'Sullivan,[69] to demonstrate the close relationship required between a developing technology and the manufacturing capability necessary for its eventual commercial production.

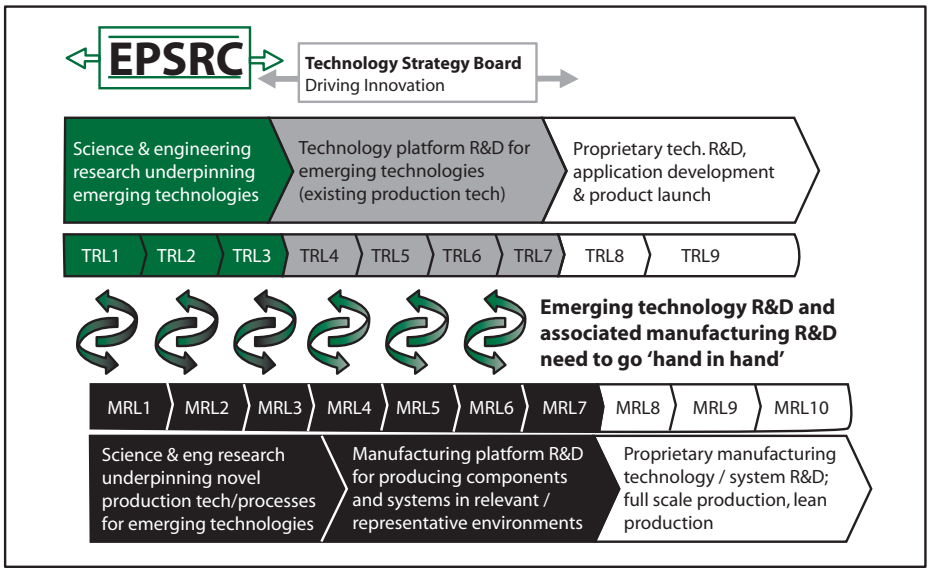
[65] Professor William O'Neill

[66] Ev 184, para 1.11

[67] *Ibid.*

[68] E.O'Sullivan, "Manufacturing Uncertainty and the Valley of Death", CSTI Briefing Note, 2012

[69] E.O'Sullivan, "Manufacturing Uncertainty and the Valley of Death", CSTI Briefing Note, 2012



Schematic illustrating the interdependency of technological and manufacturing research.

49. Engineering the Future hoped that the Catapult centres[70] and Local Enterprise Partnerships could "effectively reduce investment capital requirements for companies entering certain markets by offering open access prototyping, scale-up and demonstration facilities".[71] The University of Birmingham believed the key to the catapults contributing in this way lay in "how "open access" these facilities will actually be and/or what funding streams will be available to enable such access".[72] The Royal Society for Chemistry wrote:

> Access to facilities could be improved by providing funding to small and medium enterprises (SMEs) to use the new facilities. A good model was the funding offered for the Industrial Biotechnology pilot plant facilities at the Centre for Process Innovation and this should be replicated for other centres part of the HVM Catapult[73]

50. Dr Ruth Mallors, Director of the Aerospace, Aviation and Defence Knowledge Transfer Network, told us that "there are lots of facilities in [the university sector], but there is not an overarching understanding of what bits we need nationally to create a national capability".[74] She added that an "overarching strategy and facility approach is not there, particularly for industries where physical and virtual testing is so important because of safety and the regulatory environments. It is becoming an increasingly big issue for those sectors".[75] We heard of other examples of facilities that could provide the basis of a national infrastructure. Examples include the Open Innovation campus in Stevenage in the biosciences,[76] the National Physical Laboratory in Teddington and the Rutherford Appleton Laboratory in Didcot.

[70] Catapults centres are government funded networks of academics and businesses focussed on technological innovation in particular technology sectors.

[71] Ev 165, para 1.3

[72] Ev w52, para 5.4

[73] Ev w82, para 26

[74] Q 203

[75] *Ibid.*

[76] Ev 194, para 4.3

51. ***We share the concerns of our witnesses that the UK small business sector lacks access to large scale test and experimental production facilities. We recommend the Government to find a way to ensure that those facilities that do exist can be more readily accessed by business, that gaps in requirements are identified and a fund established to subsidise those facilities that cannot afford to remain at the leading edge in a purely commercial environment.***

52. ***We urge the Government, when looking at the issue of production facilities, to ensure that the Technology Strategy Board and other commercialisation activities address whether projects are properly supported in issues of manufacturing capability.***

Creating the right environment

Incentivising R&D activity

53. The key government support for companies investing in research and development is the R&D tax credit which provided "over £1 billion of support [...] through the Small and Large Companies schemes in 2009–10".[77]

54. Research carried out by HM Revenue and Customs in November 2010 showed that between 2003 and 2008 the tax credit successfully encouraged business expenditure in research and development (BERD) to grow from £11.33 billion to £14.99 billion while the amount of that spending used to claim tax credits grew from 50% to 72% of R&D expenditure.[78] Interesting features of the analysis within the report were that the main sectors claiming the credit were Real estate, Renting and Business activities (36% in 2007–08, 40% in 2008–09) and Manufacturing (31% in 2007–08, 40% in 2008–09);[79] and that over the period 2004–05 to 2008–09 'high tech' accounts for "two thirds of SME claims accounting for over 90% of the tax cost" (the corresponding figures for large company 'high tech' claims are 42% and 74%).[80] A key feature was that 80% of the tax credit was claimed by large rather than small and medium sized businesses:

> For 2008–09, the most recent year for which figures are complete, 6,600 SMEs made claims averaging £40k each, whereas 2,190 large companies made average claims of £328k.[81]

55. Prior to the 2010 General Election, the Conservative Party commissioned James Dyson to develop proposals to make Britain the leader in Europe for hi-tech exports. He recommended that the tax credit be refocused on "high tech companies, small businesses and new start-ups in order to stimulate a new wave of technology".[82] Greater support for

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[77] Ev 96, para 13

[78] HMRC, "HMRC Research Report 107 - An Evaluation of Research and Development Tax Credits", November 2010, Table 4

[79] HMRC, "HMRC Research Report 107 - An Evaluation of Research and Development Tax Credits", November 2010, Figures 5 and 6

[80] HMRC, "HMRC Research Report 107 - An Evaluation of Research and Development Tax Credits", November 2010, p6

[81] HMRC, "HMRC Research Report 107 - An Evaluation of Research and Development Tax Credits", November 2010, p5

[82] "Ingenious Britain: Making the UK the leading high tech exporter in Europe", James Dyson, March 2010 http://www.dodsmonitoring.com/downloads/Misc_Files/Ingenious_Britain_Support.pdf

SMEs was a feature of many responses to this inquiry particularly from industry and trade associations.[83]

56. In oral evidence, Sir Peter Williams and Sir David Cooksey, both of whom participated in the working group that first recommended the tax credit to the Treasury,[84] advocated a greater refocusing of the credit to SMEs:

> I have to say that, reflecting today, 10 or more years on, that scheme has been highly effective with SMEs. Can we have some more, please? It probably has not conditioned behaviour in R and D of larger companies. They willingly bank the cheques. It is always good news. I sat on the boards of two major plcs who received considerable R and D tax credits during my time as an [non-executive director]. I do not think you are moving the needle with big companies, but, boy, are you moving the needle with smaller companies.[85]

Both Sir Peter and Sir David appeared before our predecessor Committee in 1998 subsequent to the publication of their report to the Treasury. At that time they spoke of the measure as a way of encouraging the growth of smaller businesses by helping them stretch the value of their capital:

> in most of these companies, anything up to 70 or 80 per cent of their total expenditure in the early phase is on research and development in one form or another. If you are able to offset this expenditure as a tax credit which could accrue within the company against taxable income paid elsewhere, then that would be extremely helpful because it would just make that investment last that much longer[86]

Sir Peter was certain that the tax credits could do more to help emerging technology based companies if they were better focussed on smaller companies, possibly with some reallocation from larger companies.[87]

[83] Ev w110, para 18

[84] HM Treasury, "Financing of High Technology Businesses", November 1998 http://archive.treasury.gov.uk/pub/html/docs/fhtb.pdf

[85] Q 98

[86] Q 631, House of Commons Science and Technology Committee, Second Report of 1999-2000, HC 195, "Engineering and physical sciences based innovation", 9 February 2000

[87] Q 100 [Sir Peter Williams]

57. HMRC published an assessment in November 2010 which showed the various impacts of the tax depending on the nature of the company. Data from Table 2 in the document, Effect of tax credits and grants for R&D,[88] is reproduced below. It demonstrates very different responses to the R&D tax credit between a range of firm sizes:

	R&D tax credits
One person, one product	May not claim
Small research-based business	Useful bonus may increase amount of R&D conducted
Established SME, suite of products	Regular claims good for cashflow May increase amount of R&D conducted
High tech, high ambition	Nice to have, but not factored in to decisions
Large company, separate R&D function	Political statement of support for R&D in UK Little direct impact on amount of R&D

58. During 2011 the Government consulted twice on R&D tax credits. In response to the first consultation the Government indicated that it did not intend to refocus the tax to high technology firms along the lines of the Dyson report but it did introduce a range of measures to increase the benefits to SMEs.[89]

59. **The Government indicated that it would not follow the James Dyson report recommendations that the tax credit should be refocused on high technology sectors or on small and start-up companies. The R&D tax credit has been successful in increasing spend by business on research and development but this has, mostly, been within larger companies.** ***We recommend that the Government identify the reasons why R&D spend still appears to be drifting away from the UK despite the benefits enjoyed by larger companies. We also believe that there needs to be a mechanism to support SME's who do disproportionately badly from the current scheme.***

60. A number of submissions highlighted the need to develop more medium sized companies. The SET Squared partnership indicated that "One of the biggest problems facing the UK economy is its relative inability to develop and retain mid-sized high growth companies".[90] Cambridge Enterprise Ltd stated that "if retaining and developing such companies in the UK are objectives, they would be assisted by a consistent national strategy to develop companies beyond the early stage".[91] Mark A Phillips, first Chairman of BRITEST Ltd and a visiting professor at Leeds University Business School, highlighted a potential problem that a lack of medium sized companies might cause:

> In fields like high precision engineering and robotics the UK appears to lack companies of sufficient scale to engage in major manufacturing development

[88] HMRC, "Qualitative research into businesses' Research and Development (R&D) decision-making processes", November 2010 http://www.hmrc.gov.uk/research/report101.pdf

[89] HM Treasury, "Research and Development tax credits: response and further consultation", June 2011 http://www.hm-treasury.gov.uk/d/consult_r_d_tax_credits.pdf

[90] Ev w174, para 3.6

[91] Ev w19, para 5

> programmes and we have had to look to Europe and the Far East to provide partners with the required capability.[92]

61. **We conclude that the Government needs to distinguish in its innovation policy between small and medium enterprises: a single SME category is too broad.**

62. Engineering the Future and the University College of London both welcomed the Government's action to exempt universities from VAT on shared services and that such action was "a strong signal of support from government". However the Wellcome Trust raised an issue in relation to the Francis Crick Institute: [93]

> zero rating for new charitable buildings can only be retained if the building is used 95% for non-business charitable purposes. In the case of the Francis Crick Institute, this will restrict the ability to conduct on-site technology transfer and commercialisation activities.[94]

This was expanded upon on our visit to the Advanced Manufacturing Research Centre in Sheffield and subsequently detailed in writing. [95] A recent change in VAT rules meant that it imposed an additional cost on the "construction, equipment and running costs" of their Knowledge Transfer Centre and AMI Training Centre that can only be recouped by increasing the cost of apprenticeship fees to those companies seeking to train their future staff.

63. ***We recommend that the Government address the issue of VAT and how it might ensure that VAT rules allow academic teaching and research to sit alongside commercial and incubation activities within public or charitably funded laboratories and research centres without creating a financial burden for the institute.***

Regulation

64. On its website the Department for Business, Innovation and Skills says:

> Cutting red tape and improving our regulation and policies is a key priority for BIS. We aim where appropriate, for a light-touch regulatory environment, with less red tape and burdens on business, whilst protecting the public, consumers and employees.[96]

65. We were provided with several examples of regulation in the bio-pharma sector impeding product innovation. David Cooksey told us that, even in the USA, it was simpler and cheaper to conduct in-human trials:

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[92] Ev w21, para 3

[93] The Francis Crick Institute is a partnership between the Medical Research Council (MRC), Cancer Research UK, the Wellcome Trust, UCL (University College London), Imperial College London and King's College London. It is envisaged that the Institute will combine the specialist knowledge, expertise and resources from each of these organisations to encourage ground-breaking research, help make sure that laboratory discoveries are turned into treatments as quickly as possible, keeping the UK at the forefront of innovation in medical research, attracting high-value investment and strengthening the economy.

[94] Ev 135, para 16

[95] VAT Officer, AMRC

[96] http://www.bis.gov.uk/policies/better-regulation-at-bis

> The sheer cost, bureaucracy and difficulty of getting that done in this country means that, of the portfolio of companies that I have been involved with, probably more than 75% of them have given up in this country and have gone to do their trials in Philadelphia, Boston or North Carolina, because they can get it done quicker and cheaper and with a system that delivers more coherent results.[97]

This was supported by evidence from Action on Hearing Loss:

> Hearing research that does take place in the UK can be undermined by an overly complex regulatory and governance environment. An Action on Hearing Loss-funded project, investigating genetic predisposition to hearing loss caused by a specific class of antibiotic often used to treat life threatening infections in premature babies, has been held up for over two years due to the complicated bureaucracy involved in conducting clinical research at multiple sites in the UK and the lack of support to help researchers navigate the regulatory process.[98]

Action on Hearing Loss already sent the majority of their research overseas, mostly due to a lack of appropriate research capacity; a trend that is not likely to be reversed in the face of a difficult regulatory system.[99]

66. The British Society of Plant Breeders were concerned that regulation surrounding GM was so difficult that procedures that might be classed as GM were avoided.[100] The Aerospace, Aviation & Defence Knowledge Transfer Network highlighted the difficulties of innovating in a highly regulated environment such as aerospace when the regulations are complex and fragmented,[101] LGC[102]pointed to regulation as a barrier to the introduction of innovative procedures.[103] Rees Ward, Chief Executive Officer, ADS,[104] indicated that better information from Government could help industries working in highly regulated sectors:

> Different sectors require slightly different approaches here, but the broad picture is that we need to understand in highly regulated and government dominated sectors where the government wants to go in the long term[105]

67. Tim Crocker of the SME Innovation Alliance believed that not only did the regulatory burden fall more heavily on smaller businesses, it also added to the liabilities of doing business:

> If I want goods signed off for sale in this country, I end up signing the certificate of compliance. If I go to a German test house, the test engineer, who is an employee of the German state, signs it off. That is a massive liability difference.

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[97] Q 115

[98] Ev w73, para 24

[99] Ev w73, para 23

[100] Ev 132, para 6

[101] Ev 131, para 2.1

[102] Formally the Laboratory for Government Chemist now a private forensics company

[103] Ev w106, para 5.1

[104] ADS is the trade organisation advancing the UK Aerospace, Defence, Security and Space industries.

[105] Q 179 [Rees Ward]

68. The CBI also raised the issue of regulation, noting that intelligent regulation could drive innovation as long as companies were provided with certainty. This could be accomplished if the Government was able to:

- Inform businesses of future planned changes in the regulatory environment, allowing time to plan and comply with new rules
- Provide a degree of flexibility in how regulations could be met
- Provide clarity in requirements and ensure new rules were not open to misinterpretation
- Ensure poor regulations were dealt with effectively and that additional burdens or conflicts were not placed on business by overlapping or multiple layers of regulation.[106]

69. Iain Gray, Chief Executive, TSB, maintained that, in Germany, standards were used to drive innovation rather than being an inhibitory factor and that, "There are a lot of non-financial ways in which [the TSB] can help business".[107] The Minister indicated that he was open to exploring options that might reduce burdens on small businesses:

> We have flagged an issue that we should do more work on to try to understand this German system, though as I say, we are not necessarily sure that the earlier evidence absolutely matches our understanding of how it works. But we will undertake to look into it further.[108]

The Government, in 2011, published an independent review on how the impact of health and safety regulation might on business might be reduced "maintaining the progress that has been made in health and safety outcomes".[109]

70. ***Poor regulation adds to the risk burden of entrepreneurs. We welcome the proactive response of the Minister on the issue raised in evidence to us and recommend the TSB to undertake a review of regulatory burdens on technological innovation in the UK. This review should be consistent with the advice to Government by Professor Ragnar Lofstedt on Health & Safety matters but should not include just a list of regulatory burdens in need of reform but a roadmap of how that reform might be used to drive innovation and which institutions should take the lead.***

Intellectual property

71. Innovators often have an unrealistic expectation of the worth of their IP; the BioIndustry Association identified a problem with university technology transfer offices and businesses having different perceptions of the value of intellectual property:

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[106] Ev 151, para 13

[107] Q 265 [Iain Gray]

[108] Q 286

[109] "Reclaiming health and safety for all: An independent review of health and safety legislation", Professor Ragnar E Löfstedt, November 2011, Cm 8219

> Research conducted by the Advanced Institute of Management Research (AIMR) and Imperial College Business School showed that between 2004 and 2008 an increasing number of firms reported a range of problems that they consider barriers to greater collaboration with [Technology Transfer Offices] including a perceived lack of realistic expectations.[110]

The Royal Society of Edinburgh underlined the problem:

> There is a common perception among industry and investors that universities can be unrealistic in negotiating terms on the transfer of IP, often expecting large percentage returns even where IP is not assigned but exclusive licence granted. In a company's early years, when cash flow is often a make-or-break issue, heavy repayments to the university in the form of licence payments or wage costs for academics involved, can be a significant factor in the success or failure of commercialisation.[111]

The Minister was aware of this issue:

> One thing that does concern me is that perhaps in the past there was a kind of target culture when notching up patents was the priority, especially as universities and researchers do sometimes exaggerate the starting value of their discovery and underestimate the value added by the commercial development of the discovery. Sometimes you can have a dialogue of the deaf in a negotiation where the university sits and thinks it has high value for the IP they have, whereas the commercial entrepreneur thinks that is exaggerated. There are areas where we can improve here.[112]

72. Patent laws were introduced to encourage inventors to put their ideas into the public domain by providing them with a period in which they would have a monopoly on benefits from the use of that technology. It is commonly believed that patents prevent others from using the technology but in fact it only provides an inventor with a right to take legal action against a third party whom they believe has used the technology. The onus is on the patent holder to prove the breach: a patent holder must be aware that a breach has occurred and have sufficient funds to take the matter to court. Small technology companies can find it difficult to protect their IP. Tim Crocker, SME Innovation Alliance, stated that:

> you cannot exercise the rights of those patents unless maybe you have got a fighting fund of half a million quid; and that would be a minimum sort of fighting fund, as lawyers would advise you. [...] if you are a £20 million-worth company [you] can't continually fight half-a-million quid battles to enforce your commercial rights.[113]

[110] Ev w112, para 41

[111] Ev w40, para 28

[112] Q 309

[113] Q 219 [Tim Crocker]

73. The result is that the easiest way for a small technology company to realise the value of a patent is probably to sell the patent, or the company, to a larger competitor rather than attempt to exploit a technology they could not afford to protect.[114]

74. The Minister acknowledged that a problem existed for smaller companies. He was not aware of any Government initiative to address it,[115] though he did indicate actions taken to alleviate some aspects of the current system:

> There has been some improvement in the Patents County Court. In terms of companies getting protection through law, we have tried to lower the costs for them of protecting their patents through the legal system. We have also tried to help provide alternatives to court action, including hearings before the [Intellectual Property Office] tribunal or using the [Intellectual Property Office's] mediation and patent opinion services.[116]

The Intellectual Property Office (IPO) offers a mediation service "to help companies and individuals involved in intellectual property (IP) disputes" covering all intellectual property, "unregistered copyright and design rights, as well as registered rights such as patents, trademarks and registered designs".[117] There is however no requirement for companies to use mediation nor a compulsion to abide by any ruling of a mediator.

75. We note that the Business, Innovation and Skills Committee in its report *The Hargreaves Review of Intellectual Property: Where next?* stated that the needs of SMEs in the area of intellectual property was

> an important area to address to support growth in the economy and we recommend that in its Response to this Report the Government set out in detail its commitment to this service in terms of money and resources.[118]

While the Government did not set out any detail in its response it said that "Ensuring that these businesses, which make up 99% of UK enterprises and nearly 60% of UK employment, can maximise the value of their intellectual property assets is key to economic growth".[119]

76. ***We judge that the IPO mediation service could be more heavily used to arbitrate in matters of intellectual property. We recommend that the Government require the use of mediation before any legal action can be taken in a UK court, both speeding up the resolution of disputes and reducing the costs of protecting intellectual property. We also recommend that refusal to engage in mediation be taken into account in awarding costs.***

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[114] Q 219 [Tim Crocker]

[115] Q 318

[116] Q 319

[117] http://www.ipo.gov.uk/ipenforce/ipenforce-dispute/ipenforce-mediation/ipenforce-mediation-ourservice.htm

[118] Business, Innovation and Skills Committee, "*The Hargreaves Review of Intellectual Property: Where next?*", First Report of Session 2012–13, HC 367, 27 June 2012

[119] Business, Innovation and Skills Committee, "*The Hargreaves Review of Intellectual Property: Where next? - Government Response to the Committee's 1st Report of Session 2012–13*", Third Special Report of Session 2012–13, HC 579, 4 September 2012

77. It is unsurprising that universities generate intellectual property. Academic research is ideally placed to discover or stumble across innovative materials or behaviour that may prove commercially viable. HEFCE estimated that 19% of patent filings in the UK came from university sources.[120] The Government has encouraged universities to exploit this resource and several sources of funding have been developed to facilitate exploitation of university IP.[121] The Higher Education Innovation Fund (HEIF), provided by HEFCE[122] for the purposes of knowledge exchange, was popular among those universities that wrote to us as was the recent Government move to focus the HEIF more closely on universities where there has been greater success in translating IP into business opportunities.[123]

78. We heard of cases where universities had been reluctant to patent innovations discovered by academics. Dr Peter Dean, Founder and Chairman, Cambio Ltd, gave us an example of university technology failing to translate into UK wealth creation due to patent issues:

> We produced a patent [to do with diabetic management], which the university did not support financially in any way. The company involved, which was Canadian, suggested that they take all the patent costs and run the patent for us, which was fine. At the end of six months they pulled out; they said they had changed their objectives and were doing something else. As a result, the University of Liverpool was asked to support the patent through its foreign filings and whatever. It refused to do that, and the patent was sold to the USA for a pittance. The USA completed the patent. There are 283 million diabetics in the world. That University of Liverpool test is used pretty much throughout the world, but there is no royalty coming to this country because of the failure to strategise the patent process.[124]

79. Patents are only useful if they are exploited. We were told by Trevor Francis, Technical Director, Byotrol Technology Ltd, that universities, due to the expense of maintaining IP, may allow their patents to lapse with the consequence that the intellectual property "simply passes into the public domain instead of potentially passing to companies that could equally use that patent for knowledge and exploit it".[125]

80. Professor Nick Wright told us that some universities have, as a result begun an experiment in easy access IP:

> several members of the Russell Group universities banded together into what is called the Easy Access IP consortium. That is quite an innovative arrangement created by Steve Beaumont, a very forward-thinking guy, at the University of Glasgow. It is a system whereby UK companies can access IP from member universities for free, provided it is to the benefit of the UK. That is an excellent scheme. There are other schemes. In the north-east, we have a similar scheme,

[120] Ev 140, para 27

[121] Ev 99-100, paras 28-37

[122] Higher Education Funding Council for England

[123] For example, Ev 162, para 1.5

[124] Q 77 [Dr Peter Dean]

[125] Q 77 [Dr Francis]

> allowing collaborative working between Newcastle and Durham universities, for example.[126]

Rolls Royce warned of broader access to open data that might also have relevance to easy access IP:

> Proposals [...] for increasingly 'Open Data' must be implemented with great care. If such proposals help all companies access the mass of data in the public domain more effectively and free up Government-owned data for easier access, they are to be welcomed. However, if they make it easier for our overseas competitors to access and exploit the research base in the UK, especially those elements where UK companies, like our own, have made a significant contributions, then, far from promoting growth in the UK, they could be severely damaging our competiveness.[127]

81. ***We recommend that the Government assess the benefits of the Easy Access IP experiment and whether it improves the flow of IP not just between universities but into wealth creation activities within the UK.***

82. ***We understand the intent behind changes to HEIF that further reward institutions that have already benefitted from successfully commercialising their IP. We have concerns that IP transfer from universities that have been less successful in commercialising their IP may decrease further. We recommend that the Government review the situation after three years and publish a report on how the changes have contributed to increased IP transfer, job creation and related social benefits.***

Evidence based policy

83. It is important that Government policy, where possible, should be based on robust evidence and where that evidence may not exist that processes are in place to gather evidence of how any policy is performing. Dr David Connell, University of Cambridge, criticised the nature of information produced by government on innovation spending and policy:

> If we look across Government organisations involved in technology, rather than providing annual reports in the format that you would see from a public company, they tend to produce brochures with examples of what they are doing at the time. It would be really good to know where the money went, actually, and to see some proper reporting to the kind of standards that we should demand.[128]

84. Dr Paul Nightingale, University of Sussex, made a similar point:

> In terms of commercialisation, the UK is very good compared with the rest of Europe, with the possible exception of Scandinavia. There is an issue about relative amounts of GDP that we spend on university research. [...] The key issue is that we

[126] Q 165 [Professor Nick Wright]

[127] Ev 187, para 5.9

[128] Q 19 [David Connell]

> need proper evaluation of these schemes. We really don't know what works. It is very complicated right now and this has been a problem.[129]

Matthew Bullock highlighted the absence of information on activity by soft start companies:

> An important point to make is that the development of technology products and equipment on contract—what the great, soft majority of smaller technology companies do—does not appear anywhere in the R&D statistics: the activity does not conform to the Frascati definition used by BIS/ONS to measure R&D activity; for the small supplier the activity is recorded as sales; and in their large customer's accounts it may appear as capital expenditure or revenue expense. The Frascati definition requires the activity to be speculative, without a firm sale in prospect[130]

85. The R&D Scoreboard was an information resource produced annually by the Department for Business Innovation and Skills. The Scoreboard provided an overview of spending on research and development by private companies. In 2010, the foreword to the Scoreboard indicated that, due to financial considerations, it was to be discontinued. Engineering the Future told us:

> It is regrettable that BIS chose to withdraw funding from the well respected and widely used R&D Scoreboard in 2010. As a measurement of innovation, knowing the amounts of funding is of limited use, but without the Scoreboard there is no way of comparing R&D spend across the full range of industry sectors.[131]

The UK Deans of Science were concerned about evaluation and stated:

> [Government] has also decided to stop funding the excellent R&D Investment Scoreboard so will have almost no robust way of judging the success or failure of any of its policies.[132]

86. We also heard that, between 1991 and 2004, the Bank of England monitored the availability of finance to small and medium sized enterprises (SMEs).[133] Their role was to identify any areas where access to appropriate finance seemed problematic, to investigate and highlight those issues with key stakeholders and to encourage them to find solutions, if any were needed. This work led to the publication of a series of reports and articles including a regular annual report on finance for small firms.

87. ***We consider that the R&D Scoreboard was a useful and widely respected source of information for technology businesses and we recommend that the Government should reinstate it. We also recommend that the Bank of England should resume their monitoring activity on the availability of finance to SMEs.***

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[129] Q 18 [Dr Nightingale]

[130] Ev196

[131] Ev 167, para 5.3

[132] Ev 125, para 20

[133] Ev w58, para 23

3 Connecting science with industry

88. The importance of the university sector in attracting inward investment by business was made clear to us on several occasions.[134] BP, in its evidence to us, highlighted the value of academic research and development to where they site their own research and development activity:

> BP spends 40% of its total research & development funds in the UK and has three major research centres in Sunbury, Pangbourne and Hull. The excellence of UK academic research is a key factor in determining why companies like BP choose to site their R&D activities in the UK.[135]

A fundamental ambition of UK innovation policy is to connect the science base and industry. In this chapter we explore the Government's innovation agency, the Technology Strategy Board (TSB) and how the university sector is encouraged to facilitate and advance innovation policy.

Technology Strategy Board

89. "The TSB is the Government's prime channel of support for business-led technology innovation".[136] The TSB describes its work and role on its website:

> Our role is to stimulate technology-enabled innovation in the areas which offer the greatest scope for boosting UK growth and productivity. We promote, support and invest in technology research, development and commercialisation. We spread knowledge, bringing people together to solve problems or make new advances.
>
> We advise Government on how to remove barriers to innovation and accelerate the exploitation of new technologies. And we work in areas where there is a clear potential business benefit, helping today's emerging technologies become the growth sectors of tomorrow.[137]

Funding

90. Sir Peter Williams, Treasurer of the Royal Society and Chair of the National Physical Laboratory, was concerned the TSB would not have sufficient funding to achieve what was expected of it, stating, "you can never have too much money in this sector. [The TSB] is small by comparison with, if you like, the private equity players in this space, and, therefore, being brutal about it, its impact will be commensurately small if we are not careful".[138]

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[134] For example Q 24, Q 111, Q 241

[135] Ev w101, para 4

[136] Ev 101, para 41

[137] http://www.innovateuk.org/aboutus.ashx

[138] Q 130

91. Rolls Royce also questioned whether the TSB was adequately resourced even to operate its core remit of funding collaborative research:

> The TSB has developed efficient mechanisms for supporting collaborative research. Their funding, at just over £300m p.a. is, however, inadequate for the task in hand.
>
> The Government is spending over £3.5bn on low TRL research, and cannot hope to adequately capture the benefits from this investment when spending so little on support through the valley of death. [139]

92. Iain Gray, Chief Executive of the TSB, did not think that the balance was correct.[140] Sir John Savill representing Research Councils UK was sympathetic to that view, though he was clear that any increase in the budget to commercialise should not be funded through a cut to the Science Budget.[141]

93. Evidence on the TSB uncovered a number of criticisms on small issues but, overwhelmingly, there was an appreciation for their work and their funding programmes and a consistent call for funding to be increased.[142] The key programmes are SMART Awards[143] and the SBRI.[144] Dr David Connell recommended a huge increase in SBRI funding[145] and Sir Peter Williams told us that the Government need to pick some winners and give them generous funding. He considered the SBRI a decent vehicle through which to do this but it would need more extensive funds than those envisaged by the Government.[146]

94. We examine the role of SBRI in relation to Government procurement in more detail later in this report.

95. SMART Awards are a key funding initiative for proof of concept work[147] and have been subject to strong competition; Rolls Royce told us that the competition for those awards indicated the strength of the technology marketplace. The University of Birmingham was concerned that the inability of universities to gain access to SMART Awards would push university spin-offs into commercialisation too early just to become eligible.[148] Although there are other sources of funding for proof of concept work,[149] the University of

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[139] Ev 183, para 1.6

[140] Q 241 [Iain Gray]

[141] Q 241 [Sir John Savill]

[142] For example Ev w154, para 14

[143] SMART awards are operated by the TSB to provide support for proof of concept and proof of market activities within businesses and universities. Companies can also seek support for the development of prototypes through this programme.

[144] The SBRI is operated by the TSB to enable technology-based SMEs to compete for contracts developing innovative solutions to public sector challenges, and has helped to support the commercialisation of new technologies in sectors such as healthcare, defence and electronics.

[145] Ev 119, para 6.1

[146] Q 9 [David Connell]

[147] Ev 96, para 13

[148] Ev w 49, para 1.4

[149] For example, Ev 100 and 102, paras 37 and 51

Bournemouth[150] and others[151] argued that the total amount was insufficient. The University of Edinburgh stated:

> The valley of death can be encountered at various stages of the commercialisation process, but is most often acutely felt in pre and early stage company formations where there are gaps between the early stage/proof of concept nature of the technology and the beginning of increased production and generation of significant revenues[152]

The Association of Independent Research and Technology Organisations (AIRTO) (V45) suggested that better proof of concept funding would encourage more equity funding by effectively reducing the risk of investment.[153]

96. ***We recommend the Technology Strategy Board examine the current provision of proof of concept funding to universities and small companies and report to Government a coherent view of the amounts of funding available along with a recommendation on whether there exists a shortfall of provision of these funds and whether a consolidation of provision into a single programme would be helpful.***

Effectiveness

97. We sought views on the Technology Strategy Board (TSB) and how effective its intervention was in stimulating innovation and helping companies across the valley of death. Many responses indicated that it was still too early to make that assessment.

98. Others, however, were critical. We received evidence suggesting that TSB funding might not suit small businesses,[154] public sector research organisations or research and technology organisations.[155] The SME Innovation Alliance recommended that the TSB stop "playing at 'Dragon's Den', themed competitions, timed 'calls' and [...] stick to funding projects quickly and simply on pure merit".[156] Plant Bioscience Ltd told us that "TSB funds are slow to obtain and involve far too much bureaucracy".[157] Sir Peter Williams was more challenging. He was supportive but had some concerns:

> I am a fan of the TSB in concept. In fact, in my SET and the City report, I single them out as being worthy of receiving more Government funding and having more clout and influence. I always fear in this country when things become centralised [...] that they become risk-averse at the same time. [...] if we are here criticising Government

[150] Ev w8, para 6,

[151] For example, Ev w18, para 3; Ev w47, para 2; Ev w70, para 6; and Ev w79, para 5

[152] Ev w10, introduction

[153] Ev w90, para 6.2

[154] Ev 128, para 23

[155] Ev w91, para 7.4

[156] Ev 129, para 32c

[157] Ev w69, para 4

> for becoming timid and the City for being risk-averse, we have got to show by what the TSB does that it is bold, brave and is not risk-averse. That is my only fear.[158]

99. His main criticism was that the "central executive did not have enough absolute power to just get on with the job". [159] Imperial Innovations told us that "within our company portfolio we have many examples where the TSB programs have been a great catalyst and shared risk method of facilitating small growing companies to collaborate on commercialisation with larger companies without having to give up early rights".[160]

100. **There is an evident need for an innovation agency in the UK and it makes greater sense to ensure the TSB and its schemes evolve to meet this need than create a new organisation. It also makes sense to concentrate the innovation function within a single agency to ensure there is coherence and consistency within the system. We support the current Government's approach to its innovation policy.**

101. One of the determinants of whether the TSB is effective will be the success of the Catapult system, a key policy intended to bring together SMEs with university based research and one we commended in our report *Technology Innovation Centres* in 2011. One measure of this success may be how involved smaller companies are with the Catapults and how regularly companies of that size, which have serious growth potential, access catapult facilities. [161]

102. However both Rolls Royce and ADS[162] warned us that pressure from Government for the Catapults to start earning revenue too quickly could potentially lead to a distortion of their priorities[163] and stifle the growth of their capabilities.[164]

103. **We consider it vital that the Catapults are made to work. We ask the Government to confirm to us that they will not seek to push the Catapults to generate revenue but instead allow them to grow slowly and organically with a focus on developing the necessary capabilities to support innovation.**

The need for local knowledge

104. We received mixed commentary on the loss of the Regional Development Agencies. While there was no general desire to see them reinstated and some definite criticisms of their work, we did see some instances where particular agencies played a significant role in connecting local business and research organisations. While we found Sir Peter Williams compelling in his evidence about the potential overplay of regional policy, we have

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[158] Q 127

[159] Q 130

[160] Ev w76, para 4.1

[161] House of Commons Science and Technology Select Committee, 2nd Report of Session 2010-12, "Technology and Innovation Centres", HC 619, 17 February 2011

[162] ADS is the trade organisation advancing the UK Aerospace, Defence, Security and Space industries which, together with its regional partners, represents over 2,600 companies across the UK supply chain.

[163] Ev w198, para 5.2.3

[164] Ev 186, para 5.3.1

concerns that the TSB are properly resourced to facilitate the necessary local components of innovation activity that was once the remit of the RDAs.

105. Douglas Robertson, UnicoPraxis, highlighted the value of advice in addition to funding:

> The KTP scheme in terms of evolutionary technology developments, is a very good co-funding scheme. It has been running for over 30 years. One of the reasons why it works is because it has advisers who work with the company to help them figure out how to get through the process. It means it is more costly because you have to provide advisers[165]

106. This was supported by small technology businesses we spoke to. Dr Francis, Technical Director, Byotrol Technology Ltd, told us:

> our relationship with the North West Development Agency and through some of the business contacts was very good. It was local; they were quite often in Daresbury. You could meet them and have a coffee and talk to them about what you were trying to do, and they would help to guide you as advisers. [166]

107. Dr Worswick, Chairman, Cobalt Light Systems, added:

> The regional support was pretty well organised. Whether one is in favour of regions having their own budgets and so on is another matter, but the network they created was very helpful when you applied to them.[167]

108. Another source of local advice that has been lost to business was outlined by Stephen Welton, Chief Executive Officer, Business Growth Fund:

> If the banking industry have a challenge, it is that they have centralised their model so much that the credit committees are all-powerful, and a lot of the local credit officers in the regions do not necessarily know what the outcome of the credit committee is going to be. That is not empowering the people on the ground, who have to make decisions that are pretty fundamental. Do you trust the people you are backing? The judgment of people, understanding how they sit within their local community—all these very old-fashioned business principles—are critically important, and we need to do more to invest in that.[168]

109. ***We have concerns about the ability of the TSB to provide real local information unless they have the funding and resources to develop regional points of contact that can talk knowledgeably to local businesses. We recommend that the Government consider how they can resource the TSB to provide local level advice to technology businesses.***

[165] Q 10 [Dr Robertson]

[166] Q 82 [Dr Francis]

[167] Q 82 [Dr Worswick]

[168] Q 72 [Stephen Welton]

Leveraging our research establishments

110. The Government, in its evidence to us, pointed out that the Higher Education Institutions generated external income of over £3 billion in 2011/12. What may be surprising is that only 2–4% of that money was due income from licensing and sales of shares in spin-outs. The greater part, in cash terms, was the conduct of collaborative and contract research, consultancy and the provision of professional training.[169]

The value of universities

111. The university sector as it contributes to academic research and development is a global success. A report, produced by the Department for Business Innovation and Skills, looking at the competitiveness of UK said:

> While the UK has far fewer researchers than larger countries such as the US and China, as a country, it is far more efficient in terms of output per researcher: of the top five research nations (based on article output in 2010: US, China, UK, Japan, Germany), UK researchers generate more articles per researcher, more citations per researcher, and more usage per article authored as measured by global downloads of UK articles.[170]

112. The challenge for Government is how that world class academic research can be translated into commercial activity. Despite the problems outlined throughout this report, there are many instances of fruitful collaboration between business and universities. In its written evidence the Government provided examples of how universities have been involved in the development of new businesses, participated in the improvement of existing business, improved public policy and services and attracted foreign investment.[171]

113. David Connell, of Cambridge University, described the myth of the role of academic research:

> Besides being intuitively attractive, the myth surrounding university spin-outs has been perpetuated as a result of premature celebration by government and media of high profile, VC-backed spin-outs when they are still at a pre-revenue stage, together with a tendency to incorrectly ascribe university research origins to successful Cambridge companies such as ARM and CSR.
>
> There is no doubt that policies could be put in place to improve the commercialisation of academic science. However, the reality is that at Cambridge, just as at MIT, it is entrepreneurial university alumni rather than research results which play the key role in building successful new S&T companies. This distinction is important as it has profound implications for policy.[172]

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[169] Ev 95, para 5

[170] BIS, "International Comparative Performance of the UK Research Base – 2011", 2011 http://www.bis.gov.uk/assets/biscore/science/docs/i/11-p123-international-comparative-performance-uk-research-base-2011

[171] Ev 105, Appendix A

[172] Ev 114-115, paras 2.5-2.6

114. The UK Deans of Science questioned how far universities should be expected to commercialise their research activity:

> In addition to the financial risks and the challenges of finding commercial partners there is a question as to how far a university should extend its traditional role of teaching and research to encompass commercial activities that others are better placed to do. Thus many reports have suggested that universities and public research bodies should regard the IP they create as supporting wider societal and economic benefit rather than expecting commercialisation to deliver a significant income stream[173]

115. The Wellcome Trust was concerned that pressure from Government to increase the monetary value of knowledge exchange with business misunderstood the broader nature of the relationship with business and the longer term public benefits:

> Universities should be recognised for the broader value they add to the economy, for example through tacit knowledge and the provision of skilled graduates, rather than just the external revenue they generate.[174]

116. Plant Bioscience Ltd argued that universities' genuine need to pursue world class scientific progress was often fundamentally incompatible with business need and that the incentives for academics to do excellent science made them less inclined to pursue business related work and added:

> We find it often quite challenging to find public sector researchers interested and able to conduct some of the applied proof of concept work that is needed even if funding can be found.[175]

Cambridge Environmental Research Consultants Ltd agreed that universities may not be capable of the kind of development that innovative small companies need:

> Academic Research Council grants or short period DTI, TSB etc. research projects do not take the place of long standing applied research laboratories, which also play a role in the development of small companies. Indeed where they have existed in the UK some have been closed down such as the NE wind energy centre. The policies of the present UK Government for technology centres announced by the present government may provide some stimulus to commercialisation of research, but they do not have the same focus or continuity or labs based on a specific industrial objective.[176]

117. **UK universities collectively constitute a world class research base which is, consequently, attractive to foreign businesses. Even if they are not focussed on commercial considerations, they will inevitably generate ideas and discoveries that are of commercial value.**

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[173] Ev w51, para 5

[174] Ev 136, para 25

[175] Ev w68, para 1

[176] Ev w101, para 16

118. **They are an important facet of the UK innovation ecosystem but a resource to be drawn on rather than a primary driver of commercialisation.**

119. The value of universities also lies in the people they produce: not only the academics who will engage with the cutting edge research that is so vital to innovation[177] but also those who will provide the technical backbone to the knowledge economy. Highly skilled technicians have a valuable role in academic and private sector companies. Sir Peter Williams, Treasurer of the Royal Society and Chair of the National Physical Laboratory, told us that "the technician class is a forgotten, underrated and undervalued one in this country and has been endemically".[178]

Realising the benefits of universities

Knowledge exchange

120. Tim Crocker, of the SME Innovation Alliance, told us that the current models for knowledge exchange were predicated on universities pushing information into businesses but, he argued, the flow of information should be two way. He thought there could be a more effective sharing of knowledge if there was more mobility of people from business into universities and back again:

> in the UK we have the KTP finance system—knowledge transfer—which assumes transfer of knowledge from the university outwards. If you are on a peer-to-peer basis—in lots of cases our companies are more advanced than universities—there is no funding mechanism at all by which we can engage with the universities and our time and theirs can be paid for. All we can ever do is use TSB money to subcontract to them, and that is a very unsatisfactory relationship. [...] Visiting professors [in Germany] spend half a day a week teaching, and the integration between universities and industry is entirely on a peer-to-peer basis.[179]

121. This perspective was endorsed by Tim Bradshaw of the CBI who thought that the two way flow of information between universities and business was essential.[180] Plymouth University wrote that they would like to see "national schemes such as 'senior internships' or 'industry-academia secondments' where the exchange of senior personnel can create productive and strategic relationships".[181] The UK Deans of Science suggested "initiatives to encourage secondments to university departments".[182]

122. However, the Campaign for Science and Engineering suggested that the Research Excellence Framework (REF) might discourage "universities from hiring staff with backgrounds from industry due to gaps in (or absence of) publication records".[183] Sir Tim

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[177] For example, Ev w37, para 3

[178] Q 112 [Sir Peter Williams]

[179] Q 224 [Tim Crocker]

[180] Q 224 [Tim Bradshaw]

[181] Ev w4, para 6

[182] Ev w52, para 6

[183] Ev w177, para 5

Wilson's review of collaboration between universities and business also looked at the topic of knowledge transfer through secondment of people but followed the model of transferring knowledge from universities to business, making no mention of secondments in the opposite direction.[184]

123. **We are sympathetic to the demand that universities become more accommodating to non-traditional backgrounds among their academic staff. We regard it as axiomatic that the extended presence of people with an industrial background within university faculties would facilitate a greater understanding of commercial imperatives and the most effective ways to engage university resources within businesses.**

Technology Transfer

124. David Connell argued that innovation policy should encourage businesses to draw upon university resources rather than pushing academics into becoming businessmen.[185]

125. An important facet of commercialisation of university based research is achieved through technology transfer offices (TTOs) in universities. However the Scottish Lifesciences Association wrote that "each university having its own TTO can become a significant barrier to larger companies seeking commercialisation agreements with a number of institutions".[186] In response the Scottish Government plans to streamline the technology transfer functions of all Scottish Higher Education Institutions through a single office that will have representatives within each institution.[187] HEFCE wrote that English universities are also consolidating their commercialisation activities.[188]

126. The Society of Biology suggested that there needed to be recognition of academics who engage in commercialisation activity:

> The excellence of a University or academic has until now been judged at review on the basis of scientific achievement, publications and achievement of grant-funding, with less focus on translation and impact. Thus the former have remained academic priorities. Greater recognition for achievements such as filing IP and forming industry collaborations (at a realistic value) could address this deficit and it may be redressed by the [Research Excellence Framework] 'economic impact score'. Knowledge transfer should be recognised as a contribution worthy of academic recognition and reward.[189]

In 2003, the Lambert Review of the collaboration between business and universities indicated that:

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[184] Professor Sir Tim Wilson DL, "A Review of Business–University Collaboration", February 2012, recommendations 15 and 16

[185] Ev 119, para 6.5

[186] Ev w10, Appendix, para 7

[187] Ev w10, Appendix, para 7

[188] Ev 139, para 17c

[189] Ev w63, para 2

> The main challenge for the UK is not about how to increase the supply of commercial ideas from the universities into business. Instead, the question is about how to raise the overall level of demand by business for research from all sources.[190]

127. **We are concerned that driving an innovation agenda too aggressively through universities may have diminishing returns with regard to commercialisation and risk damaging the academic research that is working well.** ***We recommend that the Government's objective should be to create a commercial demand for university engagement to which they are already primed to respond. This echoes and reinforces the point made almost 10 years ago in the Lambert Review.***

Engagement with businesses

128. We received suggestions on how universities could be encouraged or incentivised to engage more closely with business requirements.

129. The Electronics Technology Network stated that their members felt that services tendered through universities were too expensive and that universities needed to have incentives to engage with their local businesses:

> Future funding for Universities should be based upon their past record of commercialisation. Incentives should be given to Universities to adapt research to reflect the skills and interests of their local business community, thereby strengthening the region's cluster.[191]

130. The University of Plymouth supported the establishment of fellowships for universities to engage in research, embedded within industrial partners.[192] Bournemouth University suggested the creation of "a list of 'industry/university brokers' who could assist linking industry to universities and assessing the relevance of university research to an industry".[193]

Public Sector Research Establishments

131. Universities are not the only publicly funded research organisations. There are also the Public Sector Research Establishments, The Department for Business, Innovation and Skills explained:

> Public Sector Research Establishments (PSREs) are a diverse collection of public bodies carrying out research. This research supports a wide range of Government objectives, including informing Government policy making, statutory and regulatory functions and providing a national strategic resource in key areas of scientific research. Many of these bodies are involved in commercialising research.[194]

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[190] HM Treasury, "Lambert Review of Business-University Collaboration", December 2003 http://www.hm-treasury.gov.uk/d/lambert_review_final_450.pdf

[191] Ev w115, para 3.6

[192] Ev w4 para 10

[193] Ev w8, para 7

[194] Ev 97, para 18

132. The Association of Independent Research and Technology Organisations (AIRTO) told us that these laboratories cannot access the funds available to universities to replace the loss of Regional Development Agency funds towards commercialisation activity. AIRTO suggested that funds from the Research Councils should be extended to PSREs and even to commercial organisations to make that funding more effective.[195] This stance was supported by Midven, a venture capital fund manager. AIRTO also pointed out that the structure of funding from the TSB means that PSREs may find they cannot participate in TSB related innovation activity without losing money.[196]

133. The National Physical Laboratory (NPL) pointed out that while the Government's recently published Innovation and Research Strategy for Growth[197] "recognises the importance of PSREs like NPL for translational research, it does not include any recommendations to enhance their role".[198] NPL explained the benefits that they provide to small businesses seeking to innovate technologically:

> Public Sector Research Establishments (PSREs) like NPL maintain significant scientific and technological capability to fulfil their core government function, in the case of NPL to provide the UK national measurement system infrastructure. NPL makes spare capacity on this capability available to business and government customers through R&D services at commercial rates. NPL often receives inquiries from SMEs with a need to de-risk a technology through the application of our specialist facilities and knowledge which they cannot afford to access, putting the commercialisation of their research at risk.[199]

In paragraphs 47–53, we addressed the lack of access to test facilities and the fragmented approach to capital equipment. Engineering the Future stated:

> Among the developed European nations, the UK is unusual in that it has not historically supported 'intermediate institutes' of any significance and certainly not on the scale of the Fraunhofer Institutes (Germany), TNO (Netherlands) or VTT (Finland). Instead, the UK placed greater emphasis on university research with mixed results for the nation's innovation performance. The creation of the TSB Catapult centres, following the announcement of a £200m innovation programme in 2010, was a welcome development. The TSB could also coordinate a strategic programme to support and strengthen the supply networks.[200]

134. The Council for Science and Technology (CST) in its report "A Vision for UK Research" recommended that the Government consider the establishment of Large Technology Platforms:

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[195] Ev w90, para 5.4

[196] Ev w91, para 7.4

[197] BIS, Innovation and Research Strategy for Growth, December 2011 http://www.bis.gov.uk/assets/biscore/innovation/docs/i/11-1387-innovation-and-research-strategy-for-growth

[198] Ev 154, para 7

[199] Ev 156, para 9

[200] Ev 167, para 5.1

> New technologies often need to be further developed by substantial teams for a number of years before they are commercial. These teams need to be larger than the research teams which first made the discovery. They often need expensive production equipment to make the research industrially useful. This requires a dedicated environment with a clear focus for a period of 5 to 10 years.
>
> [...]
>
> To make a difference in a global context we suspect that each of these platform technologies will need between £50 to £100m over a 5 to 10 year period to become the basis of numerous start-ups and licensed projects to large companies. This will lead to clusters of expertise in these sectors that feed off each other in a virtuous circle enabling the UK to retain global leadership in large markets.[201]

The CST recommended that funding should come from various public sources (TSB, EPSRC, European Framework Programme, RDAs, Universities etc) but should have a substantial industrial component that would require some incentive from Government.

135. Public Sector Research Establishments were identified in Lord Sainsbury's "Race to the Top" review of government's science and innovation[202] as key players in innovation and commercialisation activity. However, the review made no reference to the role PSREs might play in hosting technology that could be made available to commercial exploitation.

136. **It is crucial that the Government has a coherent plan on how to engage the research base (people, facilities and intellectual property) with the innovation agenda. However, the current situation is fragmented and confusing and, as such, extremely difficult for small businesses to engage with.**

137. **We ask the Government to provide, in their response to this report, its perspective on the adequacy of the national infrastructure for innovation, benchmarked against nations with which we compete and how it intends to remedy structural short-comings, possibly along the lines recently recommended by the Council for Science and Technology. We recommend that Public Sector Research Establishments play a key role in this infrastructure and we plan, in future, to examine their role within the research and innovation ecosystem in more detail.**

[201] Council for Science and Technology "A Vision for UK Research", March 2010 http://www.bis.gov.uk/assets/cst/docs/files/whats-new/10-584-vision-uk-research.pdf

[202] HM Treasury, "The Race to the Top: A Review of Government's Science and Innovation Policies", October 2007 http://www.hm-treasury.gov.uk/d/sainsbury_review051007.pdf

4 Government as a lead customer

138. Until now we have been looking at money the Government spends as a patron of research spending. However, that is very small compared to the amounts that the Government spends every year in purchasing goods and services from businesses. The Royal Society of Chemistry stated that "In 2010–2011 the UK's public sector spent approximately £236 billion on goods and services, which is significantly higher than the annual investment in all aspects of research and innovation of £11 billion".[203] This chapter looks at the role of Government as a customer of innovative companies and in the direct development of such companies. Procurement is important. The small companies we spoke to told us that customers were more important than grants.[204]

139. Matthew Bullock, previously head of technology at Barclays and recent holder of the Chair of the Centre for Business Research and the UK Innovation Research Centre, told us about the need for the Government to leverage its spending:

> My experience is getting people to the base where they have got a business, got the experience and know their markets, which is very important. In this country's approach, as Government, you are the biggest customer in Government; you have the most technical demands; you have an enormous range of things that you would like to see developed. We absolutely do not use it as an engine of growth; it is absolutely absurd.[205]

140. Sir Peter Williams, Treasurer of the Royal Society and Chair of the National Physical Laboratory, stressed the advantages of Government procurement:

> There is no doubt whatsoever that schemes like Merlin have been well intended to push capital down to businesses. If intelligent procurement and Government contracts pushed real orders resulting in real revenues and real cash flows into emerging businesses, that is the one thing that would persuade investors to buy their shares and back those companies. So procurement has a double whammy: it helps the company directly, and it conditions the market perception of this whole sector.[206]

This was further developed by Dr Tim Bradshaw of the CBI:

> If you look at it from the pull side—the Government procurement side—yes, absolutely, that is what can really make a difference. Despite what I have just said about grants, aid and things, most companies would bite your arm off for a contract rather than a grant. The more the Government can do to encourage innovation through their procurement lines the better, be it through SBRI or maybe making sure that all the public procurement space is also looking at innovation so that we transform it. We look at things like outcome-based procurement and whole-life

[203] Ev w82, para 24

[204] For example, Q 79

[205] Q 62 [Matthew Bullock]

[206] Q 101 [Sir Peter Williams]

> value; we encourage those involved in procurement to look for innovative new ideas that might save them money long term, rather than short-term upfront costs.[207]

141. Fergus Harradence, Deputy Director, Innovation Policy, Department for Business, Innovation and Skills outlined the major challenges to a better system of procurement:

> The first is to simplify and streamline the procurement process and free up more time within procurement functions to enable them to go out and engage with the marketplace and businesses in a strategic way, combined with better signalling of Government demand in particular areas. The work that has been done on future capability needs in areas like tunnelling would be an example of that. We published quite a lot of information earlier this year about future Government needs.
>
> Secondly, there is a big challenge in upgrading the skills and knowledge of people in the procurement profession. The difficulty in doing that is that procurement is not in most public sector organisations a centralised function; [...] The culture, structures and the way procurement is managed in the UK are fundamentally different, and that makes it hard for us to procure in the same strategic way that you see the US doing. I would not say that these problems are insuperable; they could all be tackled over time, but, being realistic about it, it will be a process of long-term improvement and cultural change.

Training disparate groups of staff to achieve a common understanding is not a new concern, especially not in the arena of innovation and commercialisation of research. Praxis originated in 2002 from a government-backed collaboration between Cambridge and the MIT to address the shortage of skilled knowledge and technology transfer personnel. Praxis merged with Unico (the representative body of professionals that worked to commercialise UK university and public sector research) in October 2009 to form PraxisUnico "an educational not-for-profit organisation set up to support innovation and commercialisation of public sector and charity research for social and economic impact".[208]

142. **PraxisUnico provides training programmes and networking events to improve technology transfer skills across the whole of the university sector. It is a good example of a government sponsored programme that delivered necessary skills across a disparate sector. We recommend that the Government should consider it as a model for the delivery of a coherent set of skills across the whole of Government procurement.**

143. Sir David Cooksey, Chair of the Francis Crick Institute, pointed to a fundamental problem for SMEs seeking to gain Government contracts:

> The situation on procurement is that, if you look at the requirements Government place on their Departments for making procurement, the qualifications required in terms of the financial size and stability of the companies are such that they positively exclude the sort of companies we are talking about from supplying Government, and that is completely wrong. What we should be looking at is Government being

[207] Q 223

[208] PraxisUnico website, http://www.praxisunico.org.uk/about-us/, December 2012

prepared to pay for the prototypes from these companies to get them off the ground and make them work.[209]

Small Business Research Initiative

144. SBRI is the Government's key policy to support the establishment of innovative companies and provide a gateway for small technology firms to gain government contracts procuring goods and services. The Government told us that it understood the principle of procurement as a tool to drive innovation:

> Innovation procurement initiatives reduce risk, guarantee sales, encourage market entry, provide early testing ground and manufacturing experience, create demand and make latent demand manifest, and diffuse technology.[210]

145. Dr David Connell recommended a huge increase in SBRI funding:

i. Increasing the UK SBRI programme in steps from around £20m per annum currently to £250m per annum. [...]

ii. Adding an equivalent sized budget for larger scale demonstration projects (above the £1m SBIR Phase 2 ceiling)

iii. Establishing a similar programme to encourage more private sector organisations to act as lead customers for new technologies developed by SMEs. [...]After piloting this programme, the aim should be to increase funding projects to £100m a year.[211]

146. We welcome the Government's ambition to grow SBRI:

> Since 2009, when we relaunched the programme, we have been able to build it to a level of about £20 million a year of expenditure, [...] In an ideal world, I would like to see it more than double, and we should be aiming to grow this to a level of about £50 million a year, which I think is feasible and achievable in a relatively short space of time.[212]

147. However, improving the funding of SBRI will only be fully exploited if that investment is not followed up by intelligent government procurement providing commercial opportunities for the companies involved. Mr Harradence, BIS, stated:

> We have been doing some work on better supply chain management and how Government can engage more effectively to support the development of new products and services over the longer term through our Forward Commitment Procurement programme. We have used that to procure zero-waste mattresses for the Prison Service, which are more environmentally friendly and cost less, and to develop a new type of ward environment, this time for the National Health Service.

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[209] Q 101 [Sir David Cooksey]

[210] Ev 104, para 79

[211] Ev 119, para 6.1

[212] Q 245

> We have got to the point where it has been demonstrated. It is in the Building Research Establishment in Watford.[213]

148. While we were pleased to hear of successes, Iain Gray, CEO of the TSB highlighted how companies that the TSB has nurtured through to commercialisation often fail to achieve sales to the Government. For example,

> Eykona won an SBRI contract. It has taken it to the next stage. The managing director of Eykona would say, "We would not exist as a company were it not for SBRI", but he has now reached the critical point John describes, which is: how does he move that on now into a procurement-type contract in the NHS? Ironically, the market he is now chasing to procure the technology that has been developed under an SBRI contract is overseas. He is chasing overseas contracts because, when it comes to the critical point of the next stage in the procurement contract, there is a risk-averse approach in the UK.
>
> We have got great science and technology; we have got the SBRI in place, which is helping small businesses get their technology to the point where they can take it to market; and we need that pull at the next stage to act from a procurement point of view to move the technology into the NHS.[214]

149. Midven, a for-profit venture capital manager, thought that the SBRI was still managed like a government grant scheme which might be one reason it did not function as a intended as "a route to early, sustainable sales for SMEs".[215] The Academy of Medical Sciences argued that the scheme needed to be properly embedded itself across all government departments "particularly the larger spending departments such as the Ministry of Defence".[216] The University of Birmingham pointed out that in the USA government departments were required to spend a defined percentage of their budget supporting small businesses.[217] In contrast, the Science Policy Research Unit unconvinced of the evidence in support of the SBRI scheme, highlighting the lack of clarity on the costs of the scheme[218] and Engineering the Future suggested that time should be taken to properly evaluate it.[219]

150. ***We were concerned that the SBRI scheme fails to assist companies to gain Government commercial contracts. We recommend that the Government ensure that its procurement officers, and those of other public sector agencies, are properly trained to take into consideration the wider public benefits of procuring services from small technology companies that have been developed through the SBRI.***

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[213] Q 245

[214] Q 249

[215] Valley 46, para 7

[216] Valley 67, para 17

[217] Valley 30, para 5.3

[218] Valley 54, para 27

[219] Valley 79, para 4.2

National Health Service

151. We were interested to discover what advantage the existence of National Health Service would deliver in enabling innovation in health technologies. Andy Richards gave us an investor's perspective:

> This is not just a statement about drug discovery; it is a much broader comment. [...] Customer traction is one of the most attractive things for any investor. There has been a situation where any business plan, business model or business idea that comes up that says, "By the way, the first thing we are going to do is sell into the NHS," just makes it uninvestable, because the NHS does not take up, let alone new drugs, new technologies, new software systems, new anything. It is notoriously hard to sell anything new into the NHS. That is partly a cultural thing. Partly, there are some elements within the NHS that, for one reason or another, have a "they shall not pass" mentality. It does make it incredibly hard to innovate in the medical field—medtech, health care, IT—in an environment where your local market, who are the easiest people you have to reach to talk to as customers, are hard to access.[220]

152. Novartis stated:

> The key point here is that pharmaceutical R&D investment in the UK is, to some extent, dependent on the willingness of the NHS to support and adopt the innovations that are developed as a result of R&D activity. Without adequate uptake, medicines commercialisation will decline.[221]

153. The Association for Medical Charities was concerned that the NHS did not provide any market certainty for innovative drugs:

> To attract investment into commercialisation of research there needs to be an end market. Our members have expressed frustration with the products of their research both failing to receive NICE approval or receiving NICE approval and subsequently not being adopted throughout the NHS. Strict commissioning guidelines are needed to ensure approved innovations are rapidly taken up across the NHS.[222]

154. ISIS Innovation, the technology transfer office for the University of Oxford, confirmed this view:

> In Healthcare there is an urgent need for the NHS to present itself as a willing customer of innovative products from UK technology companies. The NHS needs to become a first port of call. At present UK healthcare technology companies actively avoid engaging with the NHS because it is such a poor customer (slow decision making, late adoption), turning instead to overseas markets.[223]

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[220] Q 37 [Dr Richards]

[221] Valley 83, para 10

[222] Valley86 , para 21

[223] Valley 28, para 5

155. Dr Bianco, Director of Technology Transfer at the Wellcome Trust, explained that a fundamental problem in driving innovation in the NHS would appear to be that people that took risks in innovating rarely experienced any financial benefit.

> One of the disincentives, which is a real problem, is that if you produce, for example, an invention that reduces bed stay because the surgical procedure is less invasive, it is the cost centre for the beds that gets the advantage and the risk is taken by surgery. [...] Adoption has become a problem because the reward system is not necessarily linked.[224]

156. Research hospitals should be the innovation pioneers within the NHS, a source of data and expertise but Dr Goodier of the Shelford Group indicated that they were poor partners for the biopharma industry and technology:

> We are very concerned at the Shelford Group because so many of the prices set for treating patients are set on averages. If you suffer from asthma, you can have three nebulisers and go home, or you can have a week in intensive care and two weeks on a ward. The price is set at an average, and that suits more the smaller district general hospitals, whereas the academic hospitals tend to get the more complex patients and, therefore, are chronically underfunded.[225]

157. Despite these difficulties, witnesses believed that the NHS represented considerable potential as an encourager for future innovation, especially in the area of stratified (or personalised) medicine. Dr Tapolczay, Chief Executive of Medical Research Council Technology, stated:

> [] While I agree with everything that has been said, I also see it as an opportunity. If the problem is there but it could be fixed, we are still the only country in the world with an NHS. If we can find a way to allow engagement between the biomedical community in the private sector and the NHS more effectively, then it has to be a very positive step forward for both the NHS and the biomedical companies in the UK.[226]

Dr Richards, entrepreneur and business angel investor, stated

> [] It is deeply frustrating that we are the best situated country to do personalised medicine because of the NHS. If we can gather the information from well collated records and use that—we have everything in place—and if we could do it, it would be the big game change.[227]

[224] Q 38 [Dr Bianco]

[225] Q 38 [Dr Goodier]

[226] Q 38 [Dr Tapolczay]

[227] Q 38 [Dr Tapolczay]

158. We recently inquired into the UKCMRI, later renamed the Francis Crick Institute.[228] This facility has the potential to be the flagship of innovation in the UK healthcare system and to doctors trained in deploying innovation and new technology throughout the NHS.

159. ***We recommend the Government examine the critical role of research hospitals in addressing the most challenging of conditions and explore ways of ensuring that funding encourages the development of innovative solutions.***

160. ***We consider it critical for the future of the bioscience sector in the UK that the Government ensures that a significant proportion of the NHS procurement budget is accessible by small innovative companies. The Government should incentivise NHS Trusts to engage with SME companies for innovative technology solutions. A similar approach should also be adopted across other agencies including local government, police etc.***

Support for sectors of industry

161. The UK has traditionally had a strong presence in the life sciences, confirmed by the attention the Government pays to this sector. The Strategy for UK Life Sciences announced it would provide £180 million targeted at the 'valley of death' to 'de-risk' investment in life science innovation, half of which will be funnelled through the TSB to support SMEs.[229]

162. There are a number of policy instruments focussed on the life sciences sector:

Strategy for UK Life Sciences[230] contained recommendations to improve the uptake on innovations within the NHS, **Innovation, Health and Wealth: Accelerating adoption and diffusion in the NHS**[231] and outlined further steps to support the commercialisation of health research in the UK.

Biomedical catalyst scheme[232] to support the development of promising early-stage drugs into new treatments by universities and small or medium enterprises (SMEs).

Early Access Scheme consultation[233] to identify where new treatments could potentially be given conditional authorisation, have their assessment accelerated or be licensed early to speed commercialisation.

The strategy announced the establishment of a new **Life Sciences Advisory Board** comprising of representatives from industry, academia, government departments and agencies and the appointment of an MP to advise David Willetts on life sciences.

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[228] Science and Technology Committee, 6th Report - UK Centre for Medical Research and Innovation (UKCMRI),HC 727, 25 May 2011

[229] Valley 00, para 40

[230] Department for Business, Innovation and Skills, "Strategy for UK Life Sciences", December 2011 http://www.bis.gov.uk/assets/biscore/innovation/docs/s/11-1429-strategy-for-uk-life-sciences

[231] Department for Health, "Innovation Health and Wealth: accelerating adoption and diffusion in the NHS", December 2011 http://www.dh.gov.uk/health/2011/12/nhs-adopting-innovation/

[232] http://www.innovateuk.org/content/competition/biomedical-catalyst.ashx

[233] MHRA, "Proposal to introduce an early access to medicines scheme in the UK", July 2012 http://www.mhra.gov.uk/NewsCentre/Pressreleases/CON174774

> Steps have been announced to develop a **safe and secure system which opens up patient data for research**[234] and ensures patients are offered opportunities to be involved in research relevant to them are valuable.
>
> **Plan for Growth**,[235] though not life science focussed, heralded work to streamline the regulation of health research and establish a Health Research Authority.

163. The Association for Medical Charities, like other organisations related to the life sciences,[236] welcomed government initiatives in the life sciences but considered that some additional detail was still needed.[237] The framework of policies provide a big picture within which the life sciences industry can see where they might fit in the future and inform their investment.[238] The Government has developed policies to enable the sector to carry out its activities and, in partnership with charity and industry, has invested in infrastructure in the Francis Crick Institute[239] and Stevenage Open Innovation campus.[240]

164. However, Professors Anthony G M Barrett and R Charles Coombes of Imperial College, London, outlined concerns about a challenge in the bio-pharmaceutical sector where the big companies were leaving the field of drug discovery and universities were not able to fill the resulting research gap:

> Globally drug discovery is rapidly changing. The big pharma companies such as Pfizer, GlaxoSmithKline, AstraZeneca and others are leaving drug discovery rapidly and their exit will be complete in the next 5 to 10 years, perhaps sooner. The recent closure of Pfizer Sandwich and downsizing of AstraZeneca are not unusual events but are part of the inevitable global process. The trillion-dollar question is whatever next and where will the medicines of the future come from? Will pharmaceutical innovation be totally lost to the UK and the UK pharmaceutical industry, worth many billions to the UK economy, become another smokestack memorial.[241]

165. Dr Ian Tomlinson further explained that early drug discovery was not an area in which large biotechnology firms were able to effectively operate:

> Big pharma needs to take some responsibility. The costs are going up and the regulatory hurdles are going up, but we did have a culture of trying to industrialise drug discovery and development—and it did not work. [...] Innovation comes from one person having an idea, or a small group having an idea, and prosecuting that idea to some kind of milestone. That is why we have changed dramatically over the last five years. We used to have thousands of people working in R & D. We would

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[234] Department of Health, "Information: To Share or not to Share", May 2012 http://caldicott2.dh.gov.uk/

[235] Department for Business, Innovation and Skills & HM Treasury, "The Plan for Growth", March 2011 http://cdn.hm-treasury.gov.uk/2011budget_growth.pdf

[236] For example, Ev w63, Ev w68 and Ev 132

[237] Ev w191, paras 30-36

[238] Ev w147, para 2

[239] http://crick.ac.uk/the-institute

[240] http://www.stevenagecatalyst.com/

[241] Ev w194, para 2.1.2

> throw a load of people at the problem and we would hope to solve it in that way. Now, we have 50-people groups, with a leader fully empowered to prosecute a very specific area of science.[242]

166. **Both the Crick institute and the Stevenage Open Innovation campus demonstrate that the Government is working actively with the industry to ensure that bioscience retains a strong presence in UK research and development. Government support for life sciences has been excellent and there is real innovation taking place in how that sector might be supported.**

167. Despite these successes, we heard that there was some disappointment that the particular requirements of the agriculture related sectors were not included in the strategy.[243] The Agricultural Biotechnology Council told us:

> Research from the Rothamsted Institute found that the UK is losing its expertise in applied sciences, with those employed in applied R&D work increasingly getting older and fewer in number. There have been three significant closures of public research institutes associated with agriculture in the past decade. The closures of Long Ashton Research Station in 2003, Silsoe Research Institute in 2006 and the Hannah Research Institute in 2007, have all contributed to a decline in our public agricultural research base.[244]

168. PraxisUnico considered that the "commitment shown to the bioscience sector needs to diversified into engineering and the physical sciences if the UK is to reshape its industrial base".[245]

169. Another sector of government procurement that would appear open to active encouragement for innovation is that of Defence, the UK Innovation Research Centre and the Centre for Business Research stated that the USA effectively utilises its military budget to drive innovation.[246] The Rt hon David Willetts MP told us how the Ministry of Defence was using procurement to drive innovation. Fergus Harradence of the Department for Business, Innovation and Skills pointed out that the Ministry of Defence was a keen contributor to the SBRI scheme. However the Ministry would appear to be outsourcing its procurement which may limit its potential to utilise the budget in this fashion. In a statement in July 2012 the Defence Minister, Philip Hammond MP, said:

> Earlier this year, I therefore asked my officials to focus their efforts on considering the comparative benefits which could be derived from changing DE&S into either an executive non-departmental public body with a strategic partner from the private sector (ENDPB/SP), or a Government-owned, contractor-operated (GOCO) entity. The work done to date, suggests that the strategic case for the GOCO option is

[242] Q 35 [Dr Tomlinson]

[243] Ev w66, para 17

[244] Ev w148, para 7.3.5

[245] Ev 147, para 2

[246] Ev w43, para 5.1

> stronger than the ENDPB option. Further value-for-money work is under way to confirm this assessment.[247]

170. Evidence sent by the UK Innovation Research Centre and the Centre for Business Research pointed out that other governments were active supporters of innovation in their own industries:

> Many governments outside the UK support technology through specific R&D programs aimed at pre-commercial support in technology and market development around a group of applications. These provide R&D support and subsidies for specific technological areas; access to specialized equipment; forums for the establishment of standards; direct financial support for establishing new industries; public procurement by military and health departments especially of R&D services; acting as deep-pocketed first customers and procuring first quantities of technologies.[248]

171. Professor Nick Wright, of the Russell Group of universities, was particularly scathing about the way various UK governments had approached the commercialisation of research:

> We seem to be the only major economy that thinks we can make this work on fairy dust and good intentions. [...] It does not have to be heavily prescribed; it can be an informal system, but [most large economies have] a national innovation system of some kind, and we desperately need that in the UK.[249]

172. **We have not been persuaded that the Department for Business, Innovation and Skills has a strong enough voice across Government policy to effect the necessary radical change in procurement practices. Procurement by Government departments needs to focus on issues other than simply cost.** ***We recommend a Minister in HM Treasury be given responsibility for the delivery of procurement-driven benefits identified by the Department for Business, Innovation and Skills.***

173. Dr Tim Bradshaw, Confederation of British Industry, explained the demonstration effect of British companies gaining Government contracts:

> The more the Government can do to encourage innovation through their procurement lines the better, be it through SBRI or maybe making sure that all the public procurement space is also looking at innovation so that we transform it. [...]When you have some really good things in the public estate, showcase them. If you have got them in, show them off to the rest of the world and show what can be done. Make sure you are demonstrating to overseas buyers that we have done this in the UK[250]

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[247] HC Deb, 17 July 2012, c124WS

[248] Ev w43, para 6.1

[249] Q 145 [Professor Wright]

[250] Q 223 [Dr Bradshaw]

The Minister indicated that the Government was aware of the need to ensure better information of public spending needs among businesses[251] but was not convinced that more action needed to be taken to ensure broader benefits to UK industry through public procurement:

> We have to be very careful of protectionism.
>
> As I say, that is why our approach has been information in advance and sharing our future plans. [...] In the long run British businesses need the competitive challenge of winning in a competitive environment.[252]

174. ***We recommend that the Government, in two years, publish a breakdown of companies successful in tendering for Government contracts and compare whether greater openness in procurement has resulted in increased contracts among small and developing British technology companies.***

[251] Q 291

[252] Q 293

5 Conclusions

175. **During our inquiry we have become aware of the multitude of issues and problems that are faced by businesses in a variety of innovation sectors. Each of these companies find issues in funding that innovation but their concerns and needs vary from sector to sector and are often predicated on the size of the business. We conclude there is no single valley of death that all businesses, or even all small businesses, must cross.**

176. **What is consistent across business is the need for a clear vision from the Government to provide confidence into the future. Without a definite commitment from Government, business is more reticent about making its own financial commitment to the levels of risk that innovation requires.**

177. **The evidence that we have seen shows that there is no coherent innovation policy. The Government has begun to consolidate its innovation policy by bringing more schemes and responsibilities within the Technology Strategy Board. We judge that this consolidation needs to go further and that the TSB should be given more funds including monies designed to better finance existing programmes such as SMART and SBRI but not at the expense of the Research Councils.**

178. **We have seen a desperate need for government procurement to do heavier lifting than in providing encouragement to the growth of small technology companies. There is possibly a greater and more sustainable benefits to be gained by growing and developing small companies into successful medium sized ones than in attracting large companies.**

179. ***There needs to be a coherent strategy across the whole of UK industry to provide UK business with confidence in where they might expect Government support for the medium and long term—whether through procurement, R&D focus or fiscal policies.***

180. **Finally we would urge the Government to seriously consider the financial markets and the inadvertent negative impacts that changes to policy there might have on innovation policy, for example how the regulation of pension funds has effectively starved technology firms of growth capital. Where it is not possible to foresee such impacts Government should be alert to the need to detect and to rectify them in a speedy fashion.**

Conclusions and recommendations

Investment in technology companies

1. We are concerned that our small companies are too often bought up by larger overseas companies before they can develop into the medium sized enterprises that would produce substantial jobs and wealth in the UK. We are convinced that while equity investments have a place, too many companies are forced into over-reliance on this route because other types of funding are unavailable. *We recommend that the proposed bank for business, possibly in partnership with the Business Growth Fund, be used to promote a bond market for medium sized businesses, thus providing growing small businesses with an additional source of funding.* (Paragraph 39)

2. We have concerns that regulation to de-risk pension and insurance funds has had the effect of starving technology companies of a source of long term patient capital. There is a need to deploy these funds more usefully. *We recommend that the Government investigate the potential to require funds to have a proportion of European SME equities.* (Paragraph 40)

3. Lloyds Banking Group run a scheme where senior staff attend a Warwick based engineering course designed to help them make better decisions on financial risk by giving them a better understanding of some emerging technologies. *We recommend that the bank for business adopts such an approach for its staff from the outset.* (Paragraph 41)

4. The bank for business announced by the Government may provide a useful go-between for institutional investors and technology businesses. *We urge the Government proactively to seek to develop not only the market in technology equities but to ensure that the market has ready access to information that may change the perception of these equities and their relative risk and create mechanisms, such as the Lloyds scheme, to help fund managers understand evolving technologies. However, reporting requirements and other costly regulatory burdens on UK-based listed companies, especially in the AIM market, should be kept to a 'fit for purpose' minimum.* (Paragraph 42)

5. *We recommend that the Government re-examine their portfolio of interventions to determine where gaps may lie and to ensure there is a consistent spread of funding across the spectrum of business need. It is important that government funding fits the needs of growing companies rather than company growth having to adapt to gain government funding. It is also important to ensure that the incentives from Government tend towards greater growth and retention of jobs and wealth creation in the UK.* (Paragraph 45)

6. *We consider that the R&D Scoreboard was a useful and widely respected source of information for technology businesses and we recommend that the Government should reinstate it. We also recommend that the Bank of England should resume their monitoring activity on the availability of finance to SMEs.* (Paragraph 87)

The need for physical infrastructure

7. *We share the concerns of our witnesses that the UK small business sector lacks access to large scale test and experimental production facilities. We recommend the Government to find a way to ensure that those facilities that do exist can be more readily accessed by business, that gaps in requirements are identified and a fund established to subsidise those facilities that cannot afford to remain at the leading edge in a purely commercial environment.* (Paragraph 51)

8. *We urge the Government, when looking at the issue of production facilities, to ensure that the Technology Strategy Board and other commercialisation activities address whether projects are properly supported in issues of manufacturing capability.* (Paragraph 52)

Small companies

9. The Government indicated that it would not follow the James Dyson report recommendations that the tax credit should be refocused on high technology sectors or on small and start-up companies. The R&D tax credit has been successful in increasing spend by business on research and development but this has, mostly, been within larger companies. *We recommend that the Government identify the reasons why R&D spend still appears to be drifting away from the UK despite the benefits enjoyed by larger companies. We also believe that there needs to be a mechanism to support SME's who do disproportionately badly from the current scheme.* (Paragraph 59)

10. We conclude that the Government needs to distinguish in its innovation policy between small and medium enterprises: a single SME category is too broad. (Paragraph 61)

Taxation and regulation

11. *We recommend that the Government address the issue of VAT and how it might ensure that VAT rules allow academic teaching and research to sit alongside commercial and incubation activities within public or charitably funded laboratories and research centres without creating a financial burden for the institute.* (Paragraph 63)

12. *Poor regulation adds to the risk burden of entrepreneurs. We welcome the proactive response of the Minister on the issue raised in evidence to us and recommend the TSB to undertake a review of regulatory burdens on technological innovation in the UK. This review should be consistent with the advice to Government by Professor Ragnar Lofstedt on Health & Safety matters but should not include just a list of regulatory burdens in need of reform but a roadmap of how that reform might be used to drive innovation and which institutions should take the lead.* (Paragraph 70)

Intellectual property and technology transfer

13. *We judge that the IPO mediation service could be more heavily used to arbitrate in matters of intellectual property. We recommend that the Government require the use of mediation before any legal action can be taken in a UK court, both speeding up the resolution of disputes and reducing the costs of protecting intellectual property. We also recommend that refusal to engage in mediation be taken into account in awarding costs.* (Paragraph 76)

14. *We recommend that the Government assess the benefits of the Easy Access IP experiment and whether it improves the flow of IP not just between universities but into wealth creation activities within the UK.* (Paragraph 81)

15. *We understand the intent behind changes to HEIF that further reward institutions that have already benefitted from successfully commercialising their IP. We have concerns that IP transfer from universities that have been less successful in commercialising their IP may decrease further. We recommend that the Government review the situation after three years and publish a report on how the changes have contributed to increased IP transfer, job creation and related social benefits.* (Paragraph 82)

16. *We recommend the Technology Strategy Board examine the current provision of proof of concept funding to universities and small companies and report to Government a coherent view of the amounts of funding available along with a recommendation on whether there exists a shortfall of provision of these funds and whether a consolidation of provision into a single programme would be helpful.* (Paragraph 96)

The UK innovation ecosystem

17. There is an evident need for an innovation agency in the UK and it makes greater sense to ensure the TSB and its schemes evolve to meet this need than create a new organisation. It also makes sense to concentrate the innovation function within a single agency to ensure there is coherence and consistency within the system. We support the current Government's approach to its innovation policy. (Paragraph 100)

18. We consider it vital that the Catapults are made to work. We ask the Government to confirm to us that they will not seek to push the Catapults to generate revenue but instead allow them to grow slowly and organically with a focus on developing the necessary capabilities to support innovation. (Paragraph 103)

19. *We have concerns about the ability of the TSB to provide real local information unless they have the funding and resources to develop regional points of contact that can talk knowledgeably to local businesses. We recommend that the Government consider how they can resource the TSB to provide local level advice to technology businesses.* (Paragraph 109)

20. UK universities collectively constitute a world class research base which is, consequently, attractive to foreign businesses. Even if they are not focussed on

commercial considerations, they will inevitably generate ideas and discoveries that are of commercial value. (Paragraph 117)

21. They are an important facet of the UK innovation ecosystem but a resource to be drawn on rather than a primary driver of commercialisation. (Paragraph 118)

The role of universities

22. We are sympathetic to the demand that universities become more accommodating to non-traditional backgrounds among their academic staff. We regard it as axiomatic that the extended presence of people with an industrial background within university faculties would facilitate a greater understanding of commercial imperatives and the most effective ways to engage university resources within businesses. (Paragraph 123)

23. We are concerned that driving an innovation agenda too aggressively through universities may have diminishing returns with regard to commercialisation and risk damaging the academic research that is working well. *We recommend that the Government's objective should be to create a commercial demand for university engagement to which they are already primed to respond. This echoes and reinforces the point made almost 10 years ago in the Lambert Review.* (Paragraph 127)

24. It is crucial that the Government has a coherent plan on how to engage the research base (people, facilities and intellectual property) with the innovation agenda. However, the current situation is fragmented and confusing and, as such, extremely difficult for small businesses to engage with. (Paragraph 136)

25. We ask the Government to provide, in their response to this report, its perspective on the adequacy of the national infrastructure for innovation, benchmarked against nations with which we compete and how it intends to remedy structural shortcomings, possibly along the lines recently recommended by the Council for Science and Technology. We recommend that Public Sector Research Establishments play a key role in this infrastructure and we plan, in future, to examine their role within the research and innovation ecosystem in more detail. (Paragraph 137)

Government procurement

26. PraxisUnico provides training programmes and networking events to improve technology transfer skills across the whole of the university sector. It is a good example of a government sponsored programme that delivered necessary skills across a disparate sector. We recommend that the Government should consider it as a model for the delivery of a coherent set of skills across the whole of Government procurement. (Paragraph 142)

27. *We were concerned that the SBRI scheme fails to assist companies to gain Government commercial contracts. We recommend that the Government ensure that its procurement officers, and those of other public sector agencies, are properly trained to take into consideration the wider public benefits of procuring services from small technology companies that have been developed through the SBRI.* (Paragraph 150)

28. *We recommend the Government examine the critical role of research hospitals in addressing the most challenging of conditions and explore ways of ensuring that funding encourages the development of innovative solutions.* (Paragraph 159)

29. *We consider it critical for the future of the bioscience sector in the UK that the Government ensures that a significant proportion of the NHS procurement budget is accessible by small innovative companies. The Government should incentivise NHS Trusts to engage with SME companies for innovative technology solutions. A similar approach should also be adopted across other agencies including local government, police etc.* (Paragraph 160)

30. Both the Crick institute and the Stevenage Open Innovation campus demonstrate that the Government is working actively with the industry to ensure that bioscience retains a strong presence in UK research and development. Government support for life sciences has been excellent and there is real innovation taking place in how that sector might be supported. (Paragraph 166)

31. We have not been persuaded that the Department for Business, Innovation and Skills has a strong enough voice across Government policy to effect the necessary radical change in procurement practices. Procurement by Government departments needs to focus on issues other than simply cost. *We recommend a Minister in HM Treasury be given responsibility for the delivery of procurement-driven benefits identified by the Department for Business, Innovation and Skills.* (Paragraph 172)

32. *We recommend that the Government, in two years, publish a breakdown of companies successful in tendering for Government contracts and compare whether greater openness in procurement has resulted in increased contracts among small and developing British technology companies.* (Paragraph 174)

33. During our inquiry we have become aware of the multitude of issues and problems that are faced by businesses in a variety of innovation sectors. Each of these companies find issues in funding that innovation but their concerns and needs vary from sector to sector and are often predicated on the size of the business. We conclude there is no single valley of death that all businesses, or even all small businesses, must cross. (Paragraph 175)

Final conclusions

34. What is consistent across business is the need for a clear vision from the Government to provide confidence into the future. Without a definite commitment from Government, business is more reticent about making its own financial commitment to the levels of risk that innovation requires. (Paragraph 176)

35. The evidence that we have seen shows that there is no coherent innovation policy. The Government has begun to consolidate its innovation policy by bringing more schemes and responsibilities within the Technology Strategy Board. We judge that this consolidation needs to go further and that the TSB should be given more funds including monies designed to better finance existing programmes such as SMART and SBRI but not at the expense of the Research Councils. (Paragraph 177)

36. We have seen a desperate need for government procurement to do heavier lifting than in providing encouragement to the growth of small technology companies. There is possibly a greater and more sustainable benefits to be gained by growing and developing small companies into successful medium sized ones than in attracting large companies. (Paragraph 178)

37. *There needs to be a coherent strategy across the whole of UK industry to provide UK business with confidence in where they might expect Government support for the medium and long term—whether through procurement, R&D focus or fiscal policies.* (Paragraph 179)

38. Finally we would urge the Government to seriously consider the financial markets and the inadvertent negative impacts that changes to policy there might have on innovation policy, for example how the regulation of pension funds has effectively starved technology firms of growth capital. Where it is not possible to foresee such impacts Government should be alert to the need to detect and to rectify them in a speedy fashion. (Paragraph 180)

Formal Minutes

Monday 4 March 2013

Members present:

Andrew Miller, in the Chair

Jim Dowd	Sarah Newton
Stephen Metcalfe	Graham Stringer
Stephen Mosley	Roger Williams
Pamela Nash	

Draft Report (*Bridging the valley of death: improving the commercialisation of research*), proposed by the Chair, brought up and read.

Ordered, That the draft Report be read a second time, paragraph by paragraph.

Paragraphs 1 to 180 read and agreed to.

Summary agreed to.

Resolved, That the Report be the Eighth Report of the Committee to the House.

Ordered, That the Chair make the Report to the House.

Ordered, That embargoed copies of the Report be made available, in accordance with the provisions of Standing Order No. 134.

Written evidence was ordered to be reported to the House for printing with the Report (in addition to that ordered to be reported for publishing on 22 February 2012, 18 April 2012 and 25 April 2012 in the previous Session of Parliament

[Adjourned till Wednesday 6 March at 9.00 am

Witnesses

Wednesday 18 April 2012

Page

Professor Luke Georghiou, Vice President (Research and Innovation), University of Manchester, and Professor of Science and Technology Policy and Management, Manchester Institute of Innovation Research, Manchester Business School, **Dr Paul Nightingale**, Deputy Director, Science and Technology Policy Research, University of Sussex (SPRU), and Exeter Business School, **David Connell**, Co-Founder, TTP Ventures, and Senior Research Fellow, Centre for Business Research/UK Innovation Research Centre, Judge Business School, University of Cambridge, and **Dr Douglas Robertson**, Chair, PraxisUnico, and Director of Research and Enterprise Services, Newcastle University — Ev 1

Dr Ted Bianco, Director of Technology Transfer, Wellcome Trust, **Dr Ian Tomlinson**, Senior Vice-President, Head of Worldwide Business Development and Biopharmaceuticals R&D, GlaxoSmithKline, **Dr David Tapolczay**, Chief Executive Officer, Medical Research Council Technology, **Dr Gareth Goodier**, Chair, Shelford Group and Chief Executive, Cambridge University Hospitals NHS Foundation Trust, and **Dr Andy Richards**, serial Biotechnology entrepreneur and business angel — Ev 10

Wednesday 25 April 2012

Katie Potts, Managing Director, Herald Investment Management Ltd, **Anne Glover**, Co-founder and Chief Executive, Amadeus Capital Partners Ltd, **Matthew Bullock**, Chairman, Centre for Business Research, University of Cambridge, and Chairman, UK Innovation Research Centre, University of Cambridge and Imperial College, and **Stephen Welton**, Chief Executive Officer, Business Growth Fund — Ev 20

Dr Richard Worswick, Chairman, Cobalt Light Systems Ltd, **Dr Peter Dean**, founder and Chairman, Cambio Ltd, and independent consultant, inventor and entrepreneur, and **Dr Trevor Francis**, Technical Director, Byotrol Technology Ltd — Ev 31

Wednesday 20 June 2012

Sir David Cooksey, and **Sir Peter Williams** — Ev 39

David Sweeney, Director (Research, Innovation and Skills), Higher Education Funding Council for England (HEFCE), **Professor Ian Haines**, Executive Secretary, UK Deans of Science, and **Professor Nick Wright**, The Russell Group — Ev 48

Monday 2 July 2012 (Advanced Manufacturing Research Centre, The University of Sheffield)

Wednesday 5 September 2012

Wednesday 12 September 2012

List of printed written evidence

List of additional written evidence

(published in Volume II on the Committee's website www.parliament.uk/science)

List of Reports from the Committee during the current Parliament

The reference number of the Government's response to each Report is printed in brackets after the HC printing number.

Session 2012–13

First Special Report	Science in the Met Office: Government Response to the Committee's Thirteenth Report of Session 2010–12	HC 162
First Report	Devil's bargain? Energy risks and the public	HC 428 (HC 677)
Second Report	Pre-appointment hearing with the Government's preferred candidate for Chair of the Medical Research Council	HC 510–I
Second Special Report	Engineering in government: follow-up to the 2009 report on Engineering: turning ideas into reality: Government Response to the Committee's Fifteenth Report of Session 2010–12	HC 511
Third Report	The Census and social science	HC 322
Fourth Report	Building scientific capacity for development	HC 377
Fifth Report	Regulation of medical implants in the EU and UK	HC 163 (Cm 8496)
Sixth Report	Proposed merger of British Antarctic Survey and National Oceanography Centre	HC 699
Third Special Report	Devil's bargain? Energy risks and the public: Government Response to the Committee's First Report of Session 2012–13	HC 677
Seventh Report	Educating tomorrow's engineers: the impact of Government reforms on 14–19 education	HC 665

Session 2010–12

First Special Report	The Legacy Report: Government Response to the Committee's Ninth Report of Session 2009–10	HC 370
First Report	The Reviews into the University of East Anglia's Climatic Research Unit's E-mails	HC 444 (HC 496)
Second Report	Technology and Innovation Centres	HC 618 (HC 1041)
Third Report	Scientific advice and evidence in emergencies	HC 498 (HC 1042 and HC 1139)
Second Special Report	The Reviews into the University of East Anglia's Climatic Research Unit's E-mails: Government Response to the Committee's First Report of Session 2010–12	HC 496
Fourth Report	Astronomy and Particle Physics	HC 806 (HC 1425)
Fifth Report	Strategically important metals	HC 726 (HC 1479)
Third Special Report	Technology and Innovation Centres: Government Response to the Committee's Second Report of Session 2010–12	HC 1041
Fourth Special Report	Scientific advice and evidence in emergencies:	HC 1042

	Government Response to the Committee's Third Report of Session 2010–12	
Sixth Report	UK Centre for Medical Research and Innovation (UKCMRI)	HC 727 (HC 1475)
Fifth Special Report	Bioengineering: Government Response to the Committee's Seventh Report of 2009–10	HC 1138
Sixth Special Report	Scientific advice and evidence in emergencies: Supplementary Government Response to the Committee's Third Report of Session 2010–12	HC 1139
Seventh Report	The Forensic Science Service	HC 855 (Cm 8215)
Seventh Special Report	Astronomy and Particle Physics: Government and Science and Technology Facilities Council Response to the Committee's Fourth Report of Session 2010–12	HC 1425
Eighth Report	Peer review in scientific publications	HC 856 (HC 1535)
Eighth Special Report	UK Centre for Medical Research and Innovation (UKCMRI): Government Response to the Committee's Sixth Report of session 2010–12	HC 1475
Ninth Report	Practical experiments in school science lessons and science field trips	HC 1060–I (HC 1655)
Ninth Special Report	Strategically important metals: Government Response to the Committee's Fifth Report of Session 2010–12	HC 1479
Tenth Special Report	Peer review in scientific publications: Government and Research Councils UK Responses to the Committee's Eighth Report of Session 2010–12	HC 1535
Tenth Report	Pre-appointment hearing with the Government's preferred candidate for Chair of the Technology Strategy Board	HC 1539–I
Eleventh Special Report	Practical experiments in school science lessons and science field trips: Government and Ofqual Responses to the Committee's Ninth Report of Session 2010–12	HC 1655
Eleventh Report	Alcohol guidelines	HC 1536 (Cm 8329)
Twelfth Report	Malware and cyber crime	HC 1537 (Cm 8328)
Thirteenth Report	Science in the Met Office	HC 1538
Fourteenth Report	Pre-appointment hearing with the Government's preferred candidate for Chair of the Engineering and Physical Sciences Research Council	HC 1871–I
Fifteenth Report	Engineering in government: follow-up to the 2009 report on Engineering: turning ideas into reality	HC 1667 (HC 511, Session 2012–13)

Oral evidence

Taken before the Science and Technology Committee

on Wednesday 18 April 2012

Members present:

Andrew Miller (Chair)

Caroline Dinenage	Sarah Newton
Gareth Johnson	Graham Stringer
Stephen Metcalfe	Hywel Williams
Stephen Mosley	Roger Williams
Pamela Nash	

Examination of Witnesses

Witnesses: **Professor Luke Georghiou**, Vice-President (Research and Innovation), University of Manchester, and Professor of Science and Technology Policy and Management, Manchester Institute of Innovation Research, Manchester Business School, **Dr Paul Nightingale**, Deputy Director, Science and Technology Policy Research, University of Sussex (SPRU), and Exeter Business School, **David Connell**, Co-Founder, TTP Ventures, and Senior Research Fellow, Centre for Business Research/UK Innovation Research Centre, Judge Business School, University of Cambridge, and **Dr Douglas Robertson**, Chair, PraxisUnico, and Director of Research and Enterprise Services, Newcastle University, gave evidence.

Q1 Chair: Gentlemen, thank you for coming in this morning. It would be helpful for the record if you would be kind enough to introduce yourselves.

Dr Robertson: I am Douglas Robertson, Chair of PraxisUnico, and Director of Research and Enterprise Services, Newcastle University.

Dr Nightingale: I am Paul Nightingale, Deputy Director of the Science and Technology Policy Research Unit, University of Sussex.

David Connell: I am David Connell. I am a Senior Research Fellow at the UK Innovation Research Centre at Cambridge University, but my background is in the technology community, including as co-founder and chief executive for many years of an early-stage venture fund in Cambridge.

Professor Georghiou: I am Luke Georghiou, Vice-President for Research and Innovation at the University of Manchester, and also a professor in innovation studies.

Q2 Chair: We have a lot of ground to cover this morning. If one of you is asked a question and others want to supplement it, please feel free, but if there is a repeat answer just say so, if you are agreeing with each other. First of all, can I start off with some definitional issues? Does innovation begin with the intellectual property or the entrepreneur? What is the beginning of the process?

Dr Nightingale: Most innovation takes place in firms rather than with individuals. Most innovation takes place in large firms rather than in small firms, and most innovation does not involve intellectual property. There are other ways in which you can protect innovation: secrecy, complexity, degrees of scale and being first to market. When we are talking about innovation and IP we are talking about a subset of innovation, but it is particularly important in high-tech areas where lots of economic growth is driven from. In terms of entrepreneurship, the areas of innovation where entrepreneurship in small firms is important are biomedical, innovation, software and so on, but in general the focus for innovation policy should be on firms—and large firms—rather than start-ups.

Dr Robertson: When you look at the IP landscape, it is important to recognise that tacit knowledge is incredibly important, not just formal intellectual property; it is ideas that matter. Very often when a piece of technology is patented and starts to be worked up commercially, it is not that protected technology that gets to market. It is a second or third-generation technology that gets to market, alongside the tacit knowledge that comes through people.

David Connell: The answer is that it can be both, together or separately. There are important differences that have led to some confusion in innovation policy. If you look at, for example, Cambridge's most successful science and technology companies, there is a general assumption among many people, including policy makers that the innovation in those companies is based on university IP. The reality is that the overwhelming majority of the most successful, in terms of job generation and sustained profitability, are based on solving customer problems in a business environment.

The second part of the answer is that policy is often influenced by looking at the experience of some very high-profile, internet companies—for example, Facebook and Google—where it is the entrepreneurial drive that is the key rather than the university IP. Therefore, it is easier to demonstrate a working product with real users, the time to market can be much quicker and the risk is much lower. I take it that the focus of this Committee is on deep-research-based IP and innovation.

Q3 Chair: I want to turn, specifically, to universities. In terms of universities hanging on to IP, is there a rule of thumb about how long that should be or is it on a case-by-case basis?

Professor Georghiou: There is no rule of thumb. We do not find IP ready in our labs. What we find are researchers with good ideas. It often takes assistance and some work on proof of concept, both technologically and with commercial advice, to generate IP. We see our job as holding on to it long enough so that it is stable in a way that we can successfully hand it on, either in a licensing or spin-off mode. So we are custodians of it. It is not our intention to keep it forever.

Dr Robertson: It is important to recognise that one of the challenges with intellectual property protection is that it is a right to stop people doing things. Therefore, if it leaves the university and goes into the hands of somebody who does not wish to use it, it becomes a mechanism for stopping innovation rather than advancing it. The answer, as Luke indicates, is holding on to the intellectual property for sufficient time that it can then move on to someone who will make good use of it. The rule of thumb is don't hold on to it if someone else can make good use of it and start paying the fairly heavy protection costs that are involved, but don't let go of it until you know that you have a reliable partner.

Dr Nightingale: I would agree with this point. There are two issues. There is how long universities should hold on to it for the good of universities and how long universities should hold on to it for the good of UK plc. These two issues can be in conflict. For the good of universities, they will want to hold on to it for, perhaps, longer than they should and try to commercialise it, but it may be better for UK plc to distribute it much more freely. The most successful model of this would be the University of California. Their IP model is to disperse discoveries and IP as broadly as possible for the benefit for the State of California, because it is publicly funded, not for the benefit of the University of California, and that seems to be a very successful model.

Dr Robertson: I have one further thing to add. The Universities of Glasgow and Bristol and King's College are running a pilot scheme on something called "Easy Access IP", where, basically, they look at their intellectual property portfolio and divide it into two components—one that they feel they can do something with and one that they feel they cannot do anything further with and it is better to be in the hands of others. They make that available on non-exclusive licence terms without necessarily the requirement for payment. That scheme is starting to generate some interesting results. It has only been running for just over 12 months.

Q4 Chair: Stemming from that, should universities extend their traditional role of teaching and research to encompass commercial activities?

Professor Georghiou: I think we should. We should not let it dominate our activities. Clearly, research and teaching are at the core of what we do. We also have a third mission—a mission of social and economic responsibility. It also provides a focus for teaching our students entrepreneurship. If we are not doing it ourselves and we do not have the mechanisms, it is difficult to engage them. A very important area highlighted in the Wilson inquiry now is the idea that you start engaging students with entrepreneurship at the earliest possible stage in their careers.

Dr Robertson: One of the challenges for the UK is this tension between the university direction of travel and the benefits for UK plc. One of the real challenges universities face is the absorptive capacity of UK industry. We only have two of the top 50 companies in the world in terms of investment in R & D as a percentage of a country's GDP. They are AstraZeneca and GSK. Therefore, it is finding a UK partner that the university can work with in order to trap the benefits for UK plc. To some extent that is why some universities pursue the venturing route because that attempts to trap the value in the UK as the company is formed in the UK, and, hopefully, the investment and employment flow into the UK.

David Connell: Clearly, universities are already embracing that objective significantly. My colleague made a very important point—if we want to create jobs in the UK we have to look to spin-outs and exploitation by medium-sized companies of university IP as the key mechanism, not necessarily partnering with big companies, which will almost certainly be based overseas.

The problem that we have faced in the UK is that some policy makers have tended to assume that universities can take the development and exploitation of some research further along the process than is actually possible within a university environment. Universities are about teaching and publishing papers. Academics do not work full time on development. Staff are predominantly PhDs and post-docs, who tend to move on quickly, making it difficult to build spin-out teams. It is difficult to manage IP produced over the course of a project or succession of projects. University academics rarely have the technical means to produce demonstrators, which is what is required to engage with the commercial community. That means that there is an intermediate stage in the innovation process, which I call the exploratory development phase, which cannot usually be undertaken in a university, but has to be done in a more or less commercial environment before an innovation is sufficiently advanced to be funded by venture-backed capital.

There are two policy solutions to this problem, in my view. One is creating new and specialised institutions, such as the Fraunhofer Institutes in Germany, to undertake that role. The other solution is to put substantial Government money into very early stage companies, at the point before they are ready for venture capital investment, which is, essentially, the US approach through procurement-based policies, such as SBIR. We have, collectively, assumed that universities can go too far in the direction of commercialisation and we need to recognise that there is an intermediate stage that needs to be filled.

Dr Nightingale: If the taxpayer is going to pay money to universities, then universities have an obligation to contribute towards economic development activities, and that is widely accepted. The key issue would be the diversity of the university system. The UK has universities like UCL, Imperial, Cambridge and Oxford, which are world class at moving technology into the economy, and it has other institutions that do

not have that capability. Overall, that capability is, probably, pretty low. If you asked the venture capital community what they thought of technology transfer offices, you would get a fairly negative response. One comment that I heard was that there are three things wrong with universities: they are ignorant, greedy and risk averse. Not all universities are like the University of California, and we have to accept that diversity, but there is nothing wrong with universities not being world-class technology transfer institutions. It is perfectly fine for them to be teaching institutions.

Professor Georghiou: Can I disagree with my two colleagues? Our leading universities I would hope we are within that group, but also Imperial College, Cambridge, Oxford and Newcastle are, in my view, as good as US universities in fostering technology. We normally work through subsidiary companies in partnership with venture capitalists, who exercise a commercial discipline on every decision that is taken. We have a number of companies that have been capitalised in the hundreds of millions, exporting the highest of technology around the world. The challenge is more to spread that expertise rather than to try and replace it with what sound to me like bureaucratic structures—not commercial ones. We always have a challenge in situating a different kind of activity in the university model. The way to do it is to put it at arm's length and make sure that commercial people are driving it.

Q5 Chair: Would you like the last word before we move on?

Dr Robertson: I have to react to the comment that Paul made with regard to the venture capitalists' view of universities and technology transfer offices. The amount of true venture capital funding under management by BVCA members is 4% of the BVCA funds under management. It comes to £313 million a year from the early stage, through seed to the next round of funding. That is a very small amount of money to invest to try and support venturing out of a science base that is the second best and, in some cases, the best in the world.

Q6 Stephen Mosley: We have heard evidence that the traditional "linear" model of innovation—basically, in which a university generates research that moves forward, is then transferred and commercialised—has been discredited, to quote. Would you agree with that analysis?

Dr Nightingale: Yes. The point made by David that the majority of innovations and high-growth firms in the Cambridge area are spinning out of firms, not universities, is supported by a large amount of research. High-tech innovation is only 3% of the economy. Universities do play a role, but their main role is generating well-trained people.

Professor Georghiou: I agree with that. I don't think it is discredited; rather, it is a special case that happens only in a limited amount of circumstances. The worry is that it often is given more weight in policy making than it should be, and we lack the kind of things that David Connell was talking about—the importance of interacting with users, with the demand side, and therefore using instruments like public procurement.

Q7 Stephen Mosley: You have come on to my next question, which is, do you think that Government and organisations like the TSB put too much emphasis on the linear progression, and are those organisations flexible enough to cope with how it really works?

Dr Robertson: The challenge is that, if you try to institutionalise something, the linear model suits a process that is easy to manage and to challenge. The challenge for technology development is that it is full of failure. You don't just succeed. If you fail, you then figure out why you failed and you go back into an iterative process, sometimes having to go back quite a long way to go through the next stage in development. That is a very difficult model for public sector investment because it is about investing enough to succeed but being aware that you will invest and fail. That is a tough job for people like the TSB, who are looked at as the major innovation agency in the UK. It is a real challenge for them, but that is why the venturing model is one that I, personally, favour, because venturing is about investment and not grant funding. It takes you into a quasi-commercial environment in order to pursue a technology that you have to have enough money to fail once or twice. You have some other people giving evidence later this morning who will give you ample evidence on the demise of the linear model.

David Connell: Can I comment on your question also and an earlier remark about venture capital? An interesting question is, if it is not the linear model, what is it? Clearly, there are a whole variety of different ways through which technology is turned into commercial products. It can take a lot of time over many different actors and organisations, based all over the world sometimes. Again, there are useful lessons from looking at Cambridge, which is probably our best example of a science and technology cluster. There is a particular model that is really prevalent there, and that is is sometimes called the soft start-up model, whereby companies quite often start not by developing standard products for a wide market, probably with venture capital as backing, but by undertaking development contracts for individual customers, perhaps based around a piece of IP or based around their technolgical expertise and skills. Over time they might build a contract R&D business—that is a service business—or they might move out of that model into developing a product business on the back of that as a result of stumbling across a generic opportunity or building a piece of IP. The soft start-up model is the dominant model in Cambridge amongst the most successful companies. In fact, the key source of jobs in product companies in Cambridge is four technology consultancies—really contract R & D houses—which have their origins 50 years ago in three young engineering graduates who left the University of Cambridge to offer consulting services to industry. Through spin-offs this has lead over the last 50 years to a sub-cluster of companies that make a living by developing products and technology for individual customers. Over the last 30 years, they have together also created more jobs in sponsored spin-out companies making and selling standard products than the entire university.

You can see this model replicated in other areas. For example, there is a very successful CAD software company called Aveva—a product company, employing 500 people—whose origins were in what was effectively a predecessor of the TSB's new Catalyst institutes, actually set up by a Labour Government in the '70s, and called the CAD Centre.
The point I want to make is that it is really helpful to look at the process of creating employment out of research and innovation as being a two-stage process. The first stage is to create expertise-based organisations that do R & D for money, through commercial contracts for individual companies. The second stage is then to move into products, which is when you begin to get the more substantial employment gain. With different nuances, you can see this model being applied across a whole variety of different sectors. This is not just in Cambridge, by the way, but also elsewhere. Microsoft was a soft start-up. Vodafone is a spin-out from Racal, which was a classic soft start up. Wilson Microelectronics in Edinburgh, which is probably Scotland's most successful new technology business, was a soft start-up. It moved into developing and selling products as a second stage, after just providing semiconductor contract design and development contracts for many years.

Dr Robertson: The important aspect of innovation and developing research is to think of it as at least two different categories. There is revolutionary change and there is evolutionary change. For the most part, existing companies are very good at evolutionary change. That is about the next increment on their product range. It is in a comfort zone in a market that they are fully aware of. The challenge for modern economies is how you tackle revolutionary change. You would not manage to sell a new model of light bulb taken by a candle manufacturer because it would undermine their entire market. Therefore, it is how you tackle revolutionary ideas. The stuff that comes out of universities, out of basic science and basic engineering, and the stuff that we want to trap in the UK, are the revolutionary ideas—the ones that will create completely new industries as well as assisting the continuous process of evolutionary development through existing businesses.

Professor Georghiou: If I could just come back on the soft start-up, hearing about Vodafone, I spent most of the 1980s evaluating the country's probably last very large public technology programme—the Alvey Programme for Advanced Information Technology. That company had its origin in this public technology programme, and many others do as well. We do not have the same level of input going in now, although the TSB is the natural successor, but we should not neglect the fact that private success is often founded in a public activity.

Q8 Stephen Mosley: Finally, what role, with the model you have just outlined, have the Government and organisations like the TSB got to play in that?

David Connell: The key to making this model work, and it is something that venture capitalists look for as well in the companies that they back, is lead customers. What does a lead customer do? What a lead customer does is, essentially, to react to the technology and opportunities being presented by a technology company and commit to paying for feasibility studies and demonstrator developments, or maybe buying anearly prototype for that technology to be applied to the customer's particular needs, sometimes even with a view, if it is successful, for that product to be sold to its competitors.
Again, in Cambridge and elsewhere—all over the world, actually—you see the private sector playing this role. Pharmaceutical companies like GSK have played a terrific role in funding the development of drug discovery research tools, for example. However, you do not see the lead customer role applied in all sectors. The issue is, what can Government do? Government, as a very substantial part of the purchasing economy through procurement, can play a similar role to the private sector by specifying problems that officials in its departments and agencies believe need to be solved and technologies they believe they need developed either as users or as specifiers, or for policy reasons, and then funding, as a customer, the development of those technologies within small companies.
In the US there is a very effective programme which does this called the Small Business Innovation Research Program, which is worth about $2.5 billion a year. There is about as much money again, or more, coming through other programmes, which fund this kind of development. It is about as unbureaucratic as you can get in a public sector programme, because it is competitive and because it tries to link company developments to customer needs. . I would argue that what the UK should do, and this applies also to the European Commission, is to switch a substantial part of its innovation budgets—and in the case of the UK I am talking about TSB money and also R & D tax credits—into private and public sector programmes of this kind.

Dr Robertson: What Government can do, and it is a tough call in a recession, is to invest. There is hardly a country in the developing world that is not investing substantially. The US, which is lauded as a private sector-led economy, invests far more in co-investment with business through the SBIR scheme than any other country in the world. The public sector intervention is a real challenge in the early stages of technology development, but for the UK I do not think there is much alternative. In a scheme that was run a few years ago, which was called "University Challenge", the Government put £65 million in two rounds into a consortia of universities to establish their own venture funding. Some of those funds are now evergreen, like the Lachesis Fund in the Midlands. The University Challenge funds had £65 million of public sector investment and generated £430 million of private sector investment. That 1:7 leverage is exactly the kind of initiative we now need alongside our procurement strategy, which, as has just been indicated, needs to be innovation oriented, and alongside an SBIR scheme that creates an environment where winners can emerge, rather than endeavouring to pick winners.

Q9 Hywel Williams: Taking on the point that Dr Robertson was making about failure leading to success, the phrase "picking winners" is used quite a lot. Do the Government strike the right balance as between being too selective or not selective enough? How do you avoid wasting money on prolonging the lifetime of weak ventures of weak companies?

Dr Nightingale: How do you stop prolonging the support for weak firms? Don't support weak firms. There is very little evidence that supporting weak firms has any economic benefit. There is a debate going on in economics that it might be harmful for the economy to have too much rubbish messing things up. That was rather brutally put.

The key issue from economics literature on this point is that it is not the case that there are good firms that continue to grow over time. Even firms that have grown very well for 10 years may have a bad period. The growth of firms is very close to a random walk. It is very close to tossing a coin. The ability of anyone to pick winners is almost non-existent. I have a large research team and fantastic data; I can explain about 2% of the variants. This is the reason why it is very difficult to make money from technology investing. I would not advise the Government to try and pick winners. I would advise Government policy makers, if someone says that they can pick winners, to accept that they can't and that they should put their own money in before the taxpayer puts money in. The issue, as has been mentioned before, is to create an environment where you can have growth, job creation and innovation. It is not necessarily by picking firms, but by creating that environment where some firms may grow one year and a whole group of different firms may grow the next year, and it does not matter to the economy that they are different.

Dr Robertson: The challenge for the TSB is fairly large, but there is a danger of coming up with too many schemes targeting too little money in too-narrow areas. I understand the rationale that says, "We need some activity in this area," so it then leads to a move. It is a real challenge for them to get the balance right, but they need to have a sufficient portion of their funds that are responding to bright people with bright ideas that nobody has thought of apart from those bright people, and focus not on that project and evaluating that project, but on evaluating the team, the partnership and the people. That is the way universities work fairly effectively with businesses. When it works, it works swimmingly well. Actually, it is a real challenge for a university that finds a company it wishes to work with to then find a scheme that will bring in public sector intervention to support that partnership if it does not fit something that somebody else has already thought of. I would see a more responsive portion of the TSB funding being in SBIR and being in collaborative grants for research and development without pre-determining the area of activity.

Professor Georghiou: We should not confuse picking winners in companies—I fully agree with everything that has been said—with picking markets or, in some cases, technologies. We have to have some benefits of concentration and focus. A country this size simply cannot afford to cover everything. If we spread out the money evenly, we would be behind everybody.

David Connell: I agree with that. Who, 20 or 30 years ago, would have picked vacuum cleaners as an area in which the UK would have built one of its most successful new companies? One of the ways though that we can focus innovation support is through an SBIR programme. We have had a broadly similar "SBRI" programme in the UK, as you will probably be aware, for the past three years. It is quite small, about £20 million per annum. It would need to be worth about £250 million per annum if it was going to be equivalent to the US programme, bearing in mind the relative sizes of the economies. The way that it works is by using potential public sector customers and users to define the problems that need to be solved and then running the programme competitively at different stages. So companies, if they are successful, initially win a £100,000 Phase 1 contract to do undertake a feasibility study, and then companies reapply and roughly half go on to win a Phase 2 contract, typically worth £500k to £1m based on progress during Phase 1. There is therefore a natural process of progressively focusing funding on the best projects, unlike the kind of grant programmes that we have tended to operate in the past, frankly.

Q10 Gareth Johnson: You highlighted the problem of picking out winners and trying to identify those companies that are likely to be successful. Would you say that that applies to situations where we have previously had match funding and, therefore, also had problems in doing that? Mention was made about vacuum cleaners. Dyson is probably the best example of disruptive technology. It is pushing out an existing technology. If we went down the route of having more match funding, do you think it would have a disruptive effect on those companies that are trying to muscle in on technology that already exists?

Dr Nightingale: We have done an evaluation of the match funding scheme run by BIS. Our conclusion is that they are effective, cheap and generate jobs. The problem of being able to go better than 2% in predicting growth is so difficult that you need to have professional investors, but professional investors—because it is difficult to make money out of innovation—find it difficult to raise money in the markets. Match funding is an effective piece of Government policy. The UK has been running high-risk schemes for a long period of time. BIS have learned well and they have schemes that work. This is a piece of public policy that I would support. There seems to be a lot of support among my colleagues here for the SBIR initiative in the United States.

I did some work for your colleagues on the House of Lords Select Committee, and I reviewed the literature on this. Two types of evaluations are done. One is evaluations where you ask people whether they think it is a good idea that they got money for free, and they generally come out with the answer, "Yes." There are other evaluations where they look at controls and do proper econometric analysis. As far as I am aware, there have only been two proper evaluations of that scheme, and both of them found that it did not produce major improvements in job creation. One of

them found that it produced no improvements in job creation. However, it does play a very important role in providing accreditation for the value of technology, so it provides due diligence for free. It plays an important role that way, but it is not going to solve the Government's problems.

Dr Robertson: I certainly favour match funding schemes. I don't favour the Government pre-determining the areas in which that match funding should take place. Government officials should be judging proposals that are put forward by partnerships between universities and companies and companies with other companies, rather than trying to pre-determine the outcome and deciding if that is a good investment of public money, because that decision has to be made. Too often it takes too long for a company to come through some of these systems and they just don't think that it is worth the effort. What that means is that they do not work with that university to take on that high-risk idea. They will stick to the knitting, and they will do what they do very well, but without taking their company, maybe, into a new technology sector or a new challenging field.

The KTP scheme, in terms of evolutionary technology developments, is a very good co-funding scheme. It has been running for over 30 years. One of the reasons why it works is because it has advisers who work with the company to help them figure out how to get through the process. It means it is more costly because you have to provide advisers, but, when you have the investment in business R & D that we have in the UK, we have to create more businesses investing in R & D. I see co-funding and not tax credits as the way to get people to do something that they had not previously thought of doing as their company tries to come out of recession. A recession, to some extent, forces companies to think of new developments, so it is a good time to further develop co-funding schemes.

Q11 Graham Stringer: This is fascinating. To take a real recent example, £30 million to £40 million is the next stage of development of graphene at the University of Manchester. I would be interested in Professor Georghiou's view about whether that is a good decision in the light of what you have just said.

David Connell: I will go first while you are thinking. It is very hard to say whether or not this was a knee-jerk reaction to the scientific breakthrough.

Q12 Graham Stringer: You take my point. What you are saying indicates that it is a bad decision.

David Connell: No, I am not indicating that it is a bad decision. What is really important is that we have research excellence in the UK. Really high-quality research universities are critical to any economic activity and to any cluster, as much as anything because of the people that they train. I do not know enough about how that particular research centre is being structured, but the question is—if it is, essentially, for the time being, a university-style managed research environment—whether that will enable the technology to be taken far enough to be turned into products. I suspect it is a 15 or 20-year journey, in which case it is probably the right decision. But we will probably need some further decisions to ensure that we get to the end point that we need, in terms of economic impact.

Professor Georghiou: Graphene is the kind of opportunity that, probably, only comes along once every 20 years. It is different and it has to be treated differently. We have a strong world scientific lead. We absolutely dominate the science in this field, although almost every other major country is investing far more than we are. Our £50 million does not look large on the international scale at all.

The National Graphene Institute is partly there to secure the leading science, but it was formed also to support commercialisation in two ways. It has a built-in incubator for start-up companies, which we already have, and it is also there to attract business into and from the UK to work with a number of companies in developing the technology. Some aspects of it, as David said, will take 20 years to realise. Others, already with people like Samsung, will be appearing in next year's or the year after's products. It is a little bit different from lasers, let's say, where there was a very long time to market. We are doing everything we can to support that economic benefit being realised.

I talked earlier about student entrepreneurship. We have 50 PhDs in the graphene area, all of whom are having entrepreneurship training, not just from academics but with leading venture capitalists and others coming in. They have been hugely enthused by this. Several of them are already thinking about forming their own companies or going to work in an entrepreneurial environment using their own science. So we have a huge opportunity here.

Dr Robertson: Graphene is an interesting example. It is certainly an exciting technology. Anything less than £50 million probably would not have scratched the surface. One of the challenges sometimes is not the amount of money, but the flexibility that comes with that money and whether it can be used for capital or capital and recurrent. We are quite good at the starting investment in those areas, and quite often it is highly capitally focused. The question then is that you have to create an environment that would allow graphene to be truly captured in the UK, which will take recurrent funding on a regular basis with a rounded approach, as Luke indicates, looking at enterprise, developing the staff and the students in the graphene area to be true hybrids between science and enabling commercialisation on the back of that science.

Q13 Stephen Metcalfe: I would like to pick up on some of the issues around funding and particularly the way it is allocated. We have a number of submissions about how the Government allocate funding across the entire science and technology spectrum. Bearing in mind that the Government have a limited amount of resources at the moment—it is a tough economic climate—have they got the balance right between basic research, the Higher Education Innovation Fund and the TSB? Is where they are putting the money correct and are they supporting commercialising innovation?

Dr Robertson: That is a good question.

David Connell: I will attempt to answer the question. I will also comment on an earlier question that is related to this matter, which is about match funding.

Let me pick up match funding first. Match funding can take place in two ways: first, by the Government giving a company a grant on condition the company puts money alongside that. That is fine for large companies. For small companies that is really difficult. Most small companies do not have venture capital. Only a tiny minority have venture capital, cash assets or the profitability to sustain those investments. The way small companies succeed, in the main, is through fully paid contracts from customers. The Government would do well to emulate that.

The other kind of match funding is through the way in which Government has sought to encourage private sector institutional investment in venture capital funds by acting as lead investor—on the same terms as private sector investors—in specialised "fund of fund" vehicles which will invest in this kind of asset.. The problem with that is that the average return on venture capital, especially at the early stage, in the UK is round about zero. This is true across Europe. And it is a long-term issue. This is not a temporary problem. For a long, long period you would not have wanted any portion of your personal pension funds invested in a basket of early-stage UK funds. The lack of venture capital in the UK is not market failure. This is rational behaviour on behalf of our pension funds. So, if we want a viable venture capital industry, government either needs to provide significant, non-equity, financial support to start ups and small technology firms directly or it needs to have some kind of two-tier structure for its investment in VC funds in which Government takes on more of the financial risk, thereby making it more attractive—for the private sector to play its role.

Coming back to your broader question about funding—if we put aside the funding that goes into universities for the time being—if you look at the funding that goes into companies, there are, broadly, three or four elements to that. There is the TSB collaborative R & D programme, of which, I guess, probably about £150 million, maybe, goes into companies. Historically, the majority of that has gone into big companies, although the situation is changing a bit now. There are some small schemes that probably bring in a bit more. Then you have R & D tax credits that cost the Government a billion pounds a year, three quarters of that going into large companies.

If you just look at that portfolio, the companies that benefit most are large businesses. Large businesses have very strong lobbies, as of course does the university system. The part of the economy that does not have a strong lobby is small businesses, particularly small technology businesses. Basically, their directors are too busy to lobby, frankly. That is where money needs to be shifted. It needs to be shifted, first of all, more towards small businesses, and, secondly, it needs to be focused on the higher risk investments in R & D that those companies undertake. Important beneficiaries of the R & D tax credit scheme appear to be the banks, for example. According to the 2009 BIS R & D scoreboard, HSBC and RBS came above BAe Systems and Rolls-Royce in terms of expenditure on R & D, despite the fact that five years previously they had not admitted to spending more than a million pounds each. Who knows what the background to that is? What it suggests to me is that the R & D tax credit programme has grown to the extent where it is supporting a lot of routine R & D, which, basically, companies ought to be able to fund themselves. We should be trying to find a way of focusing that substantial part of the spend on the higher risk, longer- term, more difficult area of R & D, which is where companies really need help.

Dr Nightingale: There are really two issues. In terms of research, the big issue for the UK, compared with the United States, is that we spend about half as much as a percentage of GDP on research as they do. That has a big impact on our economy and a big impact on high-level skills. The big issue in terms of research is that we are an also ran. We are not playing in the premier league of international investment in university research.

When it comes to commercialisation, the issue is not so much how much money do you put in, because such a small number of innovations actually generate high returns—it is very skewed—but it is whether or not you are putting money into programmes and institutions that will generate that innovation. We have put a large amount of money into the Regional Venture Capital Funds, and that was, effectively, a waste of time. However, in the United States they have a VC scheme where they make very small investments in a tiny number of companies. VC in the US invests in about 600 to 800 early-stage companies a year. For an economy the size of the US, they have generated over a third of their stock market capitalisation. So it is a tiny proportion of firms that make all the difference, and you need professional investors to do that. People like me who work in universities are unable to make those decisions. Match funding to build up a professional investor system is very important, but it is not so much the amount of money; it is whether it is going to the right institutions that counts.

Q14 Chair: Can I just hold fire at the moment, both colleagues and witnesses? I am conscious of the fact that one of our next witnesses is on a very difficult time schedule. Can we speed up the responses? If there are additional pieces of information, I would be grateful if the witnesses would formally write to us.

Dr Robertson: We are heading in the right direction. If we wish to retain the quality of British science, it will be difficult if we move funding away from the basic science budget and stay in that position given the comments that have already been made. I would make a plea from my sector's perspective. The University Challenge Seed Fund Scheme was a very powerful scheme generating partnerships with venture capital and, potentially, now partnerships with corporate venture capital, which is becoming incredibly important. It is part of the "valley of death". If we want to capitalise on our higher education base, we need to make those kind of investment decisions alongside the things that Paul has just mentioned.

Q15 Stephen Metcalfe: Very briefly, because I am conscious of what the Chairman has just said, does the TSB have enough money allocated to it to make a difference to UK plc?

Dr Nightingale: I return to my earlier point. It is not the amount of money, but whether it is going in the right place.

Professor Georghiou: First of all, it should not be a trade-off with RCUK and HEIF because those are both underfunded as well. We should think of the overall investment in the growth of the economy. Bearing that in mind, it is probably still sub-critical in the amount of money it has by international standards. If we look at successful public technology investors, like Germany or Finland, they, relatively, have considerably more.

Q16 Stephen Metcalfe: You are not suggesting moving money from the research budget.

Professor Georghiou: No; absolutely not.

Dr Nightingale: Certainly not.

David Connell: My view is that substantially more funding is needed of the kind that the TSB deploys. I would like to see more of it deployed through spending Departments as customers—not from the research budget, but from maximising the innovation budget for business.

As our time is coming to an end, can I make an invitation? I would like to invite the Committee members to come to Cambridge—we have a compact cluster of companies—and visit some of the businesses of different shapes and sizes that illustrate some of the points that we have all been talking about. Perhaps you could come up for half a day or a day. I would be delighted to help you with that.

Chair: I will take you up on that, thank you.

Q17 Pamela Nash: I will put all my questions into one, considering we are very short on time. In your opinion, compared with our main competitor countries, what are the barriers in the UK to the commercialisation of science? I would, in particular, like to know what your opinion is, David, of the Government's recent policies in trying to bridge those barriers, and particularly will the new Catapults help to bridge the gap at the moment between universities and companies? Also, is the Technology Strategy Board taking the right approach at the moment?

David Connell: Catapults are part of the right solution. We do need those kinds of organisations for long lead time technologies. We are virtually the only advanced country that has not been investing significantly in that kind of organisation. There is still a question mark over whether they are being designed in the way that many of us would like to see. Seeing them spread over different geographical organisations is not the right solution, in my view. They need to be focused, well funded and managed in a very commercial way. More generally, a lot of what both this Government and the previous Government have been doing has been moving very much in the right direction. The same is true of the EU, by the way. The new EU Horizon 2020 proposals include very significant changes in terms of supporting small technology businesses. But there is still more to be done. The devil is in the detail, very often, in getting the policies right.

Q18 Pamela Nash: Who do you think the Government should be speaking to in that case, in order to improve the Catapults?

David Connell: That is very easy. The best role model for the Catapult centres, actually, is the four Cambridge so-called technology consultancies. Catapult centres are, basically, broadly based on the Fraunhofer Institutes in Germany, which employ 16,000 people in 60 different institutes. They are about partial Government funding of commercially orientated R & D organisations, which will then spin off companies and exploit technology commercially. The best people at doing that are the Cambridge consultancies, but they do it without Government support. The Government would do well to draw on the expertise of those consultancies.

Dr Robertson: As to major barriers, one is the early-stage venture environment. It is a real challenge in the UK. The second major barrier is the absorptive capacity of UK industry, primarily because business investment in R & D is among the lowest in the OECD countries. That is why schemes like co-investment and co-funding have to be used to catalyse the business community. In terms of who we need to be speaking to we need to be getting more of our bright technology entrepreneurs, chief execs and chairs into the room, rather than relying on people who are working with large companies that do not have a significant UK footprint. It is a real challenge for the UK, but we have some very bright technology entrepreneurs and those are the people who should be being consulted and talked to.

Dr Nightingale: In terms of commercialisation, the UK is very good compared with the rest of Europe, with the possible exception of Scandinavia. There is an issue about relative amounts of GDP that we spend on university research. One of the problems we face is unrealistic expectations about things like spin-outs, SMEs and whether or not they are going to produce that much, because there is not much evidence that they do. The key issue is that we need proper evaluation of these schemes. We really don't know what works. It is very complicated right now and this has been a problem. I would make the suggestion that, if we wanted to reallocate some money, we shut down the Patent Box scheme. Take that billion and put it into whatever schemes that you suggest. That is probably one of the worst pieces of public policy that I have ever seen in my career.

Q19 Caroline Dinenage: I am going to take a leaf out of Pamela's book and formulate my questions into one big one. The Wilson review highlighted the lack of data on the innovation ecosystem. In your view, is there a sufficient evidence base to inform the Government's decisions in this area? It also said that there was no single overriding voice across the whole innovation landscape. I would like to hear your thoughts on that. Finally, was the University of Oxford right to say that the innovation ecosystem suffers from initiative-itis?

Professor Georghiou: First of all, on initiative-itis, it is a problem that has been with us for, probably, 15 years. It is not something new. We tend to have a lot of clever schemes that are too small, are recycled, re-announced and, therefore, confuse the client communities—particularly the small business client communities. So larger, more flexible and more long-running schemes would certainly be better. On evidence, yes, we need better evaluation. We have probably gone a little backwards on that, having been, maybe, the leading country in the area a few years ago.

I should call attention to the fact that my colleagues in Manchester are working with Nesta to provide a compendium of evidence on innovation policy initiatives, trying to pull together what has been learned about these around the world. This will be a useful resource that is coming through now.

If I could, very briefly, wind back to the previous question that relates to main barriers, one more thing should come into the evidence, which is that we keep looking inside the research and innovation system, but our biggest barrier is probably an insufficient entrepreneurial culture outside it, whereby we can get our bright students wanting to work in small and high-technology companies.

David Connell: I have a very brief comment. It is not so much on evaluation but on reporting the basics. If we look across Government organisations involved in technology, rather than providing annual reports in the format that you would see from a public company, they tend to produce brochures with examples of what they are doing at the time. It would be really good to know where the money went, actually, and to see some proper reporting to the kind of standards that we should demand.

Dr Robertson: I would echo that. Case studies and lessons learned are very valuable ways to evaluate these schemes. You have to be careful. Many people around the world have been studying innovation, and if everybody cracked it we would not be where we are. There is plenty of evidence. It is the boldness of decision making that is the next key step.

Dr Nightingale: On initiative-itis, they should be flexible and larger. They should be integrated. On evaluation, there are far too many poor-quality evaluation reports where they ask people whether it is a good idea that they receive free money. They are a waste of time. If you look at a country like Finland, they build proper evaluation into every single public policy scheme. We should be doing that, but we do not.

Q20 Sarah Newton: Thinking about some of the new technologies that the Government have prioritised, such as offshore renewables, to what extent do you think we should be looking at the geographical locations of research institutes to support these new emerging industries and technologies?

Professor Georghiou: Geography is really important. David was talking about the Cambridge cluster. We have a number of other clusters. We also have a huge potential in our cities. Cities are probably the most important regional unit that we have. The kind of interactions that take place there bring technology into contact with the cultural sector, with investors and others. There are huge opportunities which we can use the LEPs to capitalise on. We also have a problem in this country that the vast bulk of public technology investment is concentrated in the south-east. We have enormous potential in other parts of the country. In the north of England where I come from, the N8 Group of research-intensive universities has been working together successfully to engage with large companies collectively. We have had some very good results.

Chair: You know how to please the Chairman, don't you?

Sarah Newton: Certainly the Combined Universities in Cornwall, I would say, are working very well.

Gareth Johnson: Live in the south-east!

Dr Nightingale: I would agree with that point. There is too much concentration in the south-east. There is some fantastic research going on in universities outside the south-east. Should geography matter? Geography should not matter. We should be relying purely on quality. That will have an effect in that people who are innovative, highly educated and entrepreneurial want to live in certain places and not in others, and they will move to those places. They may move to the south-east. There is a public policy issue as to what we should do about that, but in terms of innovation we should rely entirely on quality.

Dr Robertson: Geography does matter. You have to invest in excellence but money talks. If you invest money, then excellence will quite often aggregate around the resource, so I am sure there will be more people in graphene heading to Manchester and co-locating and working with Manchester as a consequence of that investment than would have been the case in the absence of the cash. We do have a relatively small country, but we seem to be able to create it as if it is the size of the United States of America. We are incredibly privileged. You can get from Newcastle to London in two and a half hours by train. It is not the end of the world. It is a really good place for people to invest, and I would commend it to any organisation.

Q21 Sarah Newton: We have had a very good advertisement for universities around the country. Finally, do you think there is going to be any impact at all on the commercialisation of research as a result of the loss of the Regional Development Agencies?

Dr Nightingale: No.

Q22 Chair: Are there other views on that?

Professor Georghiou: The one in our region was doing a number of good things. It was well engaged with the science and innovation community, so it is more a matter of preserving those functions than the particular channel by which those are delivered.

Dr Robertson: I would agree with that again. In the north-east we had a good Regional Development Agency. It did some very good work. The best thing it did was that it talked to people about what it was doing and engaged them in the process.

Chair: Gentlemen, thank you very much indeed. I am sorry that we had to push you a little because of time. There may be some further thoughts when you have read the transcript. I would be grateful if you provided any additional comments. Thank you very much for what was an extremely informative session.

Examination of Witnesses

Witnesses: **Dr Ted Bianco**, Director of Technology Transfer, Wellcome Trust, **Dr Ian Tomlinson**, Senior Vice-President, Head of Worldwide Business Development and Biopharmaceuticals R&D, GlaxoSmithKline, **Dr David Tapolczay**, Chief Executive Officer, Medical Research Council Technology, **Dr Gareth Goodier**, Chair, Shelford Group, and Chief Executive, Cambridge University Hospitals NHS Foundation Trust, and **Dr Andy Richards**, serial biotechnology entrepreneur and business angel, gave evidence.

Q23 Chair: I am conscious that this is going to be harder than it was with the previous panel as we have an extra person. I would be grateful if the five of you introduced yourselves for the record.

Dr Tomlinson: I am Ian Tomlinson. I am Head of Biopharmaceutical R&D and Worldwide Business Development for GlaxoSmithKline. In a previous existence I founded a biotech company called Domantis that GSK bought. For 11 years before that I was an academic at the MRC.

Dr Tapolczay: My name is David Tapolczay. I am the Chief Executive of Medical Research Council Technology, which is, in essence, a tech transfer office managing the intellectual property of the Medical Research Council in the UK. I have worked for Glaxo, GlaxoWellcome, GlaxoSmithKline, Zeneca and ICI Pharma, and also I started up seven biotech companies.

Dr Goodier: I am Gareth Goodier. I am Chief Executive of Cambridge University Hospitals and the Chair of the Shelford Group, which represents 10 academic medical centres in this country. As a CO, I have been responsible for four academic centres myself in north-west London, which at the time had 23% of the health R & D budget.

Dr Richards: My name is Andy Richards. I am an entrepreneur and business angel investor, specialising in the life sciences area. While I am a director of nine companies and chairman of four, and involved with important organisations like BBSRC, Babraham Bioscience Technology and Cancer Research Technology, I am here very much in my own personal capacity as an entrepreneur, founder and investor in more than 20 companies over the last 20 years.

Dr Bianco: I am Ted Bianco. I am the Director of Technology Transfer at the Wellcome Trust and a member of the Executive Board. We initiated a new funding division in 2003 called Technology Transfer that does translational funding to bridge the gap. This has now spent in the order of £350 million, having ramped this figure up from £8 million in the first year of operation. We have seen a leverage of something like £685 million of third-party funding on the back of these projects. This is my key job.

Q24 Chair: Thank you very much. First of all, bioscience is often quoted in the press as an area where Britain has got it right and the Government life sciences strategy has been praised. What has made biosciences so much more successful than some other sectors? Is it the right skill base, the right companies or being more in tune with the Government's financial support? What are the key things?

Dr Tapolczay: From my observations, if you look at the most successful bioscience clusters around the world, they share a certain commonality in their heritage. To a large degree that is founded by the presence of major pharmaceutical R & D establishments in their locations. Germany is successful in biotech. The UK is successful in biotech, as are the east and west coasts of the US. All those are homes to major biopharmaceutical companies—R & D establishments. A lot of the young spin-out start-up companies actually take their work force out of those big companies. They are trained in our universities and they get an excellent education in our universities, but they do not get a knowledge of the industry or how to do drug discovery and development in life sciences until they join the likes of GSK. It is people who spend time on those big industries and then leave and join a biotech organisation that lead to the success of that cluster.

Dr Richards: There is no doubt that the quality of the research base here is one of those things that has done that. I agree with a lot of what David has said. Historically, it is interesting that one of the reasons we have a biotech cluster that set up rather early on was because various companies shut down. You can end up with tracing a lot of it back to the G D Searle plant shutting down and that spawning British Biotech and a lot of the people into Celltech, and Amersham downsizing, resulting in a lot of people coming into the Cambridge cluster. That is one of the interesting phenomena. It is the movement and fluidity of people across those sectors, across from large companies to small companies and back again, which is very important to the growth of clusters. You can see that that has happened in the more dynamic and longer-lived clusters in America.

Dr Bianco: Within a few square kilometres in the region around MIT, on the Cambridge side of the river in the Boston area, most of the pharmaceutical companies have R & D headquarters alongside institutions like the Broad Institute, the Koch Institute, MIT, and Massachusetts General Hospital. This is a powerhouse of innovation where there is a very strong culture of entrepreneurship. There is a huge distinction between the level of entrepreneurship in the University of Harvard in comparison with many other players in that culture. The Wellcome Board visited recently to try and get some learning as to what created the magic at MIT. A great deal of it is cultural.

Dr Goodier: I support what has been said, but I would add that communities grow up where there is a sense of innovation. It takes, sometimes, decades to create that community. Cambridge, as in Cambridgeshire, is a very small community, yet in terms of Nobel prizes it is one of the most successful in the world as compared with, say, the Boston Cambridge. It is not a size issue, necessarily, but more the bringing together and, indeed, intimacy of different scientists working on similar problems from different angles.

Dr Tomlinson: I would agree. It is a diversity of critical mass in one place. Clusters are terribly important. Bringing together science, innovation, the entrepreneurs and the funding is clearly an important part. Again, it is all about creating those critical masses of entrepreneurs and innovation.

Dr Richards: Just to add an aspect on that cluster—it goes back to some of the discussion that occurred in the first group—geography and concentration matter. I agree with the comments on quality of funding, but concentration is about the ease of meeting and mixing of individuals, and about individual risk. A cluster is a low-risk environment for an individual to jump out of somewhere like GSK or the MRC and join a start-up, knowing that it will probably fail, but when it fails they will be able to dial up and go into something else. You can only do that within the concentration, risk environment and culture that occur as, for example, in Cambridge and in elements of London, Oxford and Manchester.

Q25 Chair: That is very helpful. Can I ask a specific question to Dr Bianco? Wellcome introduced the New Venture Fund. What has it added to Wellcome's toolkit for exploiting bioscience research?

Dr Bianco: Wellcome has three shots on goal here. The first is that we have an investment group that works for financial return to ensure that we have an income to pursue our charitable purpose. They invest across all sectors irrespective of our health care interest, because they are generating the resource with which we deliver our mission. We have my division, which is mission related. We fund projects both in companies through programme-related investment and in the public sector. There is no financial return expectation. This is around mission. In fact, we don't believe in double bottom lines. Sigma is an attempt to say that we will have a financial return proposition, £200 million in financial return motive, but it will take advantage of the particular knowledge we have of the health care sector. As an organisation we have a fairly deep knowledge of health care, yet our investment team pursues, on a financial return, many different areas that any investment house might use. Sigma is, if you like, a niche to exploit what we believe should be a competitive advantage to a financial return investor working for an organisation that lives and breathes health care.

Q26 Stephen Metcalfe: We are particularly interested in the Stevenage open innovation park. Can you explain how that model differs from what would be considered the more traditional research and development model?

Dr Tomlinson: Maybe I should start and Ted can chip in. I am GSK's representative on the board of the Stevenage Bioscience Catalyst. It is multifactorial. Location is important; it is in Stevenage. What is different about that park is that it is, obviously, adjacent to a 3,500 person R & D facility owned by GSK. There is an opportunity there for information, expertise and guidance to be shared between GSK and the people who occupy that site. I think a lot of that is osmotic. It is in the coffee room. It is like the canteen at the MRC Laboratory of Molecular Biology, where a lot of these Nobel prizes came from in Cambridge. It is those informal discussions that people have that spark a lot of the ideas and innovation that we are trying to create there. The key difference of that park is that it is co-located with a big pharmaceutical company.

Dr Bianco: I would like to add that there are very many different views on the advantages of open innovation where it has worked. For me, an absolutely key one is that the quality of British science in the life sciences is very high indeed, as we have heard. How the industry views that is governed by the level of access. Is there an interplay between public research, the insights it generates and what can be used by an industry that has to be profitable? Open innovation, which we are trying to exemplify there, will be a win for this country if what happens is that pharmaceutical companies believe that Britain is a place where you can have an ongoing, interesting and important debate about what is emerging in life sciences, so they want to be here. It is not about the IP per se and it is not about the profitability of any one small business. The big win is that this is an interesting place with a culture of sharing the learning so that everyone can try and get on and produce the products that society needs.

Q27 Pamela Nash: A BioCity has just opened in my constituency following the success of BioCity in Nottingham. My understanding is that it is a similar model but not situated next to an existing pharmaceutical or bioscience company. Just to be clear, do you think that is key to the success of Stevenage, and what is the difference, in your experience, with the success of Nottingham?

Dr Richards: With all of these it is very early to tell. That is the first point. The second point is that open innovation, this model and clusters are about people, not about buildings. So you have to think about the people. If you want to ask, "Is Biocity going to be important?", ask the question as to how you are reducing the risk for the individual to take the risk and do something to get involved in those clusters. The point that Ian made is that Stevenage will be a success, not as a building but as a place, culturally, where small companies, large companies, scientists and investors mix. If you can get them together in the coffee room, mixing in an environment where they feel they are not taking a high risk to be there, then it will work.

Dr Tapolczay: Just to pick up two points, one from Ian and one from Andy, and tie the two together, the Stevenage Bioscience Catalyst park is a very exciting

and interesting new proposition. It is the only park in the UK of its kind where a major pharmaceutical customer—and supplier, for that matter—is co-located alongside young start-up entrepreneurial companies. I think it will be a great success. I certainly hope it will be a great success, and we are working closely with them.

You mentioned BioCity. BioCity, although not having a major pharma company next to it, started by the demise, as Andy pointed out earlier, of a major pharma company. It was Boots Pharmaceuticals originally. Then it was bought by BASF, and BASF's decision to close their campus there gave BioCity the opportunity to start. The model has proved very successful in Nottingham. Again, picking up Ian's point, it is about concentration of talent and getting people to mix together. The fact that you suddenly have all these people, all in the same boat, many of whom decided to start companies with people they knew and with people they work with, led to the creation of a very successful culture in BioCity. Exactly the same is happening in Newhouse. You have the closure of a major pharmaceutical R & D facility, and BioCity have shown that they can make it work in Nottingham. Let us hope that they can also make it work in Scotland. The key, again, comes down to availability of funding, to make things like that give it the opportunity to grow. It is like a young seed that has been planted. It needs watering, otherwise it is not going to work.

Q28 Stephen Metcalfe: With regard to the interactions between the large anchor organisation and all the smaller firms and researchers that are around the place, does someone facilitate those interactions or do you just hope that it happens by itself, or is it just, "There's the coffee. Get on with it."?

Dr Bianco: I am going to pick up the Nottingham question to answer this. We have a couple of groups in Nottingham, one of which has its roots back to MIT and is using very MIT principles in trying to find a way to prevent biofilms on devices. That international link is massively important. It is because of that international link that we think they are more likely to succeed. It might well be in the US that they obtain, the first traction on the adoption of technology. The linkages that people want to make should not be seen parochially. In basic science people have collaborators all over the world, and so it is in any other branch of scientific endeavour.

The second example is that we are funding an NHS based group to develop a device to deal with cataracts. We are going to send them along with the other ophthalmology teams to India to the Prasad Eye Institute where they have a catchment of 20 million patients. That is not something that is easy to scale in Britain, but they believe they are just getting going with a catchment of 20 million patients. That provides another form of traction. I would say that the important thing in getting people together is that you can't do forced marriage but you can give invitations to embrace an opportunity. That might lie down the corridor and they will find each other in the coffee shop, so you don't need to do much about it. If they happen to lie in another continent, you had better just let them know, "Hey, there's a chance." Wellcome believes that the best we can do is facilitate but using a light touch.

Dr Tomlinson: Facilitating can come in many forms. Some is going to be formal interactions and contractual interactions between the parties. GSK is an arm's length party here to the SBC, and it is all about stimulating the UK biosciences economy. We put, currently, about £2 billion a year into R & D in the UK. We have 15,000 people in GSK in the UK. We are looking at other ways that we can stimulate the biosciences economy more broadly, whether that is through our investment in the Stevenage Bioscience Catalyst, whether it is through our VC fund, SR One, our commitment for the £50 million going into the UK via this VC fund, or other initiatives that we have. It is all about what we can do. It is all about specific and concrete action that we can take to stimulate the UK biosciences situation, because it is quite delicate. A company like GSK can invest in the UK and we can invest elsewhere. I totally disagree with the Patent Box comment made in the previous session. These pieces of legislation are extremely important in order to focus our investment—a global company's investment—in the UK. You will know that we have recently announced a £500 million investment, including something that is close to my heart as Head of Biopharmaceuticals, which is a new manufacturing plant in Ulverston that we will be building. It will employ 1,000 people and cost £250 million to build. We would not have made these investments in the absence of the Patent Box legislation.[1]

Q29 Stephen Metcalfe: That is interesting. Thank you for that. You did ask this question, but what is or was the single biggest driver behind the opening of the Stevenage open innovation park and campus?

Dr Tomlinson: What was the single biggest driver for us getting into it in the first place? It was a matter of looking at ways that we can stimulate the biotech community in general and different models to stimulate those interactions. There are lots of different ways to skin a cat. We felt that having a park in close proximity to one of the largest pharma R & D facilities in the UK would be a good way to do it. It is an experiment and a model. We think it is going to be successful. Of course it is a concrete step to try and stimulate innovation, and that is what it is all about.

Q30 Stephen Metcalfe: But there must be a commercial aspect to that as well for GSK.

Dr Tomlinson: For GSK, yes, because if there are more biotech companies in the UK, we can, potentially, do more deals with those biotech companies. Half our pipeline of drugs comes from or is partnered with biotech or other pharmaceutical companies. Partnership is a massive part of what we do. Without collaborations with biotech companies

[1] The witness later clarified that the new manufacturing plant at the GlaxoSmithKline Ulverston site in Cumbria will cost approximately £350 million to build, and combined with other investments GlaxoSmithKline announced at the same time, would create up to 1,000 new jobs.

and other strong pharmaceutical companies, our pipeline would be a fraction of what it is today. It is absolutely critical to have lots of successful biotech companies. Even if we are not involved in them financially, there is an opportunity in the future to become involved in them through business development.

Dr Richards: You have to look at the Stevenage development in the context of global moves in pharmaceutical R & D. The pharmaceutical industry has been moving away from doing the majority of its own R & D towards an open innovation model and getting more from elsewhere. When you do that, these big single centres of R & D, such as those we saw at Sandwich, as we have at Stevenage, and we have had in Scotland, Nottingham and Alderley, start looking like an old model and do not really work. It is part of a move to get a diverse ecosystem on that site. One of the sad things about Sandwich was that it was sitting out there on its own without its ability to create a diverse and dynamic ecosystem. What GSK is trying to do is to create a diverse ecosystem around Stevenage. It happens to be easier in Stevenage because you can live in Cambridge and work in Stevenage. Your partner can live in Cambridge and work in Stevenage. You can work in a biotech in London and not move house. If the company moves to Stevenage, you can be there. In an environment where companies are very fluid—it is that great fluidity of small companies at the moment that is key—that geographical closeness and the low risk to make those moves is an important factor.

Dr Tomlinson: While we are on the issue of invitations, there is an absolute open invitation for you guys to come to see the Stevenage Bioscience Catalyst. We will take you round it and also show you GSK's operations there at any time.

Dr Bianco: A key principle when Wellcome entered this as a joint venture park with GSK is that this is not a proprietary relationship. It really builds on what Andy is saying. The whole industry is hungry to learn from outside its R & D walls as well as within. We, as the Wellcome Trust, provided a level of neutrality in the way that the culture of the park would be perceived externally. It is really important that there is a sense that this is a place for all- comers. GSK, clearly by being locals, will have the advantage of being locals, and they are putting in the value, which is really what a big company can do, and shared learning with the small companies. The principle is that the governance arrangements provided a welcome to all. Everyone does well out of that because they browse off the system. They do not want to gobble the whole thing up. It is quite selective.

Q31 Stephen Metcalfe: I have one final question. Do you think that this model could work for other sectors outside biosciences and, if so, which particular sectors?

Dr Bianco: It has.

Dr Richards: It already does.

Q32 Stephen Metcalfe: Give me an example.

Dr Bianco: Aerospace. When they build a wing, there is collaboration among many companies. Aerospace has a very strong tradition of integrating intellectual property to produce things like wings.

Dr Richards: Obviously, some of the software and tech. I would even point you to Formula 1. That is an example of that sort of cluster in this country.

Q33 Graham Stringer: How does the Francis Crick Institute fit into this new ecology and new business model within the pharmaceutical industry? Will it be a big game change?

Dr Tapolczay: I certainly hope it will be a big game change, looking at the amount of money that is being poured into it. It is a commitment to invest in the basic research of the UK in biomedicine. That is one of the key selling points that attracts investment from the likes of major pharmaceutical companies into the UK. As Ian said, GSK's business model is evolving and changing. GSK spends a lot of money in this country and wants to continue to spend money in this country, but it will only do so if the quality of the science in this country is world class and world beating in the area that GSK is particularly interested in. That is true of any major pharmaceutical company. The investment in Francis Crick to bring together key research groups, such as the National Institute for Medical Research—NIMR—at Mill Hill, the CRUK and the sponsorship by MRC and the Wellcome Trust, and other partners, is an excellent opportunity to focus expertise in biomedicine in one world-leading, world-class laboratory. The success of that kind of approach has been proven by the MRC time and time again at the LMB—the Laboratory of Molecular Biology—in Cambridge, which Ian referred to and, indeed, studied at. Looking at the success that LMB has enjoyed with MRC's funding, and saying, "Look, we are going to try and build the same kind of model again," has to be in the interests of British science and, therefore, in British business in life sciences.

Dr Bianco: Paul Nurse came back from being President of the Rockefeller because this was a big carrot. If Nurse is the Aaron Klug of the LMB, we will be well placed.

Dr Goodier: The model has been established before, and most of the major academic centres medically have this aggregation of Wellcome and some biopharma. We have the Wellcome Trust, MRC, GSK, Cancer Research UK all on the same campus with the hospital. It is that integration of patient care with these research facilities that really adds weight to the bioscience research agenda.

Dr Tomlinson: It is great for big pharma as well. The more science there is in the UK, the better for GSK. There is not necessarily going to be an immediate benefit for GSK from the setting up of the Crick, but the whole thing about creating a talent pool of great scientists, great innovation and the entrepreneurs means that we have got to accelerate the growth of these capabilities. If we do, it is to everyone's benefit. It really is a win-win situation. GSK is terribly supportive of it.

Q34 Graham Stringer: Sticking with the new business model within the pharmaceutical industry, the Drug Discovery Centre at Imperial College do not see it as a win-win situation. They worry and fear that there is going to be a funding gap when it comes to commercialisation in the future. Do you agree with that? Do you think that a technology strategy board will fill that funding gap, if indeed it will exist?

Dr Tomlinson: The answer is not totally straightforward. There is, clearly, investment and more investment required in that gap between academic research, early-stage target discovery and validation, and then making a drug. How you fund that area is not entirely straightforward. It could be by biotech. It could be by initiatives such as the Biomedical Catalyst fund. I have just agreed to be on the major awards committee of that, so, hopefully, I can help in terms of that investment vehicle. It is multifactorial. TSB, for sure, hopefully, will help. There are the seed VC groups that are being set up. The Wellcome Group has just created a large early stage investment fund and GSK has invested $50M in Index's sixth lifesciences fund. I do not pretend to have all the answers. We need to do everything we can to support that kind of translational research. That is why the Crick seems to be a great vehicle for building a core cluster of capabilities in translational research.

Q35 Graham Stringer: Is what is at the bottom of this change in the business model major multinational drug companies saying, "It is too expensive now to develop the next generation of drugs and we need public sector funding."? Is that what we are saying, simply?

Dr Tapolczay: I certainly do not think that that is the case. It is very expensive. It is probably too expensive for one single organisation to do everything it has to do in its own house. If then it does it in partnership with other organisations, whether those organisations are publicly funded or privately funded, is not of relevance to the big pharmaceutical companies. What has changed is that big pharmaceutical companies have to show a return on their investment to their shareholders. That is one of the reasons why they are in business. Obviously, they want to produce new medicines as well. One of the reasons why the CEOs get paid is to show a return on investments to their shareholders. It has become increasingly difficult to do that in pharmaceuticals. The costs of doing R & D and the costs of registering new products have spiralled over the last 10 years, so it has become very expensive to do everything. The response of the model, in terms of evolutionary response, is, "Okay, so we won't do everything ourselves in-house and we will partner with other groups that do it." At present there are plenty of other groups out there for the big pharma companies to partner with. If we don't keep funding basic research that leads to these new companies and we don't keep funding start-up businesses that allow those businesses to develop, then those partners will not be present in the future, and then GSK may look outside Britain to find its innovations.

Dr Tomlinson: Big pharma needs to take some responsibility. The costs are going up and the regulatory hurdles are going up, but we did have a culture of trying to industrialise drug discovery and development—and it did not work. At that point, I guess we were quite arrogant in some respects. We thought we could do it all ourselves and we thought we could do it by industrialising science. All scientists will know that science is not something that should be and can be industrialised. As soon as you industrialise science, the innovation goes away. Innovation comes from one person having an idea, or a small group having an idea, and prosecuting that idea to some kind of milestone. That is why we have changed dramatically over the last five years. We used to have thousands of people working in R & D. We would throw a load of people at the problem and we would hope to solve it in that way. Now, we have 50-people groups, with a leader fully empowered to prosecute a very specific area of science. If they work, great. If it does not work, that is Darwinian evolution. You have a model where people are accountable for prosecuting a specific area of science. It is very different from the way all big pharma used to do it 10 years ago. There is a big change in the way that we are going about it.

Q36 Chair: In a way, Dr Tomlinson, you are saying that the pharmaceutical industry was a bit slow on the uptake, because industries like Formula 1, aerospace and telecoms did all this years ago.

Dr Tomlinson: Yes.

Dr Richards: There is a difference. The time scales between an initiative and the output are much longer than in Formula 1. In Formula 1 you make the initiative and you find out within a few weeks whether it is working. In pharmaceuticals, you do not. One of the problems in the industry—Ian is absolutely right to point it out—is that the industrialisation of the drug discovery process was a mistake and a problem. The biggest problem was that everyone did it. The industry, as a whole, tends to do this, because within a large company the career path of an individual is shorter than finding out whether something has worked. There is an incentive. As an individual—I come back to individuals—people have been very successful at jumping on the latest fashion and bandwagon, rising up in their career from it well before they have discovered whether it works or not. One of the things I am most encouraged about at the moment is that there is a greater diversity of approach and fashion in the sector as a whole, which is really healthy. There was a problem when everyone followed the same fashion. Everyone got into molecular biology and got out of pharmacology. Everyone got into combinatorial chemistry and got out of the whole industry, not just in the UK but worldwide. That has been a very unhealthy phenomenon, and that has changed.

Dr Tomlinson: In our defence, big pharma did get it wrong, but GSK, in particular, was one of the earliest to realise that they had got it wrong and fixed the problem, which is why GSK is in a pretty good position, particularly in terms of its UK investment base today, whereas others are not necessarily in as

good a position. We have been early adopters of this small, focused research model, which is very akin to the way that biotechs work in the UK.

Dr Bianco: We have run an experiment for the last five years called Seeding Drug Discovery. The board agreed £91 million to specifically address small molecule discovery of what is called "the lead optimisation stage", which is one of the gaps that is famously difficult for public labs to address. What has turned out is that transaction size is critical. We have this general translation scheme. We did not have £3 million to £5 million per transaction available. That is what it takes to do that step. That lead optimisation step, if modestly done, costs in the ballpark of £3 million, £4 million or £5 million. One of the things with all of these schemes is that one needs to be cognisant of what the transaction size is that really matters. If you have a scheme that dishes out money at one level, which is only at £35 million, it is going to be a poor fit for some people's needs. If it only puts out £35,000, it is going to be a poor fit. You have to ensure that the rules of engagement do not prevent you from addressing a need. We created this scheme because we knew it was going to be in the order of £3 million to £5 million per go. So £91 million bought us 30 projects. The board has just agreed another £210 million for a second five-year period.[2] Is it a success? We can't answer that yet, but we know that about a third of the projects are still standing on their legs at the end of our funding—only a third. That is why this is tough stuff to do. Our board has to take that on the chin. And they are willing to do it.

Q37 Stephen Mosley: You have talked about the problems with the big pharma model. Of course in the UK we have a big customer model as well. We have the NHS, which is the major purchaser of medical and pharmaceutical products. How much influence does the NHS have on the bioscience market in the UK?

Dr Richards: Let me just put this as an investor in early-stage companies. I work in angel groups, and angel groups are full of people from the technology sector as well. This is not just a statement about drug discovery; it is a much broader comment. I come back to some of the points that David Connell made in the earlier session. Customer traction is one of the most attractive things for any investor. There has been a situation where any business plan, business model or business idea that comes up that says, "By the way, the first thing we are going to do is sell into the NHS," just makes it uninvestable, because the NHS does not take up, let alone new drugs, new technologies, new software systems, new anything. It is notoriously hard to sell anything new into the NHS. That is partly a cultural thing. Partly, there are some elements within the NHS that, for one reason or another, have a "they shall not pass" mentality. It does make it incredibly hard to innovate in the medical field—medtech, health care, IT—in an environment where your local market, who are the easiest people you have to reach to talk to as customers, are hard to access.

[2] The witness later clarified that the board has just agreed another £110 million for a second five-year period

I hope and I think that is changing. For my sins, over the last couple of years, I have made some investments with other people in companies that do intend to access the NHS as their first market—in fact some of them as their primary market. I hope that that works but the jury is out. It is really important.

Dr Goodier: That is something I hear a lot. The NHS does tend to run as a top-down command-and-control massive organisation, so, when it does IT, it does it as one massive contract and, inevitably, fails. We do not seem to be able to find the middle ground. The foundation trust movement is a very good movement for encouraging innovation and encouraging academic centres to find their own place in the sun. At the moment, the tariff structure is such that the Shelford Group, for example, which is, probably, the 10 most prestigious academic medical centres, in 2010–11 had a turnover of £7.3 billion. If you take away the under-the-table supplements because of potential deficits, the group made a loss of £3 million. Therefore, there is not, in a business sense, the capacity to be able to invest in IT. As I reflect upon it, we are falling behind as a health system compared with our international comparators because what we all want is to have good electronic records, an e-hospital, with databases that can be interrogated for research purposes as well as for individual patient care. We are way behind the American equivalents there, some of the Dutch and so on, because there is no spare cash at the hospital level. The spare cash is at the SHA level.

Q38 Chair: Presumably, if we do not get the data structure correct, innovations like stratified medicine will be damaged inexorably in the UK as a research activity.

Dr Goodier: We are very concerned at the Shelford Group because so many of the prices set for treating patients are set on averages. If you suffer from asthma, you can have three nebulisers and go home, or you can have a week in intensive care and two weeks on a ward. The price is set at an average, and that suits more the smaller district general hospitals, whereas the academic hospitals tend to get the more complex patients and, therefore, are chronically underfunded. This is a serious threat in terms of the future of the biopharma industry in this country. If the core—not just the Shelford Group—20 academic medical centres in this country are not, as in other countries, given supplements because of the complexities of their patients, because they are seen as centres of excellence where they need to be the leaders in IT and so on, necessarily they are poor partners for the biopharma industry and technology.

Dr Tapolczay: While I agree with everything that has been said, I also see it as an opportunity. If the problem is there but it could be fixed, we are still the only country in the world with an NHS. If we can find a way to allow engagement between the biomedical community in the private sector and the NHS more effectively, then it has to be a very positive step forward for both the NHS and the biomedical companies in the UK.

Dr Richards: It is deeply frustrating that we are the best situated country to do personalised medicine

because of the NHS. If we can gather the information from well collated records and use that—we have everything in place—and if we could do it, it would be the big game change.

Dr Bianco: The motive when we launched the Health Innovation Challenge Fund in partnership between Wellcome and the Department of Health was exactly how to drive innovation. The areas that we called for proposals are agreed with the Department of Health. That is an attempt to say, "What do they want? We will try and build what is needed." One of the disincentives, which is a real problem, is that if you produce, for example, an invention that reduces bed stay because the surgical procedure is less invasive, it is the cost centre for the beds that gets the advantage and the risk is taken by surgery. Who should take the big decision? The next layer up. It is a well-established problem, but you can get unintended consequences. Adoption has become a problem because the reward system is not necessarily linked.

Dr Goodier: To bring a more positive note to it, the work of Professor Dame Sally Davies has really improved biomedical research in this country tremendously over the last three years, and a number of initiatives have just started but are too early to assess, which Sally has been the author of, which are very promising. What we are all trying to do is to get comprehensive electronic records with genomics attached to them, because, as I understand it, what the biopharma industry wants is not to do everything but to have very specialised interests of care. Once the research is conducted, we offer personalised care to the patients who are engaged in this. Particularly, Imperial, University College, Oxford and Cambridge are very focused on that, but all of the academic centres are striving in that direction.

Dr Tomlinson: We support the reforms of the NHS. Obviously, it is early days. The key here is to come up with a system. It is this win-win situation, where, "You can help us to help you and support the uptake of innovative medicines." We believe that the medicines we are going to be able to create can make a big difference to the patients in the UK. There is definitely a partnership here to be established and worked on. It is all about supporting innovation because without the support for the innovation there will be no innovation, and without innovation there will be no advance in medicines for patients. It is a partnership.

Q39 Pamela Nash: Which countries do you think are our main competitors in bioscience?

Dr Tomlinson: Obviously, the US. We have a big R & D presence in the US as GSK. Talking about clusters again, if you look at the investment in SMEs in the Boston biosciences cluster, it is bigger than the whole of the UK put together. Why is that? Again, they have been at it longer, there are more entrepreneurs and more large companies have sited and invested there. In fact, they have attracted companies from outside Boston into Boston. I am talking about the likes of Amgen and others, which now have large research facilities in Boston. Again, if you have that critical mass of talented scientists who, as Andy said, are not fearing for their jobs as there is always somewhere else for them to go, it is incredibly empowering. From these groups, you can spark up little biotechs all over the place. Entrepreneurs are going from one company and making it successful. Maybe the next entrepreneur is not successful, but they are moving on to the next thing all the time. We have that a little bit in the UK, but it is nothing like the way it is in Boston. We can build upon that if we make these specific and concrete investments in the biosciences opportunity in the UK.

Dr Richards: Just to add to that and go on the US model, the US has a number of things, including a health care system that uptakes innovation somewhat earlier. One of the other reasons why you look at Boston is not just its longevity, but this is about the valley of death, as this hearing is. There is no doubt that in the US the financing continuum is more complete or there are fewer discontinuities than there are at any one time. Those discontinuities change and move. It is one of the things that is very hard to assess. At the moment there are specific ones. It means, as an investor, you invest in things and you are most worried about the financing risk. That is less of an issue in the US. It has allowed companies to grow bigger.

The Cambridge Phenomenon Conference last year was a conference about tech as well as life sciences and biotech. A leading US venture capitalist said, "You guys have created the most effective corporate veal factory in the world." He was talking about Cambridge. What he meant by that was that we were creating beautifully formed high science—great little companies, which were then being sold very early, rather than financing them up to the next stage. While there is a gap early, the moment one of those gaps is on the public market, no one IPOs the company. So ventures, angels, high net worths and corporate venture are investing in companies to get to a certain stage, stay virtual, get sold on, rather than grow. In Boston, you will find that there are those companies that have made that jump to the next stage and become $1 billion, $5 billion or $10 billion companies.

Dr Tapolczay: I agree with everything that has been said, but I think your specific question was where our main competitors are in bioscience. They are Germany, for sure; Scandinavia, for sure; in Europe; obviously, the US. Then I do not think we can—or we do at our own risk—ignore China. There is a phenomenal amount of investment, the kind of investment that this panel would dream of having at its own disposal, being pumped into basic academic research in Chinese institutes doing medicine. The number of high-quality publications coming out in China now is overtaking us. We are becoming third in the world. Historically, for the last 50-odd years, we were second in the world to the US. China is now starting to overtake us. Is that a real threat or can we do something with them? Because Germany has a long and well-established history in biotech, much like ourselves, and many of the big pharmas started life in Germany, they could be seeing us as a competitor. Scandinavia, potentially, similarly. The US, clearly, will see us as a competitor. With China, we have an opportunity to become a partner rather

than a straight competitor because the one thing that China has in spades is plenty of cash, but the one thing they don't have is knowledge of this industry in the translational space between lead optimisation and pre-clinical to clinical development.

In terms of manufacturing, they can outperform us any day of the week on scale, but it is that knowledge-based bit in the middle where we can strive to create a really strong partnership with China that, potentially, can bring economic benefit here in the UK. It is not just teaching them what we know. It is becoming a true partnership so that economic gain in China is mirrored with economic gain and growth in the UK.

Dr Goodier: It depends on what aspect of research you are talking about. In experimental medicine and early-phase research we are still regarded as very high quality. By the time you get to phase 3 clinical trials, frankly, Novartis would just put that where they could do the trial the cheapest and get the easiest return. So all of the BRIC countries and quite a few others are competitors for that sort of research. I would agree that China is amazing in the way they are making progress. We have a lot of contact with China, and the partnership model is, frankly, the only way to go.

Dr Bianco: It depends on which bit of the valley of death you are talking about as to where our main competitor lies. This conversation illustrates that. The US, definitely, if you are talking about the interface between basic science in the public sector and business, which is why the cluster in Boston is the way it is. Why is that? I believe that is because it is underpinned by clarity of motive. MIT gave us some statistics when the board visited. In 2009 figures, they had $2.3 billion coming in as revenues across US academic institutions, but set against an outlay of $54 billion. The research base is $54 billion and it brings back $2.3 billion. That is 4.8%. This is no way to make money, but it creates 500,000 high-end jobs. Where is the win? The win is in the richness of your entire sector, not the individual companies.

MIT has a policy that it will not allow its investigators to roll into the company. You can be a consultant but you stay in the academic department. You might be a serial entrepreneur, so you do what you are good at. You advise to ensure the success of the enterprise you have spawned. These are very important principles. They do it because they believe it is their mission as an educational establishment and as an establishment endeavouring to put out societal good. They get enough return that they can reward the founders and others to create the entrepreneurial instinct. Six institutions across the US bring in the vast majority of that $2.3 billion of revenue receipts, but if they have a profitable business it is probably selling T-shirts. That is the local joke. They know what their margin will be on selling T-shirts, but they do not know what their margin is on intellectual property.

Pamela Nash: You have covered most of the points that I wanted to raise. Thank you very much.

Q40 Caroline Dinenage: I have a quick question. I know you are here to talk about the bioscience sector, and it clearly is a great British success story. I wondered what other sectors could learn from the experience of building this success, the pitfalls and the quick wins.

Dr Richards: It could be smart about ensuring that a financing continuum of investors who understand the space grows up. When the financing continuum is too diffuse and too spread apart, it does not work. It is a challenge at the moment in areas like food and agriculture, elements of bioenergy, energy and renewables. Bringing that financing continuum and investors together, with the academic and entrepreneurial base, is really important. I don't quite know why it happened early on in the life sciences area, but it did, and it has been growing. We have the City of London, so we have a heritage in investment and investors. They get, periodically, interested in areas and build on that. They ensure that in areas that we are going to focus on we can have a concentrated investor base and a connected investor base as an important thing.

Dr Tapolczay: The point Andy makes is really important, but we also need to consider that there may be different types of investor that will be interested in a particular investment during its evolution. Clearly, the venture capital community and most of the professional investment community are interested in a return on whatever cash they are putting in. There is a second potential investor, which was discussed in the earlier session, which is the state itself—public cash going in. For publish cash, I do not believe that the return should solely be how much cash we have generated in return on the investment. We should consider, and I am sure we do consider, other societal benefits associated with funding that particular project. They may be unmet medical needs in patient populations where, commercially, you are never going to make much money because there are too few patients in the UK. The medical charities in the UK invest very heavily in the area of unmet medical need in areas that major pharma companies would not want to go into because the return on investment does not make sense, and certainly venture capital firms will not want to go into them because they cannot see an exit.

There is a much stronger need in the UK for a greater integration between public and private funding. With many fantastic pieces of scientific discovery, at the point at which they are discovered, it is not obvious how you are going to make any money out of them. They need funding in order to be developed to a point at which, suddenly, somebody goes, "That's it. That's how we are going to make money out of this." When you get to that point, there is plenty of VC money floating around or professional investor money. It is how you get from the stage of, "Well, it looks really interesting, but we really don't understand how anybody is ever going to make any money out of it," to the point where suddenly the investment community is willing to take it on. In many cases, it is a bit of a relay race. You need different runners for each leg of the relay race.

Dr Tomlinson: I do not think you can overestimate the importance of the critical mass of talent. In the end, the reason that Cambridge is the way it is, and the reason why it was so easy, relatively speaking, to

set up a biotech company in Cambridge and to hire scientists in Cambridge, is because there are loads of scientists in Cambridge. In a way, it is as simple as that. Yes, you hire people from overseas and you hire people from outside Cambridge, but half the people who worked for Domantis were from a 2-mile radius around our facility in Cambridge and came from the LMB, the university and the other biotech companies in Cambridge. That is why clusters and focusing investment in the clusters are so important, because they grow and you get that snowball effect. That is what we need to ensure when we are considering how we are going to treat London, Cambridge, Oxford and Stevenage, the triangle, and all that stuff, going forward. We need to create the critical mass. If we do not have it, we will fail. If we do have it, we can be much more successful than we have been to date. I agree that we have been pretty successful in the biosciences sector, but it is nothing compared with some of the US cities. If we can just keep the ball rolling, keep the momentum and make the investment, be very specific about what we are going to do and make concrete moves, we can be more successful. Clusters, for me, is the way to go.

Chair: I think this follows on very neatly because it is challenging the other side of the coin as our final question.

Q41 Roger Williams: Just to follow on from Dr Tomlinson's comments, we understand about the golden triangle, the critical mass and the concentration of scientific expertise and scientists. Is it important to be near London as well in order to be near financial institutions that will invest in these opportunities, or will the investors go where the expertise is?

Dr Goodier: I would suggest, from Cambridge's point of view, that this is a community and they feed off each other. The scientists are there, as you have heard described, and the money men follow the scientists because they know that the deals are to be had there, the start-up companies and so on. It creates a community that feeds off itself.

Dr Bianco: We had an interesting debate with Merck, who came over to talk about what the industry was looking for. They gave a great anecdote about their in-licensing groups. They had no in-licensing group in Europe. Consequently, they picked up no projects. Then they set one up here in London with tentacles reaching into continental Europe and they started hoovering them up. They noticed they were hoovering them up at a greater rate than on the west coast of the US. Why was that? Because they had not put an in-licensing team in there. It is massively parochial. Stuff under their nose was getting hoovered. That is because it does not happen in a moment in time. They don't have a group come in, do a show and tell, and say, "We are buying today." It is a dance. There is stuff that goes on; there are tos and fros: "This is interesting but..." Unless there is a feeding frenzy around that particular product, and you are lucky, there is going to be a dance. That means that proximity matters. They found out that it completely mattered, even to the point that they were not getting from the Bay area what would seem fairly obvious that they could have got; they just did not have a team there.

Q42 Roger Williams: I asked that question because one of the more outspoken members of the other panel did suggest that some of the more peripheral universities ought to concentrate on teaching rather than research that could be spun out into commercialisation. I come from one of those more peripheral areas and would like to see our universities involved in that high-quality work as well. We are told, for instance, that good teachers are always up to their elbows in research and commercialisation. From my point of view, teaching and research go together.

Dr Bianco: The University of Dundee is an absolutely fantastic example. There is no reason, geographically, why it is well placed, but it has a fabulous tradition in drug discovery, in the way that the kinase group has become a magnet for many industries. It has just been deliberate.

Dr Tomlinson: They have just done it. That is the thing about Dundee—they have done it. They were sending out flyers many years ago. They were just doing it and that is what it is all about. You can't just talk about it. You have got to do something to make these things happen. While it is true that a lot of the biosciences R & D is centred around the south-east, if you look at manufacturing, there is a lot of that in Scotland and in mainland Ireland. There is manufacturing all over the place. We are going to put a biopharm plant at our facility in Ulverston, Cumbria because there is talent there—talent that knows how to do manufacturing. There are people on the site already. There are people round and about who you can bring in to do that kind of work. It is horses for courses. There are certain places where there is a critical mass of certain expertise. If a university has an expertise in a particular area, then good for it. It should focus on that and make the most of it. It should not just focus on teaching. If it has a critical mass of expertise in a particular area, there is no good reason why that university should not exploit it.

Dr Tapolczay: I would agree. In one sense, geography or location is not particularly important. What is important is that you have the right team in order to do it. Dundee, clearly, had the right team. When they started in drug discovery, they realised that they did not have the right team so they imported the right team. They brought the right team to them. They hired people who were ex-GSK, who knew what drug discovery was about, and they put them there. The industry does not care. AstraZeneca does not care whether they are collaborating with Dundee, Aberdeen, Manchester or London. What they care about is the quality of the team that they are collaborating with and the quality of the science. To your point, is it a waste of money to try and do this activity at your university? Absolutely, if you do not have the right team. If you have the right team, it will not be. Dundee is a perfectly good example of that.

Q43 Roger Williams: I visited Syngenta recently to look at the work that they are doing. They were telling me that in identifying agrochemicals they are very

much curtailed by EU regulations in terms of percolations of water and these sorts of issue. Do EU regulations hamper your type of science and investments?

Dr Tapolczay: That is probably one for you guys.

Dr Tomlinson: No. Obviously, companies like GSK have a responsibility to become more green. We have investments in green chemistry. We are in discussions with Nottingham University about the possibility of setting up a new laboratory there in this field. It is our obligation to become more green, to have less waste, to use less water and all that kind of stuff. We have quite a big programme in place to make ourselves more green and to exceed all the regulations that exist. It is important that we make those moves. It is simply a corporate responsibility to do that as a company like GSK.

Q44 Roger Williams: The point they were making was that they are a worldwide organisation and it was much easier to produce new chemicals and new reagents in other countries than it was in the European Community.

Dr Tomlinson: We have a considerable manufacturing base in Europe and especially in the UK. So I don't see it as an issue for us.

Dr Bianco: The European regulation that has been brought to my attention that is most problematic for a small company is employment law. You have to take on people with a longer-term commitment than you have cash flow. That can create very extreme problems. For the very small companies it is employment law issues.

Q45 Roger Williams: With the Regional Development Agencies not existing—we never had one in Wales—as I understand it, and talking to some people involved in your sector, they were very useful in producing capital in order to set up fairly large research organisations. Did you find that to be the case or will they be missed when they are not there?

Dr Tomlinson: The East of England Development Agency did contribute to the Stevenage Bioscience Catalyst, as did the TSB. I guess that most of the focus is now going to shift on to TSB being the main vehicle to pick up the slack that has been created by getting rid of the RDAs. Again, we need to focus on what that is going to be, how it is going to work and how those investments are made to make sure that they are as effective as possible. That is my understanding.

Dr Richards: The RDAs did some useful things. Was it the most efficient mechanism? Probably not. You ended up so often with discussions about the north-west versus the north-east, when it should have been the UK versus Boston, Shanghai, Palo Alto or San Diego. That is one of the problems in a global industry like ours.

Dr Tapolczay: I would 100% agree with that. Having funding available has to be a good thing. Whether it is managed properly, administered properly and whether the rules of engagement with the fund were too complex in the RDAs, those are all debatable points. Having funds available has to be a good thing. My experience of the RDAs was that it took an incredibly long time to get to a decision point. Frequently, I could get money from other sources faster than going through the RDAs. It cost businesses, because if I went to the venture community I was frequently giving large chunks of equity away to the venture community. Therefore, it was more attractive to try and get RDA funding, but, bureaucratically, it was difficult to handle.

Chair: Gentlemen, thank you very much for your evidence this morning. It has been extremely helpful.

Wednesday 25 April 2012

Members present:

Andrew Miller (Chair)

Stephen Metcalfe	Graham Stringer
Stephen Mosley	Hywel Williams
Sarah Newton	Roger Williams

Examination of Witnesses

Witnesses: **Katie Potts,** Managing Director, Herald Investment Management Ltd, **Anne Glover**, Co-founder and Chief Executive, Amadeus Capital Partners Ltd, **Matthew Bullock**, Chairman, Centre for Business Research, University of Cambridge, and Chairman, UK Innovation Research Centre, University of Cambridge and Imperial College, and **Stephen Welton**, Chief Executive Officer, Business Growth Fund, gave evidence.

Q46 Chair: Good morning and welcome to our witnesses. We are extremely grateful that you have given up time to come and speak to us. It would be helpful for the record if you would be kind enough to introduce yourselves.

Anne Glover: I am Anne Glover, chief executive of Amadeus Capital Partners. We are a technology venture capital group that has been in existence since 1997 with £500 million under management. I have been in the industry in the UK since 1989.

Katie Potts: I am Katie Potts from Herald Investment Management. I started my working life at GKN, which, somewhat eccentrically, educated me as a welding engineer. I then went to the City. In 1994 I set up Herald Investment Management. It was born of my frustrations at Warburgs because I thought large companies were boring. Investors were not going to make money and you had to invest in smaller companies, but there were too many risks and there was too little liquidity. So I said, "Why not have a collective vehicle that invests in lots of them to spread the risk?"

Matthew Bullock: My name is Matthew Bullock. I have been involved in financing technology companies since the late '70s. I spent 10 years as Barclays head of technology financing team and 12 years as chairman of a life sciences company that grew out of the Cambridge phenomenon. I am also chairman of the Centre for Business Research and the UK Innovation Research Centre, which is a joint venture between Cambridge and Imperial. I am a director of Addenbrooke's where I take an interest in the commercialisation of medical services and devices.

Stephen Welton: I am Stephen Welton. I am chief executive of the Business Growth Fund. We were set up last year by five of the major UK banks to provide growth capital to SMEs across the UK. We have £2.5 billion worth of capital. We are investing in a range of companies, which include technology-related businesses, and we provide growth rather than start-up capital. I have spent my career in the investment industry, and also for a couple of years I ran a media and technology company. So I have seen businesses from both sides of the fence.

Q47 Chair: We have got rather a lot to get through in a very short time, so we will try to make things reasonably succinct. If you have any additional information to feed to us afterwards because we don't have time to squeeze it in, we would be grateful if you would follow up with letters. We all accept that cash flow is the lifeblood of small companies. What is your impression of where small high-tech companies get their money to maintain cash flow?

Anne Glover: At the beginning, it is their own capital as entrepreneurs and angels. Later on, they can get it from venture capitalists but also corporations who do licensing agreements with them. For small high-tech loss-making businesses debt is not an option, so the grants that are also offered by various Government bodies like the Technology Strategy Board are an important component.

Matthew Bullock: There is a different model from that, which is a respectable one. The one that is more commonly adopted is that people get into business basically by selling their competencies as a service. This produces quite early cash flow. It requires large lead customers, usually large companies, but they can be research institutes or could possibly be Government—which is perhaps an issue for us to come back to—where they sell their services, usually on a term basis, delivering a particular technical service, and that gives them cash flow very early on. This is the soft model as opposed to what Anne is talking about, which is the hard start-up model, and it is in fact the dominant model. Although the hard company model is the classically understood one, it is very much the exception.

Q48 Chair: Is there in the different models an ideal balance or is it horses for courses?

Matthew Bullock: I think the answer is that if you can get venture capital it is the first best solution, but the truth is that it is not very readily available and most companies get into businesses by selling their services and moving up the scale gradually to create a product. It is possible to get into that business with personal equity, maybe with some angel support, but it is also a business that we in the bank, when I ran the group, were able to finance from a fairly early stage on debt.

Anne Glover: I agree that it is horses for courses, and it depends on the competitive framework. If you need to move very fast because of competition globally, the softer model cannot respond quickly enough.

Stephen Welton: A related point to all of this is investment readiness and the quality of financial

controls and planning, which one often finds lacking in very small companies and is an area in which they invest last. Clearly, cash flow is the lifeblood of any business no matter how big, so the better prepared they are in being able to present themselves to outside investors, be they corporate or financial investors, the greater the likelihood of achieving success.

Q49 Chair: We have been told that heavy reliance on equity finance is not always welcome due to its dilution effects. What are the barriers to preventing better availability of non-equity loan finances to small firms with genuine growth potential to become medium-size companies?

Matthew Bullock: If I was to compare this with America, which is often cited as the home of multiple venture capital, the real difference is Government's attitude to procurement. Since the 1940s the US has had a consistent policy of using small firm procurement as a way of developing technologies, from both a policy and industrial point of view. In the second world war they adopted a series of what were called "V for Victory" contracts where Government Departments that wanted to stimulate the production of key bits of sensitive technology would place R and D contracts for delivery with small companies where they knew they had the competencies technically but not necessarily the business competencies.

Q50 Chair: How does that explain the success of, say, biotech companies these days?

Matthew Bullock: If you look at many biotech companies, they are actually tool companies and not necessarily people who are going for a silver bullet drug. One has to say that in America there are very large programmes of support. My own company had a major contract with DARPA for the production of blood. As a simple voir dire, soldiers die on battlefields because they lose blood. They wanted to produce sacks of fresh pluripotential blood in the battlefield. To do that, they needed to have equipment that could produce such things. There is nobody in the world who does that.

They came to us and said, "You are part of a consortium. We would like you to bid for this, and we will give you milestone payments for the achievement of different steps in the production process." It was an extremely well-run process by a rather experienced postdoc. This was a Government Department bureaucrat in the DOD. At the end of the period, he changed consortia members to make sure he got the best bid. He said to us, "When you come to your second stage, here is our market forecast for the world market for blood. When you put forward your next proposal we want you to come with a plan of how you will deliver us blood for $10 a sack."

That is driven by a very clear and long-experienced group of people in DARPA, ARPA, the Office of Naval Research and other Government Departments, who use procurement creatively to stimulate the growth of companies. On the back of that many venture capitalists then come into these companies and put their money in when they have got a product defined from the result of such contracts.

Stephen Welton: Often it is incredibly difficult for small companies to deal with government because they do not have a lot of resources in terms of management capability. It is often the tender process or finding the right way to deal with government in public contracting that is too difficult, and yet that is a natural way to support these smaller businesses who are trying to innovate. The companies we talk to bemoan the rhetoric in terms of being able to work with the public sector. The reality of landing contracts and the cost of tendering puts them off even from starting in the first place. They find it too big and amorphous a body to work with.

Anne Glover: I would agree that Government procurement can add tremendously early on, but, frankly, the bigger reason for the success of high-tech growth companies—very specifically growth companies in the US—is the financing chain that exists all the way up the ladder. Therefore, it is the presence of the exit markets and capital exit that encourages middle and early stage investors to continue to finance the company through its losses. I think we will come back to that later. For the 10 years when Sarbanes-Oxley was dominant, US venture returns were very low. The House has just passed the JOBS Act, which is removing and rolling back five years of regulation and is going to transform the venture industry in the US again. We will, unfortunately, be left behind by that or have to go to those markets.

Q51 Chair: It is a slightly different explanation. To try to bring the two together, is there any evidence that your additional points would not exist if there was not in the first place that different approach to Government procurement?

Anne Glover: I think they are complementary.

Matthew Bullock: Historically, small and SME American technology businesses grew from the 1940s through to about the 1980s before venture capital became freely available. What happened was that the entrepreneurs who went through those first phases sold their companies typically to large corporations. They did not go to IPOs but they gained the skills, and many of those people were the first venture capitalists.

Katie Potts: There has been far more angel investing in the States because there have been more successful companies. Look how many household names there are of first generation billionaires who have deep pockets to recycle. One area in which we have invested in start-up straight into the quoted market, even in the last year or two, is where individuals have come to me and said, "Look, we sold out our business; it was a takeover. We're starting again. Will you put some money in?" It is backing people. They can raise worthwhile amounts of money.

Matthew Bullock: Kleiner Perkins—both of them ran businesses before they started the financing operation.

Q52 Sarah Newton: We have been told that venture capital is not very well placed to support innovative science and technology start-ups or indeed to enable organisations to grow. If you look at the enterprise capital funds, so far they have tended to invest in things with a shorter return and quicker gain, like the

next generation mobile, rather than graphene and new sorts of renewable energy where perhaps it is harder to understand how they can be commercialised. Do you see that as a problem given the time scales required for venture capitalists compared with the need to invest in that sort of science and technology-led innovation?

Katie Potts: Every fund manager has a pot of money and the choice whether to buy this or that. It depends on where the value is. One of the problems is that equity valuations are so low that you think, "Why take the risk that something may or may not succeed when I can buy something that is already profitable?" I consider that a real bottleneck. The problem is that the UK equity market has been shrinking month by month. If people do not have positive cash flows, they do not have new money to put into new companies. I think that is why there is such a logjam, which then makes it too risky to invest early stage because you do not know if you will get the follow-on funding to take it to the next stage. I am quite exercised about it because it is something I have done all my life and I am worried that people do not realise that the situation is so much worse than it has been.

Q53 Sarah Newton: To focus on that logjam, is that driven by the need to get a return back into the fund within a particular time scale or just lack of preparedness to take on extra risk, because, as you say, it is something that might take longer or is less known to be able to be scaled up commercially within a reasonable period?

Anne Glover: I agree with Katie. The difference is that when I was doing early stage investing in the mid-1990s there was a large number of growth capital players who would continue to finance the company, and there was the prospect of a public market after that. Two of our companies are now public. For 16 years we were investors in Optos, which is in the Best of British Manufacturing exhibition for the Olympics. The reason that our time scales are short is that at the moment, historically, until Stephen's fund came along, the availability of the next stage of capital was too weak. Basically, we had to assume that we could work only with our own and that made us much more risk averse. If there was a ladder of financing that worked, we would take the long-term risks and be happy about it.

Katie Potts: I remember in 1996 and 1997 ARM, or Acorn as it was then, coming to me desperate for money. I put in £1 million when they needed it. I doubt that ARM would get funded in the current environment.

Anne Glover: It wouldn't.

Matthew Bullock: I think there is a distinction between the two examples you gave. If one were to look at something like the energy market you talked about, that is really an issue of distribution. How do you break into the distribution in a way that enables you to overcome the inherent conservatism of some of the big utility companies or people like that? That is where I would argue that procurement, pushing some of the utility companies to procure new technologies, would be a very good way of opening their eyes to it. Graphene is different. Graphene is at a state of development that is quite common in technologies, which is what I would call really quite inchoate. We do not know what we can use graphene for. To pump equity into a graphene venture at this stage when we do not know what we are going to sell would be quite risky.

There is a company in Cambridge called Teradata, which has been working with a range of spectrum that people do not understand; it is kind of new. You spend your time going out with soft contracts trying to develop areas of the market without betting the whole company on it. I refer to people like Government Departments. I would cite the Ministry of Defence as the largest single buyer of anything in the country, and it has resolutely refused to deal with small companies; it loves being locked in with the large suppliers, for the reason that no doubt they will be arraigned by the Public Accounts Committee if they do anything as wasteful as spend money with small companies. But go off with them and try to work out what you can use the technology for. Take small bets until you are clear what product you can do with it. I use the philosophical expression "We rush to reify"; we try to turn it into a product too soon before we know what it will be used for. Sometimes you just have to get into the market in this soft way and find where you can get the applications.

To come back to Stephen's point about skills, the two gentlemen who discovered graphene are not the kind of people who could take an investment of, say, £5 million, invest it gently over a period and go through a loss-making phase where, as the losses get greater, the pressures on you as an entrepreneur get bigger and bigger each month. You have to turn it round, successfully market it and get it exactly into the market at the right price against all your competitors from a standing start. The whole point about the soft contract is that it also educates the entrepreneurs to become business people before they start to take in equity finance from venture capitalists, which, when it comes, is always very welcome.

Stephen Welton: I have perhaps a slightly different perspective on it structurally. One of the reasons that capital is provided over the short term is the way it is raised. If you look at a classic venture capital fund or a private equity fund, for that matter, it is normally raised as a limited liability partnership with a 10-year life, and it has a five to six-year investment period. Then you have to liquidate the investments to give them back to investors, so there is a structural way in which capital is raised, which drives a need to achieve an exit.

One of the things we are capitalising on is that we are investing off our balance sheet. We can take whatever time frame we think is appropriate, subject, clearly, to our shareholders being supportive of the company. That flexibility is incredibly useful because it enables us to evaluate a business and what its cash flow is going to be, going back to the initial question. It may well be that in the short term you will be very cash negative because you are expanding overseas or investing in R and D. For many small companies, the need to get a return quickly is a disincentive because they do not feel confident enough in doing that. Often

that leads to a deferral of investment, or they limit their ambition or they sell the company.

Matthew Bullock: Can I make a point on bank finance? We provided bank finance in Barclays for the kind of venture I am talking about, not the one that was running very quickly towards product development and going down through the negative loop. We lent very consistently. We had a loss rate of one sixth of the bank's average over a 10-year period, and basically it was a very good business. We rotated our finance because basically we were providing working capital finance against contract payments from creditworthy customers who we were satisfied would be very sound debtors. We had to monitor things very closely, which we did, but it was basically quite good business for banking.

Katie Potts: On the comment you made about a lot of companies that are started by people getting revenues from services, that has been very prevalent in, say, computer software where people provide services that have generated cash for them to do other products that they can then scale, but that is not so for deep technology because you need product development; you need to file patents and get designed into a product. That takes much deeper capital, and that is why there is a funding shortage.

Matthew Bullock: I beg to differ. The company I chair now turns over 20 million and is the leading company in cell culturing automation in the world. We started off selling some contracts to Merck and Pfizer for a particular system. We got paid by them, and we have been self-financed throughout. That was a very big product; they were sometimes $2 million to $3 million sales.

Q54 Hywel Williams: The situation that you describe seems to favour structurally the safe and the status quo. Do you think this provides a further problem for people enterprising in unlikely locations? I should say that I am a Member of Parliament for north-west Wales where we have some high-technology companies, but I think there is a substantial geographical problem there as well.

Anne Glover: There is but not as much as you think. For example, I know a very interesting start-up in St Asaph that came out of Daresbury. Their challenge is in the medical technology field. They have been funded by angels and venture capitalists because they are so world leading in what they do. The challenge is not location but getting profile and being willing to travel to meet the investors sometimes, because the investors are not in St Asaph, sadly. This particular company attracted a chairman from Chicago in the field because it is so high profile. However, they are struggling with the next phase of fund raising, having developed a product and just getting it ready for FDA trial.

Q55 Hywel Williams: I should say I have a company located in my constituency that was based in Los Angeles, New Jersey and Llanberis.

Matthew Bullock: I think the whole issue of clusters is that they are basically risk management systems; they are ecosystems that help people to manage risks, and that is why people go there.

Katie Potts: I do not agree. I have done exercises going out to Stanford and MIT. Why have there been such successful clusters in California and in the Boston area? I think the simple reason is that there is a whole generation of management who have been trained and watched companies scale. It is not the deep technology but the management and sales skills. They feed on themselves.

Matthew Bullock: I wrote a history of the development of technology financing in America, which interviewed the original people who were involved in the 1940s. They did start, I am afraid, with very deep technology but typically came out and sold services, and it was over a period of time. This is one of the difficulties you have. If you go to California and just visit, you get a snapshot of where they are now; you do not see how they develop.

Katie Potts: I go five times a year.

Matthew Bullock: You have to go backwards, not just currently.

Anne Glover: I agree, Matthew, but I think the world has accelerated. This is the challenge. I know the history rather well myself having lived it. It is very informed and helpful, but the reality today is that development activity is much faster than it was even then. I do not necessarily mean in just mobile where Instagram goes in nine weeks to $1 billion. In the life sciences and deep technology the pace of change is just phenomenal. The good news is that we can be connected through the internet and by travel, and we can create these distributed organisations. It has never been so good to be an entrepreneur in a wonderful place to live, as opposed to where you do not want to live, as long as you have a global attitude and build an organisation globally and travel for the needs, whether it is customer contracts or finance. I am not as worried about the regional problem. Clusters are very helpful, and I agree with Katie that it is the experience you get from clusters that matters, but it is how we get the people connected to the growth prospects that exist in the world today, which are well beyond America, frankly.

Stephen Welton: I think that raises a very interesting opportunity for all these small companies, which is to harness the experience of very capable people who are keen to work with smaller businesses, and that has no boundaries. There are a lot of very talented people who have made money; they become angel investors, or they have experience in particular areas of technology and science. If you can harness that expertise with somebody who has got something very innovative and the passion and ambition to grow, that truly has a lot of potential. They should be thinking globally. We are a small market. In Wales, Scotland or anywhere else in the UK there is no lack of innovation and entrepreneurship. I do not think that is a nationalistic thing. If you have a good idea, you should be able to attract capital and get people who will in a way endorse that idea because they are prepared to put their time and effort into it, which in turn helps to bring capital. Capital will follow the experience. If somebody has a brilliant idea but not the proven track record to commercialise it and build the sales network internationally, it is very difficult to

convince somebody who will be more dispassionate in looking at an opportunity that it is going to work.

Q56 Stephen Metcalfe: I want to explore a little further the soft start-up model. One of you said that ARM would not get funded in the current climate. Would ARM have been able to start up using the soft start model?

Matthew Bullock: To go back, ARM was founded out of Acorn; Acorn was funded by bank finance against the contract from the BBC. Its original contract was from Bally, a slot machine manufacturer, for whom they did some small electronic cards. It was a development contract of exactly the sort I am talking about. They then shot forward. As you know, the BBC contract put them into a position where they did an IPO, and some of that is history. ARM was project no. 96 in their R and D portfolio. They had to go down because they were bumped out into the real world by the collapse of Acorn. They had to go off and get licensing contracts to get themselves going.

Katie Potts: They raised money from other investors—from public market shareholders.

Matthew Bullock: Did they?

Anne Glover: Yes, absolutely. There was substantial funding. The IP licensing model is a difficult one to get up and running. Interestingly, there is a small listed company on the AIM market on the same business model based in Los Angeles. They came into the UK market because the market did understand the licensing model and were able to get public capital. They were not able to get private capital at that particular time. It is a very difficult business model to get off the ground because it relies so heavily on the belief that these large companies will deal with a small company, but it can be done. I do not think a venture capitalist would finance it today.

Katie Potts: I flatter myself that I have been significant on a global basis in investing in the IP licensing model. I have invested in Ceva in Israel, in ARM and in Imagination. I invested in a company called Virage Logic in the States. That is a material proportion. It has been a good model that I flatter myself I spotted early. You have to invest in advance of revenues, and it is a classic example of why it is a capital-intensive business. What happened with something like Imagination is that they sold a $2 million licence to Intel and a $2 million licence to Texas Instruments. They had to design their technology into their products, and then Texas Instruments had to sell it to Apple, Nokia and so on. There is another 18-month design cycle, so from signing the licence to having products on the shelves is a three-year period. That needs a lot of funding. It is a classic of development costs occurring in advance of revenues. It is absurd to think you can fund it out of—

Anne Glover: Correct me if I am wrong, but you have done it as a public market investor.

Katie Potts: We have done it as a public market investor.

Anne Glover: That is the point.

Katie Potts: My concern is that in days gone by we could do it with nine other people and there are not nine other people to do it with any more, because pension fund and insurance companies at their peak in 1994 owned about 60% of the UK stock market. They have now withered to less than 20%, and they have been replaced by overseas investors, who do not look at smaller companies and do not care about early stage companies. That degree of shrinkage means cash outflow. That is why people have also been too ready to accept takeover bids. If you have redemptions, you have to give some money back. They say, "Oh, great; there's a takeover bid. We can take some money out." It makes me weep having gone through the risk phase and then finding that foreign companies buy them too cheaply.

Matthew Bullock: The licence is not the soft model. If you are going to do licensing, you have to produce a product, so you are into all the heavy capital expenditure. You do not have the marketing so much because you have dealt with that issue, but you have all the production expenditure, which is high risk. That is not bankable.

Q57 Stephen Metcalfe: I suppose what I am trying to get at is: what are the limitations of the soft model?

Matthew Bullock: It is slow.

Q58 Stephen Metcalfe: But is that the only limitation? There is no technology that could not develop under it. What I am concerned about is whether there are particular sectors of technology that will slip through the gaps because they do not fall into either of the two main models.

Matthew Bullock: Pharmaceutical development is very hard to do. You are doing something very specific. It is possible to develop pharmaceutical tools companies that get into areas and develop ideas that you can then sell in the soft model. It is impossible to do a drug development as a soft company. My view about biotech is that a lot of people rushed to set up silver bullet companies because the money was there. They spent the money and often produced very little. Mine is a more gradual approach—perhaps more a farmer's than hunter's approach. I would come back to the Cambridge area. Cambridge is predominantly filled with soft, not hard, companies. When the money is there it is great, but the money does come and it does go.

One point on clusters, which I do think are important, is that they are social systems. If the system suddenly withers because there is no money, the skills go. When Acorn and Sinclair both collapsed, we as a bank worked very hard to try to make sure we did not have a cataclysmic collapse. We allowed them to subside so we did not fracture the social network that meant everybody said, "Oh, gosh, British technology companies are a mess. Don't go near them." We sustained the Cambridge network across that period so that people stayed in the game. It is very important that people do not adopt strategies that tip them over the edge. It is the valley of death. The reason it is called that is that most people do not get across it.

Q59 Stephen Metcalfe: But was that out of the goodness of your heart or because there was a commercial imperative?

Matthew Bullock: Commercial value. We were making money as a bank out of doing lending of this sort and we thought it was worthwhile trying to sustain the system.

Anne Glover: You asked whether there were businesses being missed by either of these approaches. I think there are. I would argue that it is not so much businesses as opportunities that get missed; in other words, we are rather good at starting companies, or even rather good at getting them up to a certain small scale, but the financial ecosystem as it is currently—I am not talking about what it was—does not necessarily encourage those companies to stay as the global leader in their space. There is a combination of factors happening here, which is a little bit of the public market point that Katie is bringing in, which is that, even if you do get listed, you are not able to scale because there is not the support, the price is not as competitive, and you cannot make acquisitions. That means it is rather difficult for us to maintain a leadership position. So it is not just the valley of death; it is taking those opportunities and creating heroes out of our entrepreneurs. I was saddened when Mike Lynch sold his company to HP. It was 8.6 billion. That was a venture-backed start-up in the mid-1990s. It required venture capital because he was a very ambitious leader who went on an acquisition spree.

Katie Potts: We put money in before there was profitability in the public market.

Anne Glover: That happened in the mid-1990s; it is not happening today. We can look back on our laurels. I am worried about right now.

Stephen Welton: That is an excellent point. For the start-up and innovation phases to work you have to have the next stage on the next rung of the ladder, because it provides the liquidity and returns to the early investors and entrepreneurs can fund more start-ups. When people talk about equity gaps, there is more than one; there are multiple equity gaps. It will always be hardest to start up a company from scratch. A lot of companies fail because they do not have commercial viability, but a lot of companies are then getting to the first phase where they have a commercial product and sales; they have gone through proof of concept funding, and they then need to scale up. It is a completely different set of challenges.

Then there are challenges of management as well as product commercialisation, and the amounts of money are considerably greater. They are going to go beyond the realms of what either individuals or venture capitalists can fund. That is where you need growth capital. The returns for growth capital are clearly lower because you are not looking for a home run; you are looking to try to build something that has already got a degree of substance. The more you can make that part of the market work, the more it will reinforce the financing for start-ups. As businesses get bigger, it becomes easier to raise capital.

Katie Potts: I have raised two venture capital limited partnerships without any tax subsidising from institutional investors. Regularly I say at my venture meeting that I just do not get why we should take the risk of investing in an early stage company that needs 10 million to get to revenues when we can buy things cheaply in the quoted market that are already profitable. Looking investors in the face, I say it is better for them to put money into the quoted market.

Stephen Welton: Maybe that shows there are opportunities in the quoted market, so for the 10 million venture start-up you have got to find something more compelling to do that. I think the fact you can raise money for businesses that are more mature in and of itself is not a bad thing. What we want to do is expand the number of growing medium-size companies. Based on the research we have done, there are 5,000 companies currently in the UK turning over between 2.5 million and 100 million, growing in excess of 10% per annum.[1]

They are not growing at 50% compound per annum, but they have grown well. These are the businesses which can go from 2.5 million, 5 million, 10 million to 20 million. The economic effects of that are dramatic in terms of employment, tax revenues and everything else, but that market needs funding from investors and banks. If that market works well, it does not necessarily mean that the start-up end of the market is working well, but it will clearly be a healthy part of the ecosystem, because the more this continuum of finance is proving to be successful the more it will help all companies.

Anne Glover: I think we are hearing a theme here, which is public growth and venture. We are all suffering from a lack of local capital interested in taking risk. All three of us are trying to raise capital in today's market. Stephen, you have already done it, but through rather unusual means. It is the lack of appetite for risk at any of these stages that is present in today's financial markets that we have to address.

Q60 Hywel Williams: Do the Government do enough to encourage serial entrepreneurship? We have heard, for example, that failure is less stigmatised in the United States than, say, in the UK. Is initial failure too stigmatised in this country to promote serial entrepreneurship?

Stephen Welton: I would pick up the point that Anne made. I think the entrepreneurs who create successful businesses really are heroes, and they are local heroes because they start in all different parts of the country. We do need to have Government as well as the media promoting entrepreneurial activity. We want to get behind entrepreneurs. These are the people who have the ideas, courage and ambition to set up businesses. We should focus more on what it is that makes an entrepreneur successful. Often failure may be that you are just not realising your potential. Sometimes the best advice to an entrepreneur is, "This particular idea isn't going to work. You've got a lot of potential as an individual, but try something different."

Maybe there is an element of serendipity in doing that, but, focusing right now on where the economy is, there is quite clearly a lack of investment. That goes right across the cycle, and that will be true of the largest as well as the smallest companies in the country and is reflected by the fact that companies are hoarding cash. If you look at the SME sector now,

[1] The witness later stated that there are 4,000 companies currently in the UK turning over between 2.5 million and 100 million, growing in excess of 10% per annum.

they are net depositors with the banking system, which is absurd. You have small companies effectively lending money to the banks because they are not investing. I think it reflects a culture now that there is an unwillingness to invest, and partly that is to do with confidence, but it partly reflects the need to promote entrepreneurship. Government can definitely play a part there.

Katie Potts: At a higher level it is completely bewildering to me that pension funds are happy to buy Government bonds that yield negative returns in real terms rather than own equities that can yield 3% or 4%. The stock market is incredibly cheap relative to bonds. I do not understand actuaries driving allocation.

Anne Glover: I would like to give you a piece of good news. I think that problem is solved and you do not need to worry about serial entrepreneurs any more. In our latest fund 70% of the people we back are serial entrepreneurs, not all of whom have been successful. I would not say that the cultural challenge that I encountered when I came back has gone completely from every pocket, but it has largely gone. Entrepreneurs' relief has been very helpful in attracting people back into that risk-taking mode. It is not the people that we are missing.

Matthew Bullock: I would say it depends on how you fail. There are good and bad failures, and people watch that. If you fail honourably, by and large people say, "Okay; you've tried your hardest and it didn't work out. That's fine." If you commit fraud and burn people, they remember it.

Q61 Chair: That has always been the clear case in the US. There is an absolute distinction between the person who takes somebody for a ride and the person who goes down honourably. Do you think that is more the case here now?

Matthew Bullock: I do. I agree with Anne that we have come on a long way, and people can have honourable failures and start again with a different idea. To be clear, the truth is that we have had an economy that has been pumped up on debt steroids for a long time, and, as we withdraw from that, it is going to be enormously painful for a very long time. There is going to be very little cash. In the case of the Biosystems company that I chair we have managed to raise a bank loan. It took us a long time when we thought we were a pretty successful company, and we just went through a great moil with the banks. They are all going to suffer while the banks go through their own de-gearing nightmares.

Q62 Hywel Williams: This is a comment rather than a question, but I think it is counter-intuitive. It was picking winners but is picking losers, and there is some mileage in that.

Matthew Bullock: To be clear, if an entrepreneur can get venture and equity capital, it is by far the best route, but it is not very frequently available. Is it 4% of businesses who go for venture capital actually get finance, so 96% do not get equity finance of one sort or another? Are we going to say to them that they cannot get into the business? As a banker I was very happy to deal with the 96%. I was very happy for the 4%; it was terrific, but let's keep those percentages in mind. There are 96% of people who do not get venture capital who could still be in the business, and those are the ones who could grow slower businesses but build up their skills. To come back to Stephen's point, growth capital is more frequently available than start-up capital. My experience is getting people to the base where they have got a business, got the experience and know their markets, which is very important. In this country's approach, as Government, you are the biggest customer in Government; you have the most technical demands; you have an enormous range of things that you would like to see developed. We absolutely do not use it as an engine of growth; it is absolutely absurd.

Q63 Roger Williams: I have just had a message to say we are back in recession, or a technical recession, so perhaps the Government will focus on these things a little more. Banks are not really held in very high esteem in this country at the moment. Do you think there is a lever there that Government could use in some way to encourage banks to be a bit more generous—that is the wrong word—or to invest with greater passion in some of the businesses we are talking about?

Stephen Welton: We have to remember that banks are there to lend money and therefore they have to be repaid. It is a pretty old-fashioned idea. To pick up Matthew's idea, we have gone through the last 20 or 30 years with an explosion of debt finance, whether that is for companies, individuals or countries. One can see the consequences of that now. What we absolutely need is a banking system that is working very well but is prudent, because to lend too much money especially to small companies too early, to go back to the point about cash flow, will lead to inevitable consequences and the business will fail. What is important is to make sure businesses are soundly capitalised and they raise the right type of finance. If they are a small growing company, they can raise invoice discounting on the back of their debtors. There is a continuous debate about whether banks are not lending or companies are not borrowing. There is probably an element of both. There is a need to get the banks to lend, but companies need to be prepared to borrow and be happy with the terms on which they are raising that debt.

Part of the answer here is to look at the whole picture. From our standpoint, when we invest in companies we put capital on to the balance sheet; we strengthen the management by putting people on to the board; we review the financial and strategic plans; we challenge the management. All of those things are a good thing. We turn round to the banks and say, "Given all of that, this must be more creditworthy. Therefore, you should lend more because it is a stronger capital base." In my mind that is a much more practical way of trying to address this. We need the banks to be lending but to make sure that borrowers understand how to borrow. How do you approach a bank? What is a bank looking for? I do not think that in terms of what we are talking about here for start-ups you will get banks lending large sums of money to businesses that have no proven cash

flow, because then it is not a loan they are making; it is an investment, and they need to recognise it as such.
Katie Potts: Primarily, the banks should fund the growth in working capital for a growing business, i.e. to fund stocks and debtors, whereas equity is needed to fund development costs.
Matthew Bullock: If you go down the cash flow profile of a start-up, you will start up with development expenditure, which is people's equipment, laboratory space and so forth. Then, if you stabilise the product, you will start to invest in machinery to produce the product, and you will have to start to invest in marketing and distribution. To go back to what I said in my evidence, IBM's rule was that it was one, three, 10: one to stabilise the product; three to get it ready and manufactured; and 10 to market it. For some technologies it would be bigger than 10. If you are a small company, you will have to find 13 units, as it were, before you even start to get a sale.
You do not know whether you are going to get a buyer if you go down the speculative route, which is the hard company route. It is very hard for a bank to say, "I'm going to invest all that money in the hope that you have judged this brand new market correctly." We turned it round the other way, which was to say, "Do you have a sale? Do you have somebody who will actually buy something from you?" Typically, they were large lead customers. Then we would say, "Get a contract from that person and we will then finance it." He did not have any of the major manufacturing expenditure because typically it was a softer start; he did not have the marketing expenditure; and he was therefore able to start the business at a much lower figure. That is bankable. The kind of company that goes off down product development and then takes the product to market has to have equity finance. Banks cannot touch that and deal with that.
Katie Potts: Why can we not require pension funds to have an allocation in their portfolios to equities or UK or European smaller company equities? It would not cost anything.
Anne Glover: As to our portfolio, those who are qualifying for bank loans can find them. It is the equity capital that is missing in today's environment; it is the follow-on equity capital and the exit equity capital in the capital markets.

Q64 Roger Williams: It is unrealistic to expect that banks would change their criteria against which they would lend to these companies.
Matthew Bullock: Although it is tighter because basically there is less money around, period, banks are continuing to lend in this way. I have now left Barclays, and I do not think they have the same focus team they had when I was there. As a way of doing the business, it is still possible to get that kind of finance, but it is against many other priorities where people are clamouring for finance. As a bank it requires quite a commitment to do it, and I do not see that at the present time.

Q65 Roger Williams: Over the years many organisations have been charged by Government to lend in to SMEs. In hindsight, some of those have seemed to be quite successful. I think 3i was set up in 1994 or something like that.
Matthew Bullock: In 1946, after the Macmillan gap.

Q66 Roger Williams: So in a way we are not dealing with a new issue.
Anne Glover: They called it loans but it was actually equity that they provided.
Matthew Bullock: They used to provide convertible mortgages, so if they gave you a long-term loan and took the freeholds of your property they would take equity in your company. When I was starting in finance in Cambridge that was what 3i offered. From a bank shareholder point of view, it did not make a very good return for a long time; I think it made below 10% return. In the end, banks were quite happy to get rid of you.
Stephen Welton: I think that is too much of a simplification. If you look at the creation of ICFC after the second world war, that was created on the back of the Macmillan report, which he worked on with Keynes to look at small companies. This is a long-standing problem, and it will be here in another 70 years. Small companies will always find it harder to raise capital. ICFC was very innovative for its time; it effectively created the venture capital industry in this country. A lot of people who worked at ICFC, which went on to become 3i, now populate the private equity industry and that model was replicated across the world, so it clearly worked. What happened over time is that the very gap ICFC was set up to address, which was small amounts of capital, maybe by way of loan capital, preference shares or ordinary shares, moved away from its roots, so it became a private equity firm operating on a global basis doing what other private equity firms are doing. I am not saying that is wrong; it is just a natural progression that it made as a company. In doing that it moved away from providing small amounts of capital to lots of companies.
Matthew is right in the sense that the return from investing in lots of small companies is not as great as investing tens of millions in a few companies and having some good successes. I suppose the capitalist system works on the basis that capital will always go to the highest returning asset classes, and buy-outs and private equity have performed very well. They are not performing as well now because the leverage in the system is reducing. If I look at what we are trying to do, essentially it is to go back to where ICFC started. We are providing between £2 million and £10 million worth of growth capital to small companies. It is harder to do that because we need to have a lot of people right across the country to talk to lots of companies, but our own experience in a few months shows that there are lots of companies who are interested to talk to us because we are providing something they cannot get anywhere else. There is definitely a structural gap here and the challenge is to fill it, recognising that it is only part of the solution. That goes back to the point we are all making that there is a continuous range of issues here.

Q67 Roger Williams: You would say that the business growth fund that you operate at the moment

is the current institution that takes the place of ICFC or 3i.

Stephen Welton: We have some similar historical origins in terms of how we have come about out of a recession with the support of the banks encouraged by the Government. There are direct parallels there, but it would be naive to think that one institution alone can plug a gap. We can certainly make a big impact on that. The much bigger effect will be how we work with the banks generally and the banking system generally, because, if banks are lending more to SMEs and SMEs are borrowing more, the economy will be healthier. One of the things we are tracking now is the population of companies that are growing at 10% per annum. It was 7,000 companies three years ago; it is now 4,000 companies. A very simple litmus test for us is that on a quarter-by-quarter basis, if those 4,000 become 5,000 or 6,000, the economy must be healthier. It is no more scientific than that, and I do not think it needs to be. It is a reflection of the fact that there is growth at the bottom of the economy.

Q68 Stephen Mosley: On the business loan fund, what sort of metrics are you using to determine whether or not you are successful?

Stephen Welton: Following on from the previous comment, this is a structural gap. If we are here in 10 years I think we have been successful. To be here in 10 years we have got a commercially viable business, because we have shareholders, who are not running a charity and expect to get a return on their capital. In order for us to be commercially successful, we have to back businesses that are in turn going to grow and be very successful. We are very confident that there are a lot of companies in this environment, even if we are back in recession, that are growing.

Maybe entrepreneurs are by nature schizophrenic individuals. The companies we talk to are almost bashful about telling us they are growing. It is almost as if they think they are tempting fate by saying, "We're growing; maybe we'll stop growing, or maybe somebody will come and clobber us." There is a lot of enterprise and innovation. These are businesses that will be able to capitalise on the weak environment we are in. A lot of the successful companies you are going to see in five and 10 years will be growing right now. They will be the ones that are taking advantage of what is a different view of the world. When the economy is growing and every company is growing, it looks easy to make a business successful. It is not. The really good quality companies of the next five to 10 years are being created now, so we are very positive, frankly. In a way it is self-selecting, because the companies that come to us are by definition more ambitious because they are talking to us about raising capital, but we have not seen anything to suggest that it is a very small segment and that companies are not prepared to sell a stake in their business if they think they get something for that. It has to be about more than just money, because I think you will hear a consistent theme that for small companies to succeed they need a range of different things. Expertise and help are as important as the money, because money invested in the wrong area will clearly not make a return.

Katie Potts: On a brighter note, I have about 120 investments in UK tech companies and there is not a recession. I am old enough to have dealt with recessions in the past. In 2002 every conversation was, "What's the burn rate? How many people are you making redundant?" It is not that environment at all. Now we hear, "We cannot get the right skills; it is hard to recruit."

Anne Glover: It is not a global recession in tech; I agree with that.

Katie Potts: It isn't a global recession in tech.

Anne Glover: No; it is not a global recession in tech; tech is doing very well.

Katie Potts: But there is a shortage of capital for new start-ups.

Matthew Bullock: We have come quite a long way; we are not back to the 1940s, as it were. The management community—people who have been involved with companies and have that expertise—and the simple density of angels is much greater than it was. Companies are growing, and I would echo the comment that it is not in a recession there. It is clear that the banks are more difficult to deal with than they were. If I look at the 1990s when the Centre for Business Research did continuous studies of the availability of finance, there is no question that finance became more freely available to small companies. It dropped down as a barrier to growth versus availability of skills. It has come up again. Is it going to be insuperable? No; it is just difficult. On both the bank and equity side it is more difficult. Because of our experience in the last 30 years we have built a much more robust entrepreneurial community that can cope with that, but it is important we do not think there is only one way to start a company. There are many ways to start a company, and we have an active start-up community that is continuing to form companies, and when the equity comes back undoubtedly they will be there to take advantage of it.

Q69 Stephen Mosley: One issue that has cropped up several times in the discussion has been the availability of pension fund money. The regulators are encouraging pension funds to invest in things like bonds, which are well understood; there is plenty of information about them; they can make predictions as to their future earnings, growth and so on. When it comes to small equities, you do not have that information. What sort of information is needed? Is there any way that we can improve the information that you get on companies in AIM or before that?

Anne Glover: That is the fallacy; it is about taking risk and allocating a small proportion of a very large capital base to long-term risk equities. You could do a statistical analysis on history, but even that would not tell you very much because it is about the future.

Katie Potts: The frustration is that the long-term records show that small companies have out-performed. One of the problems of the abolition of defined benefit pension schemes to defined contribution is that corporates do not then have a vested interest in maximising the return; they just want not to get into trouble.

Matthew Bullock: I think that is true. The environment for trustees coming on to pension fund

trustee boards is to minimise risk. Companies themselves have to put in large amounts of capital so they do not want to make any mistakes, and the trustees are told in the regulatory environment, "Your duty is to make sure that you take no risk."

Anne Glover: It is a real problem. Only yesterday I was sent through the data on what is happening in venture. I found it fascinating that Katie came up with exactly the same figure for public markets. Less than 20% of the capital provided to venture now comes from major financial institutions: pension funds, insurance companies and banks. All of them have withdrawn from this risk category because of regulation. Much of it is at the European level; you have Solvency II for the insurance companies, Basel III for the banks, and now you have the EU Pension Funds Directive coming through as well. Then you compound it with the asset allocators basically saying, "Go for bonds instead of equities", and our savings industry—this group of equity providers who are managed institutionally—do not support the equity culture that is required to build high-growth companies. We have to completely reinvent where we go to raise our capital—from family offices and individuals.

Katie Potts: We used to hide behind the pension funds and insurance companies because they were responsible investors with good corporate governance and kept pay under control. Why has pay gone out of control in the private sector? It is because pension funds are not there.

Anne Glover: We need to figure out how to address that issue for the whole chain to work.

Matthew Bullock: And the love of trading. To take the banks, I have to say that the big shift in the financial sector is from "invest and hold" to trading.

Q70 Stephen Mosley: As MPs we get constituents coming to us with good business ideas. Sometimes they are running their own businesses and they are looking for finance. We also get people who have either sold a business or, in many cases, have very substantial sums of money they want to invest. They say, "Do you know how we can get more funding or how we can invest some money we have got?" In both those situations what would you advise? Can people with money come to guys like you and say, "I've got x million to invest"?

Anne Glover: Yes, they can.

Stephen Welton: I tell you how we address that. We are fortunate that we have a substantial capital base, so we do not need capital. What we definitely value, though, is expertise. We have private investors; they could be angel investors or exactly the sort of individuals you are talking to. They have sold a business and have a lot of capital to invest. We are very keen to work alongside them. If a company needs £3 million and we have a private investor who wants to put in £1 million, we will invest £2 million. We do not mind how much we are investing. We would prefer the latter because we get the benefit of somebody who, in the great phrase, has got skin in the game. They have money in the company and take it more seriously; they commit more time to it. That is a very positive thing.

How you get pension funds to invest is a different issue. As to how you get private individuals with money to invest, I do not think that is a problem. In my experience, most individuals who have made a lot of capital are quite keen to reinvest it. They like working with small companies because they understand it; they think it is quite fun and enjoyable, and clearly tax policy is trying to encourage that as well. I do not think that is a problem area. As Anne said, there are enough serial entrepreneurs out there, so if there are issues they are focused more on the institution than the individual.

Katie Potts: I would say they should go to the British Venture Capital Association for the list of people who invest in various companies.

Q71 Graham Stringer: In answer to previous questions you defined a number of issues that are important to successful companies, but when you look at where the UK Innovation Investment Fund has invested, approximately half of its investments have gone overseas. Why is that? What are we not doing as well as the Germans, who take half of that half for their investment? What are they doing better than us? Why are we not getting more?

Katie Potts: From my perspective, Germany is not innovative. Germany has been fantastic at making its big companies even bigger, but there is not innovation in Germany. The start-ups are in Israel and America.

Anne Glover: I do not know the answer to that. The decision making on some of them has been extraordinary. I agree with Katie that it is not particularly because Germany is more innovative.

Katie Potts: There are successful first generation businesses in Germany.

Stephen Welton: As to where the Germans have clearly been successful, they have coined this phrase that everybody trots out about "Mittelstadt". Everybody talks in hallowed terms about the "Mittelstadt", which is the backbone of the German economy—that is, medium-size and small companies up to companies like Bosch and huge global engineering companies. What the Germans have shown they can do very well is build a business for generation to generation, so there are more examples of family companies going through generations than in this country or the US, where there is perhaps a tendency to sell and capitalise on the gain you have got. I think they are very good at harnessing Government and exporting very well. They use their commercial power as a country to support their small and medium-size businesses. That is something we definitely should be doing, going back to what Government can do here. Trade missions focused on small companies, technology and innovation are clearly a very good thing. The likes of Rolls-Royce are fantastic businesses, but look at all the suppliers to Rolls-Royce or all our automotive companies. The Germans are very good at getting behind those sorts of small businesses.

Matthew Bullock: The German model is a real puzzle. Even though we have done a lot of research on different industrial policies, we do not understand clearly how the German economy works in the Mittelstadt. One thing that I think is clear from the

research we have done is that the role of the trade associations has turned out to be more important. They create, if you like, communities in sectors whereby the large companies tend to have a clearer relationship with their small suppliers and place contracts with them. I would say that is very non-existent here. When I was in the bank I used to deal with GEC, Racal and people like that. The bank had a 40% market share. We knew all these small technology companies. I used to say to them, "Are you interested in seeing these small technology companies? You might find something of interest." One finance director said to me, "Why should I pay any interest? I'll just wait until the banks put them into receivership and then pick them up cheap."

Anne Glover: The German venture industry is suffering in exactly the same way as the UK and a number of countries, so it is not isolated at all, but one thing it does have which we do not is a big private wealth management industry. There are lots of German doctors and dentists who will add capital to funds. This is entirely speculation. I know that the innovation fund has always required matching investment, which it should do, so it is entirely appropriate; but the German VCs I know have been able to raise money from those domestic sources more easily than the equivalent domestic sources available in the UK.

Q72 Graham Stringer: I have diverted my own question on to Germany, whereas I was interested, if not more so, in what this country and the regions, which again do not do as well as the south-east, could do better to attract funds. What we are interested in as a Committee at the end of the day is what recommendations we can make to Government to help small businesses in this country do better. What is missing?

Matthew Bullock: One of the things that we have done in the eastern region is set up an SBIR programme in the health sector. This was done when we had EEDA, and obviously such entities no longer exist. It has been quite interesting. I met a company that had got one of these contracts. It is producing an innovative product that has some legs on it; it is a device. That was done at a regional level. It was capable of being done at a regional level, and it is producing a number of companies that have got into business as a result.

To go back to Germany, Germans are very regionally as well as sectorially oriented. They find it easier to put together their thinking at regional level than we do in this country, where everything is very metropolitan and goes straight up to London.

Stephen Welton: As a very recent experience, we set up in May of last year. One thing that is absolutely critical is not to be a London-centric organisation, dealing with the UK from London. Obviously, the south-east is an important part of the economy, but it is a part of the economy. The thing we were adamant to do right from the beginning was to be regional. You need to be local to the companies that you are talking to. There is a lot of expertise around the country, which was why we set up six offices around the country very rapidly. The thing we found hardest to do, which was a surprise to me, was that, when we started to open offices and expand, the professional services communities in some of the regional cities in the country—that could be in Bristol or Manchester—had diverted their own resources away from helping small companies to raise capital because it was not very profitable. We need to be reinvesting in the professional services communities around the country because they are important. The accountants and lawyers who deal with small companies are often the source of advice and mentoring to get them to a bank or investor. That will definitely help in promoting things regionally and making sure you have expertise—and, critically, that you have real accountability and decision making locally.

If the banking industry have a challenge, it is that they have centralised their model so much that the credit committees are all-powerful, and a lot of the local credit officers in the regions do not necessarily know what the outcome of the credit committee is going to be. That is not empowering the people on the ground, who have to make decisions that are pretty fundamental. Do you trust the people you are backing? The judgment of people, understanding how they sit within their local community—all these very old-fashioned business principles—are critically important, and we need to do more to invest in that. I think the banks are taking that on board just in terms of the qualifications of the people working within them to make sure their regional centres have more power than they used to, so it is going to regional credit committees rather than national credit committees. Things like that, which are perhaps unseen, will start to make a difference.

Anne Glover: To dovetail a couple of ideas that have come up in this conversation, local authority pension funds could become a major player in the provision of equity capital for SMEs across the UK. They probably need to be co-ordinated through a fund-of-fund programme and incentivised to do it as opposed to being told to do it. It would be possible to create a win-win situation if you created a fund-of-fund type of activity, with the local authority pension funds getting a benefit from being asked to participate in some way if the Government could figure it out or perhaps create that on the fly. That would be a way of involving local authorities.

Chair: Thank you very much for a very informative session. I have let it overrun a few minutes because it was a very useful session and we are extremely grateful for your time. I know there will be some follow-up questions. I have had to stop colleagues pushing harder. Thank you very much for the session.

Examination of Witnesses

Witnesses: **Dr Richard Worswick**, Chairman, Colbalt Light Systems Ltd, **Dr Peter Dean**, founder and Chairman, Cambio Ltd, and independent consultant, inventor and entrepreneur, and **Dr Trevor Francis**, Technical Director, Byotrol Technology Ltd, gave evidence.

Q73 Chair: Good morning, gentlemen. Thank you very much for coming. I know you were listening to the previous session. Would you kindly introduce yourselves for the record?

Dr Dean: I am Peter Dean from Cambridge.

Dr Worswick: I am Richard Worswick. I am currently non-executive chairman of a small company called Cobalt Light Systems Ltd, which has developed sophisticated instruments mainly for use in the pharmaceutical industry and for airport security, using novel Raman spectroscopy, which arose from work at the Rutherford Appleton Laboratory, part of the STFC. I was previously the Government Chemist and chief executive of the Laboratory of the Government Chemist. In 1996 I led a management buy-out to purchase the laboratory as part of a competitive privatisation. As chief executive of the company I formed, I developed LGC into an international company with laboratories and offices in more than 20 countries. In recognition of LGC's achievement I was awarded Entrepreneur of the Year in 2003. I should emphasise that I finally ended my involvement with LGC a couple of years ago when the company was sold to Bridgepoint. During my career I have had experience of both the private and public sectors and small and large companies.

Dr Francis: I am Trevor Francis. I am director of technology for an SME called Byotrol based in Daresbury. We are an AIM-listed company employing 27 people. Our technology is an anti-microbial technology that is applicable for hygiene disinfection. We also have a consumer division where our products are currently found in Boots, Tesco and other locations.

Q74 Chair: I can see Daresbury from my garden. Welcome to all three of you. You are here to tell us about your experience, if you have had it, of the valley of death. Have you been there? When did you realise you were there?

Dr Worswick: In my career financing has never been straightforward, but I have to confess that I have been very fortunate in not having experienced the valley of death. It was a term with which I was not particularly familiar until your inquiry. I should emphasise that my experience at LGC was quite different from my current experience with a very small company, Cobalt Light Systems. LGC is a science-based service company and grew from a turnover of about £14 million when I took it over to well over 100 million in less than 10 years. It now employs well over 1,000 people in many countries.

I think the toughest part was the initial growth. There are certain barriers when a company grows. Getting to £50 million for us was a huge achievement. During that period most of the expansion was funded from revenue. To pick up a point made at an earlier session, early sales—particularly of services—enabled us to generate a good cash flow, even though we were not particularly profitable. We used that cash flow to invest in new ventures. We also got bank loans, particularly for some acquisitions, both in the UK and Europe, but the 1990s was a period when it was relatively easy to get such loans. We also received some modest regional development funding when we wanted to expand in the north-west, which was psychologically quite important.

Q75 Chair: Was that from the RDA?

Dr Worswick: That was from the RDA, yes. In Germany we received some generous capital allowances from the federal state of Brandenburg because we had a company just south of Berlin that was very innovative. Their allowances and the relationship with the local government there was one of the reasons we decided to invest more in that area in Germany.

Q76 Chair: Before I ask the others to respond, in both the UK and Germany the availability of funds through a regional government structure made a difference to you.

Dr Worswick: It made a small difference. I do not think it would have changed our decision, but in the north-west it enabled us to take on more people more quickly than we would have been able to do. In Brandenburg we decided to invest quite heavily in equipment. We got very good grants. I think it was 50% of capital on instruments and so on. That was very attractive at a time when we were not flush for cash. That reinforced our decision about that area. There were other reasons why we wanted to expand in Germany, but that was one of the factors.

Coming to equity finance, for LGC our initial investor was 3i, but their cash input was relatively small. Once we got to £50 million we could afford much more in the way of infrastructure, business development and so on, and in 2004 we brought in a new investor, Legal & General Ventures, and got a lot of capital and bank finance which we could use for a further phase of growth.

Just to finish, and I don't want to hog the conversation, Cobalt is very different. Cobalt Light Systems is a small company making a liquid bottle scanner that can be used at airports. It scans a bottle in four seconds and tells you whether there is an explosive, or something like it, inside it. It got going as a company only three years ago. I joined as chairman in March 2009, and the chief executive, Paul Loeffen, was appointed shortly after. Current sales are only about £1 million per annum, although we have plans for a very rapid expansion over the next 18 months. The initial investment of £700,000 came from Oxford Technology Enterprise Capital Fund, a Government-backed seed fund, Rainbow Seed Fund, a few private individuals, and the Research Council, STFC, put in money. We have since borrowed money

from HSBC for working capital, which I can talk about.

Dr Francis: We are in the valley of death. As a small technology company. We went a different route. The founder of Byotrol is Stephen Falder. His family owned a paint company in Manchester. They put family money into it initially and got some additional seed money. In 2005 they went to AIM and got AIM-listed on the basis that there was no alternative source of income for them. That has taken them down a route where they need to commit to sales targets and delivery against sales revenue at a time when the company is looking to try and expand its technology base and build its capability. As we speak, we are trying to balance our cash flow against our sales commitments, identify new markets in which to sell and, equally, to try to find sources of revenue to fund new technology programmes that we would dearly like to run.

Q77 Chair: Are you seeing light at the end of the tunnel?

Dr Francis: We are in a joint development agreement with a Fortune 150 company. That joint development agreement has had an extension of six months to this summer while it carries out some market concept work. If that comes through, we will see light at the end of the tunnel; if it does not come through, then we will see a longer tunnel, I suspect.

Dr Dean: One of the biggest problems I have seen over the years, which is a stumbling block within the valley, is the appalling attitude in our universities towards patenting. In the UK we suffer from having a patent system that is not a level playing field with the rest of the world. In a paper which I have prepared for you I make the point that Japan, USA and Canada all have grace periods that we do not have. I know the European collective system is improving and is up for further improvement, but in the British university context one of the difficulties is that there is no patent strategy to guide the inventor through the process.

I think one of the reasons why your colleagues picked me out was the invention to do with diabetic management. I was happy enough to get asked to solve the problem in the '80s. We produced a patent, which the university did not support financially in any way. The company involved, which was Canadian, suggested that they take all the patent costs and run the patent for us, which was fine. At the end of six months they pulled out; they said they had changed their objectives and were doing something else. As a result, the university of Liverpool was asked to support the patent through its foreign filings and whatever. It refused to do that, and the patent was sold to the USA for a pittance. The USA completed the patent. There are 283 million diabetics in the world. That university of Liverpool test is used pretty much throughout the world, but there is no royalty coming to this country because of the failure to strategise the patent process. To me, that is one of the stumbling blocks within the valley.

I have had seven companies start up with me. The one I am in currently has much more serious problems within the valley. We are getting in enormous revenues from the States with crucifixion on the time it takes to clear cheques, would you believe? It can take three or four months, and we are expected to fund that cash flow differential, in an outrageous manner in my opinion. This is because the international banking community insists on protection against money-laundering, blah, blah. It is all perfectly valid, but, believe me, when you are in the valley, it is hell and I wish that we could do something about it. If Government wish to do something about the situation immediately to create a level playing field, it would be to improve our patent system so that we enjoy the same grace periods or at least a level playing field.

Dr Francis: To comment on Peter's view on patents, I recently sat as a panel member at the R and D Society, which reviewed Sir Tim Wilson's business-university collaboration paper. The vice-chancellor of Cambridge, Professor Borysiewicz, made a very similar statement about the ownership of patents within universities. The patent process definitely needs looking at for the particular reason that universities may well come up with technical know-how; they identify it and file it as a patent. The complication is that to maintain patents becomes very expensive. We spend in the region of £500,000 every two years simply protecting our patents around the world. When you are a small £2 million or £3 million business, that is an incredible amount of cash flow that you need to manage. However, we are a technology company and we thrive on new technology and patents.

The difficulty is that, if a university, having filed a patent, decides after two years that it does not want to continue to fund it because it is no longer of interest, it simply lets it lapse. That puts it into the public domain. Companies like us do not even know about the patent because there is no national database you can search to identify patents of relevance to you as a business. That simply passes into the public domain instead of potentially passing to companies that could equally use that patent for knowledge and exploit it.

Q78 Stephen Metcalfe: We have heard conflicting reports or different views on the best way to support a company in its early days, whether that is access to some early major clients or finance. Which of those two do you think is more important? Please do not say "both". We want you to decide which route you think works best.

Dr Worswick: If I could speak for Cobalt Light Systems Ltd, this was technology that came out of the Research Council, STFC, and the Rutherford Appleton Laboratory. It was very fortunate that that laboratory had an innovation unit, which incidentally handled the patents. We have not had the same problems because they were quite savvy about the things that needed to be patented. We obviously pay for them now, but the work had been done very well. It is important to remember that the time taken to go from proof of concept to a product that is marketable is quite long. Before our company was even formed, they supported quite a lot of work—£5,000 here, £10,000 there—showing that this technology had applications.

That led to the forming of a company. Again, that innovation unit, of which I have had good experience,

was very instrumental in finding investors–and so on. Clearly, in getting things going, the initial capital is absolutely vital. Having said that—I am not going to say both are important—early sales are incredibly important, because not only do they bring in cash flow but they give you experience of the market and an understanding of how you manufacture or provide a service.

Taking up a point from the earlier session, Government can be incredibly helpful, particularly in novel technologies like Raman spectroscopy. We were fortunate in getting an early contract from a Government Department, which involved a certain amount of development, and making some early sales to the pharmaceutical industry. Investment is very important, but I would say that getting going and pulling yourselves up gradually through sales and processes is perhaps more important.

Q79 Stephen Metcalfe: But you started off with finance.

Dr Worswick: A little bit of finance to get the thing going and then early work and you gear up, but it takes time, and it has taken a long period of time even to reach the point we are at now.

Dr Francis: I would definitely say that customers are more important than capital. We have been fortunate in a couple of our directors. I had a long career with Unilever, so it gave us real influence, action and entry to a number of senior people not only in that organisation but other people you can network. I think it is the selling of innovation that is one of the most difficult parts of the total process. I know that the Committee has spent a lot of time looking at the finance, venture capital and access to funding, but, if you look at the complete process of commercialisation of research and understanding what the customer needs, selling a technology that is looking for a solution is incredibly difficult. If somebody has a problem and you can solve it, it is incredibly easy.

In Unilever there were scientists who had worked in research for maybe 25 years and had never seen one single piece of the research on to the consumer market. On the other side, there are all these orphans—i.e. technical ideas, sitting in research that never got commercialised. First and foremost, I think it is the customer.

That takes me on to Richard's previous point about Government. We at Byotrol try to sell into the healthcare sector. Healthcare in the UK is dominated by the NHS. I know you have heard it before, but when I was at Liverpool at an innovation conference about nine months ago, the lady chairing it was a BBC presenter who had been on "Tomorrow's World" and so on. She said she was doing a documentary to be called "Seventeen". When asked why, she said that it had taken 17 years for a small technology company to get innovation into the NHS. As you can imagine, most small companies do not have that period of time.

Q80 Chair: You must relate to that.

Dr Dean: I agree with the other two. Customers have always been first. We have been asked, for example, by FSS to provide support in various things, all funded by ourselves but they were the customer. I think it is a pointless comparison, because Richard's point was that you needed to get proof of concept before you get anywhere near a customer. Of course, that does cost money, but I would say, as a small business in biotech, that customers come first and always have done.

Q81 Stephen Metcalfe: As we have already discussed, one of the biggest potential customers is Government. It operates, via the TSB, the Small Business Research Initiative. Do you rate that as a way of stimulating innovation and supporting businesses in this sector?

Dr Francis: We had one entry into SBRI; interestingly, it was for a hand hygiene system for the NHS. We thought we were pretty well placed for it. We did not get it; a new and more novel technology did. I do not know how that technology got on. My view about SBRI is that there are probably better schemes that are more relevant for us as a company. We were fortunate to receive from the North West Development Agency what was called a GRAND—now a SMART award—and we recently put in a European WP7 application. We are also looking at KTPs. It may well suit other companies, but for us there are other more interesting opportunities.

Dr Worswick: Coming back to the point about the NHS, at LGC I spent the best part of a year of my life trying to sell genetic services to the NHS. I went round lots of hospitals and met lots of people in the Department of Health and so on. After a year we decided we could not waste any more effort; it was terribly difficult.

Leaving that aside, I come back to your point about other support and TSB in particular. Cobalt has been fortunate. We got a grant from the South East England Development Agency—SEEDA—which is now of course closed. That was quite important. It was £100,000 to develop a particular instrument. We have just recently been awarded £180,000 from the TSB—the Technology Strategy Board. The procedures there have not been very helpful. We applied last September under an open round and got a huge amount of support from people who said this technology was incredibly important. We did hear very quickly. Within a month we heard informally that our proposal was likely to be accepted. It then went into a black hole.

I have seen it from both sides. I have worked for large organisations. Perhaps a four-month delay for a large organisation is not very long, but last September Cobalt had cash to last it a few months. You have to pay your staff and so on. Knowing that we were getting this would have made a lot of difference. There was a helpline at TSB, which was never answered, and we had unhelpful exchanges of e-mail. They are probably doing the right thing overall, but as a small company interacting with them we found it quite difficult. We have been awarded this grant, for which I am eternally grateful because it is very important to us. The £180,000 will contribute to this airport scanner, which is potentially a huge market and is very exciting.

Dr Dean: One of the problems is that many of the rules for application are rather unclear and complicated. My own view, and that of several people

I have talked to, is that the Government are not doing their job if there are too many consultants to help you through this morass of technology information, how to apply and all those sorts of things. Several companies I have been in have applied for various bits of support. One TSB support was very successful: Medesign. It went on to become a substantial company, but for Cambio in Cambridge we have not failed; we just have not got the time to apply, and that is awful.

Dr Worswick: The time to apply is quite important. There is a comparison with the US system, because we are also applying to be on the qualified products list. There you have quite a good system. You just fill in five pages, submit it and very quickly you get a yes/no answer as to whether it is of interest. If it is of interest it is followed up, but you have a filter system, which means that, if you know you have no hope in the first place, you do not waste a huge amount of time filling in very long forms. The way in which you interact with Government Departments is incredibly important.

Dr Francis: To be fair to SBRI, they have that scheme; it is two pages for the very first application phase, and it takes more detail afterwards. When you look at some of the European schemes, they are even more complicated. We put in an application last week and we would not expect to hear anything until July. That is for about £1 million, which would be a significant piece of research activity for us.

Q82 Stephen Mosley: We have heard evidence that people find it difficult to navigate the complicated and ever-changing Government funding initiatives. I guess from your previous responses your answer to that would be yes.

Dr Dean: There is an additional complication, which is the business of full economic costings that go on. You put in for a grant or make a case for some money, to whomsoever, and you find that the institute you want to work with has a very expensive loading, which in a way is paying for something we have already paid for. The business taxing system allows for the fixed costs of universities. Many of the industrial people I have talked to feel that the industry already pays for that. The difference is small and not necessarily a problem; it is the fact that you have to pay twice that comes over hard. There are 135% costings for a typical NHS laboratory for a trial, when we are already paying taxes to support that. That does not seem fair.

Dr Worswick: Coming back to Government support, the one thing that is very simple is R and D tax credits, of which I am a strong supporter. When they were introduced in the mid-1990s by Gordon Brown, it took a little while before tax inspectors and companies learned how to use the system, but it is now well established. It has been extended a bit, but from the point of view of small companies it has not changed a lot. It is completely non-bureaucratic, and it has been a real help to us. I cannot remember the sums exactly, but it is of the order of £60,000 or £70,000. That helps our cash flow enormously at Cobalt Light Systems. It did at LGC; it encouraged us to invest more in R and D. I strongly support that system as being very simple and clear cut, and I would happily see it extended.

Dr Francis: My experience has been on two levels. Going back to the Regional Development Fund, at that time our relationship with the North West Development Agency and through some of the business contacts was very good. It was local; they were quite often in Daresbury. You could meet them and have a coffee and talk to them about what you were trying to do, and they would help to guide you as advisers. Within the KTP there are business advisers. The difficulty of being a small company is that you just do not have the time and resources, so you have many people trying to keep a lot of different plates in the air at the same time and running from one thing to the next, never really sitting down and spending a lot of real focused time on saying, "What am I going to do? How am I going to use the TSB? How am I going to get the innovation awards?"

The other point I wanted to make is that companies need to decide almost strategically that they are going to be very focused on going after awards as part of their financing system. You can then spend a lot more time looking at virtually every single award, but that takes a strategic direction, which I do not think many companies take. You have an entrepreneur who has an idea that he wants to get to market, but he has problems with finance and cash flow, and the whole thing becomes a mêlée. More Government advice about what his strategy is, how he will get to market, how he will get funding and whether he has looked at the TSB could be provided for many of these small companies.

Dr Dean: This is all about communication, if the Government were prepared to advertise in places where inventors read stuff—for example, the fashion magazine *Nature*, which is regarded very highly by most scientists as a good place to read things. Very infrequently do I see adverts that promote Government activity in particular areas. I think it is all about simplifying the system and communicating.

Dr Worswick: I would agree with that. The regional support was pretty well organised. Whether one is in favour of regions having their own budgets and so on is another matter, but the network they created was very helpful when you applied to them.

Q83 Chair: I take it that for all three of you the simple answer to this question is that you do not know. With the demise of the RDAs, where do you go to find the parallel information and support?

Dr Worswick: I suppose it is the TSB, which is getting going, but I agree with Trevor. If you are very small, you have to make a decision. Are you going to spend a lot of time understanding these schemes and tailoring your application to them, or are you just going to go ahead and do what you can without them?

Q84 Sarah Newton: We have heard a lot of discussion about the different sorts of finance that businesses can access or would like to access. What has been your experience of the ease with which you can access them versus your preference? Are you driven to what is easily accessible rather than your preference?

Dr Worswick: For a bigger company, in LGC we had substantial equity finance. I was keen that all the staff should have shares. We had schemes so they would have some ownership of the finance, but we went for bank loans as well. Starting up a smaller company is different. Obviously, you have to start with equity finance. We got that from an enterprise capital fund (Oxford Technology ECF) and other investors. About a year ago we felt that we were getting in orders and we could do with some support with working capital. We approached HSBC, with whom I had had a very long and excellent relationship, under the Government loan guarantee scheme. We wanted to borrow £400,000 for working capital on a specific project. It took a fair amount of time but that is okay; they had due diligence and so on. Remember that 75% of that—£300,000—was covered by Government guarantees. They then turned round and said, "Well, the directors of the company will have to warrant the other £100,000." I did warrant for my part; I was in a position where I could afford to lose that amount of money if push came to shove. Another director was able to do that; another director did so for a very small amount. But there was a bank saying, "We'll lend you money, but you've got to cover it all so there's no risk to us at all", and for that you pay a premium interest rate. I think 2% is added on for the Government risk premium and so on, so it is about 7% on all of it.

At the end, they said, "Moreover, we'll lend you £400,000, but we will give it to you in two tranches. We'll give you £200,000 and then another £200,000 when you've met certain milestones." Six months later we thought we had met the milestones. We went before the bank's credit committee and were turned down and another milestone was produced. In the end, we made lots of protests and got the £400,000. According to my contacts, we were one of rather few companies in the area who got that far, so we have done jolly well in getting that loan.

I make this point not to knock HSBC because other banks—not so much HSBC—have got into terrible trouble with dodgy loans to all sorts of people. They have now reacted and said, "Why should we put £400,000, albeit for working capital, into a small company with a relatively small turnover? The risks are quite high." They probably are. I can see their point of view, but I have to say it was deeply frustrating from our point of view.

Having said that, a month ago we finished another funding round. We have raised £2 million, largely from existing investors, to fund manufacturing. We are optimistic that we are going into a very steep growth phase. Because it was from existing investors who knew us it was relatively straightforward, so we did not experience a valley of death there.

Dr Francis: We went AIM in 2005, for the reason that, as a technology company that is not involved in manufacturing, the heart of the business is the technical know-how that we develop. Venture capitalists really do not want to touch us with a bargepole. We have not got assets. Therefore, we are incredibly high risk. After getting through the early family and seed money, AIM was really the only place to go. I would not knock AIM too heavily. We have been back five times and over that period of time we have raised about £15 million. On at least one occasion we were offered an awful lot more than we were asking for, which we declined, perhaps rightly, because the founder would have found himself incredibly rich. What you then do is squander the money instead of using it wisely.

The difficulty of AIM is twofold. First, at the very early stage as an entrepreneur you go along and then list. You are desperate for money. There is no other choice; you have to get the money or the company will literally fold. You tend to be over-optimistic and commit to sales targets that are probably far too early. It is all about managing the expectations of the AIM market and what you as a business are likely to achieve. Had we gone along and said, "Look, we're going to take four years to develop our technical base; we're not going to be delivering any sales", life would have been so much easier. However, in order to get the money, we committed to a sales revenue over a period of time. You are then committed to delivering against that, which then becomes the management focus instead of doing what you really should be doing, which is developing the technology.

Dr Dean: In the 1980s we tried to raise 20 million-odd for agricultural genetics. I was one of the directors. We were very successful. Most of it came through Rothschild and other venture capitalists. Venture capitalists imposed an IRR of 33%, which was punitive but very nice for them, if we could get it. I think that was the demise of that particular technology transfer exercise, and I hope that it never gets done again that particular way. If anybody wants to consult me afterwards, I am happy to tell them about it.

Q85 Sarah Newton: Some of the types of finance that are available come with so-called expertise and advice. How important do you think it is to have that type of support perhaps for the start-ups or people who have reached a particular stage and need to get up to the next one?

Dr Dean: It is absolutely vital. If you are lucky enough to be on a science park, of which there are, I think, 17 around Cambridge, you have blessings of communal activity and communal patenting. You have lots of technology around lots of people who are looking to move and so forth. I think that is a lovely place to start. I have done it several times, and I recommend it to anybody.

Dr Worswick: I would echo that it is not just the investment; it is getting advice from your investors. 3i were fairly hands off in that they had a minority stake in LGC, but when we had Legal & General Ventures we had very helpful advice from them, particularly initially. Banks—as I have said, I have had a long relationship with HSBC—have provided some extremely good advice. When you are trying to expand internationally, you desperately need help in different countries. You may have to raise finance in different countries. A small company does not have the expertise to do that, so you have to be able to draw on their expertise. It is a very important part of investment.

In the case of Cobalt Light Systems, at the beginning, Oxford Technology Management, which invested in

us, were very hands on. One of their partners spent time with the company. They are quite experienced in the pitfalls of getting small start-ups going, and they have given some very useful advice. At Cobalt we have an excellent board with our investors represented on it as well as other senior management.

Dr Francis: I agree it is absolutely vital. If I go to our experience of AIM, the AIM investors did not impose the disciplines that some of the venture capitalists would have done. There is nobody on the board. Yes, it appoints non-execs, and, yes, AIM is expensive as well, but you do not get people coming in and telling you how to run your business. However, people who would have worked with the management at the time would have said, "What is your strategy? What is your business model? Who are you trying to sell to? Are you trying to sell to people who will really appreciate the technology?" That in itself would have been a very useful exercise.

Q86 Stephen Metcalfe: I think we are all aware that clustering or supported networks have a role to play in helping to nurture this. How important do you think that is in helping to convert early technology?

Dr Worswick: It is quite important. Cobalt is on the same site as the Rutherford Appleton Laboratory in a building that was built for start-up companies. Right from the beginning, the innovation unit there was able to provide us with some space. The scientist Pavel Matousek, who invented this clever technology, is just across the road. Particularly at the beginning he spent quite a lot of time with the company sorting out problems that arose, so there was close proximity to and association with a larger organisation. In enforcing patents and so on a small company has very little muscle, but if you say you are a spin-off from the STFC Rutherford Appleton Laboratory you hope someone will take notice. That is incredibly useful.

LGC was at Teddington, which is a very bad place to be for a technology company. I much preferred being in the north-west and the proximity to Manchester university, where there was a pool of excellent young staff to join you and so on. Location is important. Although I have never been on a science park, I like the idea; it has distinct advantages.

Dr Dean: You need a critical mass around the inventor. If you have an enterprise club, science park or that sort of thing, it is so much easier and networking there is absolutely vital. You can pick it up so much more easily that way. I think the Government should be prepared to fund things opportunistically. For example, in Manchester the discovery of graphene was very well brought out. There was a sudden realisation that if we did not do it now we would lose it. I am hoping to start something up with the John Innes Institute in Norwich on exactly the same lines. They have a good attitude in that area. They have a sort of science park, but it could be much improved.

Dr Francis: It is utterly vital. The reason we are based in Daresbury is that I was looking for a laboratory for Byotrol at the time and was part of the Daresbury business network meetings that happen once a month on a Friday. From my career in Unilever, there are two things. First, innovation happens at the interface; it does not happen internally; it happens when you interact with others. Creating networks and contacts between similar types of businesses, universities and all the other players is critical just for innovation itself. Second, innovation is chaotic, so you try to make sure you have got the interactions wherever you can.

Daresbury has been a great place for us to be located. We are close to Manchester, Liverpool, Lancaster and so on. I just wish we could get more interaction in Daresbury with the universities. There is still a belief that universities expect people to come to them as opposed to going to the customer. I think that getting greater interaction between universities—

Q87 Chair: It used not to be the case, did it? I remember that one of your colleagues from Unilever was a visiting professor from Manchester working in Daresbury.

Dr Francis: It depends on which area you are talking about. Where there is a big research programme in Daresbury relating to physics or whatever, that is more likely to be the case. If you are an SME based in Daresbury, that is much less likely to happen.

Sir Tim Wilson's review of business-university collaboration spent a lot of time looking at big business and universities. I am not necessarily just critical of universities, but they really do not know how to interact with very small technology companies, and it is quite a struggle.

Dr Worswick: I think it is quite a good model. I do not know whether your Committee will be visiting science parks or companies, but you will be very welcome to visit Cobalt Light Systems, which is an example of a very small but interesting company, and see how it interacts with the Research Council laboratory on the same site. It is not too far from London.

Dr Dean: Innovation is not taught in our universities. It is a fundamental process, which follows invention. I go round the country giving talks on this and I am appalled at how few people have heard half the points I want to make.

Q88 Stephen Metcalfe: The Government have a focus on investing in science and technology commercialisation. Do they have their balance right in funding capital projects and putting money into that side of things, or should they be investing more in the support structures and networks to try to encourage self-development?

Dr Worswick: That is an incredibly difficult and complicated question. The fact that the science budget has to a degree been protected is hugely beneficial. From a rather parochial view of someone who is helping a company to supply scientific instruments, there were cutbacks in the capital budgets of universities, which affected us terribly because what we are selling is a capital purchase. You buy an instrument to analyse something very quickly. That has slowed down the market, because a lot of the market is in universities, Government establishments and so on. I would like to see investment in science continuing. I do not think it is an either/or. It has to improve some of the linkages. Clearly, for the NHS, for example, the linkages are appalling, but I would

hate to see that being at the expense of capital schemes.

Dr Dean: I regard that question as extremely complicated. I do not know how to answer you most accurately. If you read the paper that I have written for your colleagues, at the back of it you will find a bit about Cambridge university's failure to keep a business going even though they were getting a good revenue stream from it, basically because they were not prepared to support the technology—the machines—with simple contracts for maintenance.

Dr Francis: I am probably not best placed to answer that question because we are not really that heavily involved in capitalisation. The bigger question is not an either/or, but the total amount of money that is available for the commercialisation of research is the biggest challenge.

Q89 Hywel Williams: I am a Welsh MP. First, how important is it to be close to London in order to commercialise research? Secondly, how aware are you of the efforts of Governments in Cardiff, Edinburgh and perhaps Belfast in this field? Are they salient at all in your thinking, or is the relationship here and with Government here?

Dr Worswick: From our point of view, being close to London is not hugely important; being close to some centres and having good transport links is important. But you must remember that even small companies are acting internationally on the supply side in buying in pieces of equipment. We buy equipment that is manufactured by a company in Northern Ireland; we buy in equipment manufactured in Denmark and the US. We are selling into markets that are international, too. It is really being networked rather than where you are actually sitting. I would love Cobalt to move to Cornwall, but quite seriously, there are some transport problems. Our instrument is quite big and we need to get it around Europe and internationally, even to Wales.

Dr Francis: For us, other than the links with the financial investors, it does not matter at all. In fact, for us, it is more about identifying the right university. I am in Cardiff on Monday and Tuesday of next week looking at the university. It really does not matter at all.

Q90 Hywel Williams: I am just wondering whether the Welsh Government have any salience at all in your thinking, or is it just the university?

Dr Francis: We have a sister company through one of our investors that is based in Flint in Wales. We know that they probably have good access to alternative types of funding, which we look at with a degree of jealousy, but it is not such a critical aspect of it.

Dr Dean: Cardiff pulled off a spectacular one when they got Martin Evans from Cambridge to join them. He is obviously doing very well.

Q91 Chair: I think the mention of Cornwall has pricked up Sarah's ears.

Dr Worswick: It is only because I like Cornwall.

Q92 Sarah Newton: As a Cornish MP I would like to do everything I can to overcome those barriers that would enable you to move to Cornwall and join the other vibrant and innovative manufacturing companies that we have there.

Dr Worswick: More seriously, at the next stage, if we are to set up manufacturing facilities for this instrument, there are some quite difficult choices, to be frank whether you put it in the UK or somewhere else.

Q93 Chair: I was going to come to that.

Dr Worswick: We are not in that league yet.

Q94 Chair: Given the three of you have very broad and somewhat different experiences—I do not invite you to look outside at the weather before you answer this question—if you were starting again now, where would you locate both as a start-up and subsequently developing into a manufacturing operation?

Dr Worswick: For LGC, it would not have been in Teddington. Would you be in the UK? There was a little discussion about Germany. Our experience in Germany was very positive. When we were expanding in the Brandenburg district we were visited by Ministers from the area. They made you feel really good about it. There is something about the culture in the UK that means we do not link politics with industry terribly well. You have pictures of politicians in hard hats visiting engineering firms and it looks as if it is the first time in their lives they have ever been inside. I have taken Ministers round LGC and it is the first time in their lives that they have been in a laboratory.

Chair: Yes?

Dr Worswick: I don't know; maybe I am being unfair. This is all very anecdotal and I am not critical of politicians in any way, but in Germany you have a network among the finance sector, politicians, industrialists and so on. This does affect the growth; it is the climate.

Q95 Chair: You have moved around a bit.

Dr Dean: I have started three companies in Liverpool. Michael Heseltine was appointed by her Ladyship to visit as the Minister. I am afraid that not even he was able to make much of an impression. Much as I love Liverpool, the critical mass does not exist. As to the networks you can create, albeit Manchester is excellent, they are too far away for Liverpool. Abingdon or Cambridge in my experience have been the easiest places because of the points I have made.

Dr Francis: As to the UK, there has been a lot of discussion in previous panels about the soft innovation model. Where you have a couple of very large companies that have real needs, small technology companies can feed off them, be close to them and interact with them. Creating a hub of innovation with universities and small technology companies is absolutely the ideal place to be in many ways. In the north-west we have AstraZeneca; in Macclesfield we have Unilever and Port Sunlight; but the ability to interact with either of those companies is difficult. There is no hub, for example, in the north-west of a

soft innovation model. As a result, we are very much in a hard innovation model.

I did my postdoc in Germany. What amazed me continually was the ability of the prof at the time to be able to go to companies like Volkswagen and simply say, "I've got a visiting professor coming from Japan. I need you to give me 200,000 DM." He got it without any difficulty. Subsequently, when I left Unilever and was running an innovation consultancy, I looked very much to the German model. The German family model is absolutely critical. The key point is that, if you are an entrepreneur and you have to go and get money, you virtually sell 95% of your idea very quickly either to venture capital, AIM or whatever. You are left with 5%. That literally leaves the vast majority of people emotionally drained of the energy to take their idea forward. In Germany you have a family business model that is willing to put more money into it. It does not necessarily take complete ownership away from the individual—from the entrepreneur—and that allows greater ownership of the idea, the technology and the company within the hands of the individual instead of investment houses.

Chair: Gentlemen, thank you very much for your time this morning. It has been a very interesting session. I hope you found it valuable, too.

Wednesday 20 June 2012

Members present:

Andrew Miller (Chair)

Caroline Dinenage	Stephen Mosley
Jim Dowd	Pamela Nash
Gareth Johnson	Sarah Newton
Stephen Metcalfe	Graham Stringer

Examination of Witnesses

Witnesses: **Sir David Cooksey** and **Sir Peter Williams** gave evidence.

Q96 Chair: Gentlemen, can I welcome you to this morning's session? We are extremely grateful to you for coming in. Just for the record, I would be grateful if you would identify yourselves.

Sir David Cooksey: I am David Cooksey, chairman of the Francis Crick Institute. I have been involved in the venture capital business since starting the first UK venture capital fund back in 1981—so quite a long history.

Sir Peter Williams: I am Peter Williams. In my semi-retirement, I am treasurer of the Royal Society. I sit on one or two boards. I am chairman of the National Physical Laboratory and have walked through the valley of death with one or two small companies in the past. So far I have survived.

Q97 Chair: Gentlemen, we recognise that you are both involved in very important institutions, but we have invited you here today as two wise men in the field in your personal capacity. We would be grateful if you could just share information with us from your own point of view and experience. You have both written important works in this area. Had you been doing it today in the current financial climate, would you have made any different recommendations?

Sir Peter Williams: Shall I go into bat first? That is always a difficult question. If you perceive wisdom in the two of us, that is your judgment. You have also got age and distance from past events, so the rose-tinted spectacles come out. On the environment today, the first thing I would like to say is that the reason we are even able to have this conversation today is that the science base in the UK is clearly as strong as it ever was. You can benchmark it internationally against the best of breed anywhere on the planet, and we still backed IAP. We Brits tend to disparage ourselves—witness the hysteria over England's 1-nil win against Ukraine last night—and we do so at our peril in the world of science. Science is in great shape.

Q98 Chair: The Committee is not doing an inquiry on goal-line technology.

Sir Peter Williams: No; perhaps you should. In terms of whether we would say anything different today from the various reports, I suspect among your catalogue of reports you may not have seen the one David commissioned and I chaired to the Treasury in 1998 on the financing of high technology businesses, which is very much the question that is intimately linked with what you are talking about today. Were I talking today about the things that we put in this report in 1998 to a committee of Members of Parliament, I would be drawn immediately to that which Government can and cannot do to optimise the chances of traversing the valley of death. You would look immediately at the taxation environment. In 1998, we raised issues of capital gains tax, which, by the way, led to the business assets taper. We had a 10% CGT, so that entrepreneurs were incentivised on exit, not that we want them to exit too quickly; that is a British disease that we need to get away from. I have to say that the CGT environment, while the current Administration are trying hard with things like the Patent Box, probably still ignores some of the basic facts we put before Government in 1998, which are that you must have the most competitive taxation environment in order to attract entrepreneurs to take the undeniable risks in traversing the valley of death. The other thing we put forward then was what we called emerging growth rebates, which became R and D tax credits. That has run and run very successfully for a decade. If I look at the detail, however, I have dug out the recent BIS independent evaluation of R and D tax credits conducted in 2010: £980 million was committed to the tax credits in that year, split between our original scheme, which was to be focused entirely on SMEs in technology, and larger companies. Larger companies were introduced in 2002. I have to say that, reflecting today, 10 or more years on, that scheme has been highly effective with SMEs. Can we have some more, please? It probably has not conditioned behaviour in R and D of larger companies. They willingly bank the cheques. It is always good news. I sat on the boards of two major plcs who received considerable R and D tax credits during my time as an NED. I do not think you are moving the needle with big companies, but, boy, are you moving the needle with smaller companies. That, I would reflect, has moved positively.

The elephant in the room in all this is not Government; it is the City of London financial services that provide the working capital for all these businesses. There I would say the environment is in current circumstances, inevitably so, less propitious than it was, but, leaving aside current challenges and difficulties, I think there is more risk aversion today vis-à-vis technology-based businesses than there was when David and I started down this track many a decade ago. In your case, David, it was probably in 1980. Those would be my opening reflections, Chairman.

Q99 Chair: Sir David, is there anything you want to add?

Sir David Cooksey: I very much endorse what Peter has said. There are a number of issues I would like to raise. One is that in order to make the valley of death crossable you need to have finance to do it in the first place. If you look at what has happened to the venture capital industry, it has not made the returns (over the 30 years I have been involved in it) that are needed in order to persuade the City, with their risk-averse nature, to invest in venture capital, which is a very long-term investment they cannot get out of once they are in it. If you look today at the successful venture capital firms, they are the ones that are investing at the later stages of the process, as the company comes up the other side of the valley of death, and the real problem is getting from the early stage to where you see the growth beginning to take place.

What we have got is an unfinanceable situation, and we have got to look at ways to improve on that. As you know, I have spent quite a lot of time looking at the life sciences industries in particular. What became very obvious to me when I was asked to write the Cooksey review of 2006 on the financing of health research—but I ventured into the whole business of authorisation of drugs at that time as well—was that the model the pharmaceutical industry had been using was broken. The costs of developing a new drug were rising and rising, and the pressure on the price that would be paid for that drug was going in the opposite direction and there was a big squeeze coming. While not many of the pharmaceutical companies have yet admitted it, what they have got is a broken model, which we have got to do a lot to rectify.

I think it was an absolute classic in 2006. That report was commissioned by Gordon Brown at the Treasury, rather than the Department of Health or BIS. When it was published, after a lot of negotiation with the Department of Health, all of the recommendations were accepted on day one. If I look back, six years later, at what has happened, there has been an awful lot of huffing and puffing, but, in getting to the end points that I wanted to acheive, in truth we have made almost no progress whatsoever. There has been a lot of political good will. People in the Department of Health, universities and so on have all wanted to go in the right direction. The MRC and NIHR benefited from hugely increased funding as a result of that report, but it has not got the critical support to make it work.

Q100 Chair: That leads me very neatly to the next question. Very simply, apart from more tax credits and a better tax system that Sir Peter described, give us a shopping list of actions that Government can take to improve the environment.

Sir Peter Williams: Let's look at tax. One has to keep a watchful mind on the concept that there is no new money around. We are talking about shuffling the deck. The point I made about R and D tax credits is that the singular omission in the 2010 evaluation was the apportionment between large and small companies. Were that data to be available, I believe it would show that disproportionately the £980 million is going to large companies where, as I asserted earlier, one does not move the needle. Quite readily, the Treasury could redirect getting on for £1 billion much more heavily towards the emerging company sector. While the scheme is reasonably generous as currently embodied, it is not quite as generous as David and I and colleagues envisaged back in 1998. I think a simple resharpening of the pencil on R and D tax credits—my plc colleagues will kill me for saying this, of course—would assist with what you are engaged in today, which is traversing the valley of death.

I doubt you can do much about CGT rates. As to the entrepreneurs that I know, my next door neighbour is Jan Hruska in Oxford, who founded Sophos, an anti-virus software company. Many of you will not have heard of it; it does not sell to the retail user; it sells only to corporates. That is hugely, massively successful. It was founded in Oxford just 20 years ago. Jan has never been motivated since the very earliest days by the exit rates on his CGT bill, but his investors undoubtedly keep a watchful eye on this parameter.

The Patent Box, which is a wonderful concept, is immensely complex and busy entrepreneurs will shove it to the side of their packed desk and not focus on it, so it is not having an incentive. I think in that arena—those two areas we talked about in 1998—there are things, neutral in overall cash terms, that can be done to sharpen the pencil.

In terms of TSB activities, schemes that go directly to the heart of SMEs and trying to incentivise them, frankly, pale into insignificance with the one big item on my wish list, which is that, somehow or other, you can bring pressure to bear on Government to become an intelligent procurer of goods and services with set-aside for emerging SMEs, which has been the norm in the United States for decades. It works. If anything, over the last 15 to 20 years, we have gone in the opposite direction: the perceived flight to safety of a large company rather than risking it on a small supplier. If you think large companies are a flight to safety, try building aircraft carriers for a living. It is time the Government woke up and started pushing a set-aside-style procurement scheme on the US model slap bang into the middle of this sector of emerging companies having recently crossed, or about to cross, the valley of death.

Q101 Chair: Sir David, your report was, as you say, well received by Government—by BIS and the Department of Health as well—but, apart from reminding them that they needed to take some actions to implement your well-received report, is there anything else that you would add?

Sir David Cooksey: Yes. Just picking up that procurement point, procurement is absolutely vital to small companies in the life sciences area. They tend to have longer gestation periods than IT and telecoms companies. The situation on procurement is that, if you look at the requirements Government place on their Departments for making procurement, the qualifications required in terms of the financial size and stability of the companies are such that they positively exclude the sort of companies we are talking about from supplying Government, and that is

completely wrong. What we should be looking at is Government being prepared to pay for the prototypes from these companies to get them off the ground and make them work. There is no question about that.

Peter mentioned state aid. If I speak to my colleagues in the venture capital industry in France, Germany, the Benelux countries or Italy, they will laugh at me when I talk about having to wait for state aid approval. They just get on and do it and worry about state aid when Brussels reprimands them. Here, we spend months and months. Look at the Catalyst Fund scheme proposed by the MRC and TSB to get TSB into the business of supporting life sciences companies. It is only very recently that the TSB has paid any attention to life sciences at all. We waited for, what, six or nine months for approval from Brussels? We should have got on with it. It is ridiculous.

There is another area that I find very inhibiting. The Francis Crick Institute is a good example of this. We are building a building: the building will cost about £540 million to complete, and there are lots of other expenses on top of that. We are going to have to pay VAT on those buildings if we have more than 5% commercial activity within them. I might say that includes the canteens if you get a subcontractor to come and run your canteen for you. But the point is that what we are trying to do with the Crick is have a much more open relationship with the pharmaceutical and medical devices industries and so on. What we would like to do is invite people who are, yes, commercial in origin but who can contribute to what is going on in the Crick and enable the translation of scientific discoveries into good commercial products that will benefit patients. Very often, the way you collaborate best is to bring in some of the people from the commercial sector, but we are faced with the fact that, if we do that, we will probably be charged VAT on the entire building, which adds another £100 million. When you see this going out of one pocket of Government and into the other, it is even more ridiculous that they should insist on it, but those are the sorts of problems we are up against.

I mentioned earlier the whole business of bringing forward the licensing process. What I called "conditional licensing" has now become "adaptive licensing" for new drugs. Everybody welcomed it in 2006 as a concept. There have been lots of discussions, conferences ectetera about it; but, somehow, because it requires bureaucrats to take more risk and use new techniques, which are not necessarily proven to the last i dottted and t crossed, you have a situation where that whole process of trying to shorten the approval cycle for drugs has run into a snowdrift because bureaucracy is standing in the way.

Sir Peter Williams: To add just one more comment on my procurement wish list, which is, I think, a fairly obvious one but I would like to draw to your attention nevertheless, Governments of all shades find it extremely difficult to move the elephant in the room in any given direction. The financial sector is its own creature and soul. There is no doubt whatsoever that schemes like Merlin have been well intended to push capital down to businesses. If intelligent procurement and Government contracts pushed real orders resulting in real revenues and real cash flows into emerging businesses, that is the one thing that would persuade investors to buy their shares and back those companies. So procurement has a double whammy: it helps the company directly, and it conditions the market perception of this whole sector.

Q102 Stephen Mosley: Sir Peter, I was very interested in what you were saying about the R and D tax credits. You have outlined that you believe most of those tax credits go to large rather than small companies and we need some sort of rebalancing. But does the particular sector of those R and D tax credits matter? We have seen evidence that some of the biggest beneficiaries of the R and D tax credit schemes are the banks. The 2009 BIS R and D scoreboard shows that HSBC and RBS spent more on research than BAE Systems and Rolls-Royce. Would you consider refocusing which sector or areas of research are funded by tax credits, or would you just talk about entirely shifting all of it from large to small companies?

Sir Peter Williams: There are a couple of questions intertwined there. The first thing is that the 2010 report was interesting and revealing, but it was important in what it did not say and the absence of data. The first thing I would do is put in a pitch to reinstate the R and D scoreboard. That is a general, publicly available database, which tells you exactly the nature of the R and D expenditures of all these various companies and brings out for anybody with an interest in the field exactly what you have just observed—that banks nominally conduct more research than BAE Systems. Let's get the facts on the table and bring transparency and openness and make rich databases available to everybody.

With that in mind, it is probably true that the nature of the marketplaces that the credits finally find their way to inevitably is very difficult for legislation to condition. You can never anticipate the inventiveness of the organisations you are dealing with, which is why banks have prevailed so successfully in that sector. When we originally suggested what is termed in this report the emerging growth rebate, it was aimed fairly and squarely, and unambiguously, at emerging technology-based businesses. We went as far as to define an SME in financial terms and to give a definition of technology-based businesses. You are building on Frascati and all the various other pieces of history you can dig up for yourselves.

It is genuinely difficult to ring-fence a sector like that effectively, as we have always found. Legislation always finds that the money leaks out somewhere unanticipated, but I believe that you could make a stride forward by re-emphasising SMEs. Already you have a concession from Brussels—dare I say it?—to define an SME as employing not 250 employees but 500, which is quite a significant size business, so you have plenty of scope to push in that sector. Just get the absolute facts on the table, because if, as I believe to be the case, the great majority of the £980 million goes to big businesses, frankly, they do not need it as much as these emerging companies we are talking about. If you can work out a way of legislating to put it into technology sectors, which I believe you can define accurately enough, that will be even better.

Q103 Stephen Mosley: There are some clear actions there, which is always nice for us on the Committee. One of the problems we hear not just with R and D tax credits but funding in general for SMEs is that, if you are an SME, they are entrepreneurs who are putting all their effort into developing their ideas and growing their business, rather than filling in forms or lobbying to get funding, whereas universities and big companies have got the resources to lobby and to play the system, basically. How would you alter the system to try to ensure that SMEs have a more level playing field when it comes to lobbying, filling in the forms, meeting the right people and finding out about these grants?

Sir Peter Williams: That is a difficult one, because you have accurately hand-sketched a typical entrepreneur, who is busy, unpredictable, somewhat idiosyncratic and off the wall in style and so on. They do not really have any time, philosophically speaking, for red tape; it annoys them. By the way, that also brings in a broader question of regulation and red tape in this country, which, contrary to myth and rumour, has not been reduced in recent decades; if anything, I think it has increased. These are people who do not want to spend much of their day on that.

Equally, if you have a clear, well-drafted scheme, as I believe the business assets taper CGT was prior to Alistair Darling's last budget, it is pretty simple for a busy entrepreneur to see, when they are contemplating an exit of their business, the nature of the advantages of the scheme in front of them. It is pretty easy for them to see in a SMART award what is in it for them. So make it simple and straightforward. Frankly, an entrepreneur establishing a 20-person company in technology, looking at the Patent Box definition, will just stick it to one side. It is far too complicated; it is too wrapped up. It may look wonderful to a legislator in the Palace of Westminster, but, as you say, it does not cut it on the desk of a busy entrepreneur, if indeed they do have a desk. Keep it simple; make sure the financial incentives are abundantly clear and razor sharp; and, above all, make sure there is liquidity. The great thing about R and D tax credits for small companies is that they get real folding money out of it and it keeps them alive for a period.

Q104 Stephen Mosley: That ties in nicely with something Sir David said about the 2006 report. It came up with all these recommendations, but then nothing was done. We have seen evidence from people saying that Governments tend to believe that things must be done, so they keep coming up with these new schemes. All these schemes are being announced. There is a feeling that you have to announce things to be seen to be doing things; but of course it leads to a much more complicated environment and it is a lot more difficult to handle. You said, "Keep it simple." Sir David, do you think that a few good clear and simple schemes are better than having a situation whereby Governments keep announcing things but nothing seems to improve?

Sir David Cooksey: When I say nothing is done, very often the organisation is put in place to make it happen, but the whole system does not allow it to happen. I agree with Peter entirely; keep it as simple as possible. An area I would draw your attention to is the fact that venture capitalists are really only prepared, with very few exceptions, to invest on the upward curve from the valley of death. There is one area where you can get money at the moment, but it is like sucking blood from a stone. Some rich private individuals are still prepared to back really interesting new investments. Quite frankly, whatever can be done to incentivise angels of that type to invest early in companies and to provide that really high-risk capital is, I think, absolutely vital, but, again, they do not want to be tied up with incredibly complicated rules and regulations; it has got to be simple.

It is interesting that Peter was saying earlier that we had agreed with the Inland Revenue back in 1998 on a definition of a Small High-Technology Company. They agreed they would put a wrap around those companies and enable them to identify them. The truth of the matter is that the Inland Revenue, or HMRC, as it is now, have pushed that back and back because they do not like incentives being provided to one particular sector of the economy.

Q105 Stephen Metcalfe: Sir David, I think it was you who said that venture capitalists had not made the returns they had hoped. Is that because they were trying to pick winners too early? Is it because they did not necessarily understand what it was they were looking at? That brings me to the second part of the question, which is: is it important that entrepreneurs understand science? Does science need to understand entrepreneurs, or is it just another business?

Sir David Cooksey: So often, it is the scientist who is the entrepreneur who starts these businesses. There is a certain degree of arrogance about academic scientists who think the business bit is easy. If you look at what happens out there in the real world, scientists often hang on to running companies far too long beyond their capability. Where we have found the greatest success is where we have been able to bring in really good seasoned businessmen to come and work alongside the scientists. They have got to understand the science and so on. It is those two forces working together with good marketing and so on that really make a difference to the performance of the companies.

I think a lot of people going into the venture capital industry have been too willing to put on rose-tinted spectacles and think these companies are going to have a wonderful run into the future and beat Google at their own game, or whatever it is, but the truth of the matter is that penetrating the market, and very often establishing a market for a new product, is a tough business. That is the problem.

Sir Peter Williams: Could I add a comment? I have some data that I dug out for another purpose the other day. Lest you feel that this problem about the returns on venture capital that David has alluded to is solely a British problem, it is not. In the US and EC industry until the end of the 1990s, the upper quartile managers—the best of breed—were getting four or five times money out. The best of breed today are getting 1.1 to 1.4 times money out, so the whole marketplace has got tougher since the turn of the millennium.

Against that background environment, the Royal Society has established a philanthropically-funded enterprise fund, which is basically venture capital but is solely into the science space that our Fellows inhabit. Whenever we talk to the fledgling companies we are about to invest in—some are very tiny companies still at the university lab bench—the two issues that always come up are the inability to raise finance and, as David has pointed out, the inability to find an enlightened manager, who is both technologically savvy and business-wise. These people are in great demand. The reason the business angels have such huge value in this space is not just the investments they make and the private money they put in, but they are the exemplars; they are typically people who have walked through the valley of death. They have done it and built their reputation, often several times over. They are a role model, but it is still extremely tough.

Q106 Stephen Metcalfe: You said that the latest data says 1.1 as the return.
Sir Peter Williams: David knows these figures better than I.

Q107 Stephen Metcalfe: I do not need it exactly but the spread.
Sir Peter Williams: When I dug them out the other day, the spread of returns is currently from 0.7 to 1.4 times money. That sounds like a good return to you and me, but to a venture capitalist that is nothing. It used to be five times in the 1990s.

Q108 Stephen Metcalfe: How does that compare with other sectors that venture capitalists might invest in?
Sir Peter Williams: That is the whole of venture capital.

Q109 Stephen Metcalfe: But is investing in science and technology companies at the bottom end or top end of that?
Sir Peter Williams: In the US, I think you would not readily distinguish between technology businesses and others, for the simple reason that they are the home of all the great success stories, particularly in the new economy—Google, Twitter, Facebook and so on.

Q110 Stephen Metcalfe: The other thing that I think is required other than ideas and money is a supply of good, well trained staff—employees, people—which is a really important resource. Are we creating enough of those people and in the right mix with the right skills to be able to support these companies as they emerge?
Sir Peter Williams: I speak as a former chancellor of Leicester university. Having inhabited a few other universities in the golden triangle, it has got better. Let's be optimistic about a few things. It has improved. When the challenge seed fund-type schemes came in 10 or 15 years ago, universities started realising that their business schools were not just an adjunct to make money down the road from their main campus but had a value within the university to bring undergraduates into familiarity with business, entrepreneurship and so on. We have made steps forward. In that sense, what can you in Government do? All you can hope to do is create an environment. You cannot be responsible for the fact that there is a deficiency of mechanical engineers who happen to want to found businesses, but you can create an environment, and the environment has improved in the last 20 years.

Q111 Stephen Metcalfe: From the sound of that, there is still some way to go.
Sir Peter Williams: From a low base, yes.
Sir David Cooksey: I certainly agree with that. Universities have taken on the business of business education much more seriously, which I think is positive. I also think that there is increasing mobility in employment. Recently, a company that I chair, which is halfway through the valley of death at the moment, managed to recruit a very senior executive from Thomson Reuters to head it. The fact is that, if you get the right combination of financing and quality of product, you can attract the right people these days much more easily than you could 20 years ago.

Q112 Stephen Metcalfe: As that company grows and you require a range of people to support it, are we educating at the right levels? We have a fantastic pure science base—I think we all accept that—but are we creating the right environment that is encouraging people to take on technical subjects—STEM subjects—where they can act as middle technicians and skilled people who will allow a business to grow? Are we creating that framework?
Sir David Cooksey: I think that is always a problem. We do not train enough of those people; I agree.
Sir Peter Williams: If David Sainsbury were with us today, he would undoubtedly point out that the technician class is a forgotten, underrated and undervalued one in this country and has been endemically. I agree with him entirely that in the 1990s we had this obsession with turning everybody in the country into a university graduate without any thought whether the market and demand was there for such people, and at the same time and in the same process, we therefore implicitly devalued what the Germans might term the product of the Fachhochschule, rather than the university. The net result is that you sow what you reap—sorry, you reap what you sow and vice versa. We could get into deep philosophy here. We miss this at our peril. It does not necessarily relate to the value. The people in these small companies are polymaths—they all do three or four jobs—but the technician class for big and growing businesses is sorely in need of more technicians.
Sir David Cooksey: On top of that, if you look at the science base, yes, it is very good; the research base is very good, but we are bad at translating that science base into good business. This is the crucial factor. It is the people who can take the thing forward; it is taking the bench discovery in the university laboratory through the clinic to producing a drug that is valuable to patients and the economy. It is the same thing through the engineering base as well. It is the people

who can translate good science into good business that is the crucial missing factor.

Chair: The chip is still on my shoulder about the denigration of the technician class, but I am in the chair now.

Q113 Gareth Johnson: Sir Peter, at the beginning of your evidence you said that the British science sector was very praiseworthy. I know it is a big question, but what more can we do to ensure that we retain some of the benefits from the UK science sector? It is all very well investing in British companies and so on, but surely we need to ensure that more of the benefits from that remain in the UK and do not go abroad. Do you have any suggestions as to how we can make that happen?

Sir Peter Williams: I have a comment on whether it is either likely or desirable for it to happen. Higher education, like technology business, is basically a global industry today. Undergraduate teaching and taking our young from their school days and transitioning them into more useful and well trained human beings is a vital part of our national needs, and will remain thus. When you look at an average university today, however, particularly the Russell Group, that which dominates their planning and horizon, financially and intellectually, is postgraduate training and research, and that is where their efforts are going.

As soon as you look at postgraduate training and research, you are in an international and totally global industry. An average research lab in Cambridge will be full of Americans, Chinese, Danes, Dutch, South Africans, Australians and Brits, of course. The same is true in the National University of Singapore or Tsinghua in Beijing. That is something I would urge you not to try to roll back, because it is good for humanity and for the planet that that is the case. It is a great way of mixing the future leaders of all nations together, and the benefits accrue to everybody. Putting it more bluntly and financially, the way Margaret Thatcher summarised it is that we do 5% of the world's research and we need access to the other 95%. The same is true for every other nation, including America, Germany and China. I am not sure that you can easily capture for Britain the research fruits and outpourings of our British research universities, but what you can ensure, if you get more candidates across the valley of death and grow more businesses domiciled in Britain, with their employment base in Britain, is that we capture the benefits of everybody's science base globally.

Q114 Gareth Johnson: How do we do that? You say that we need to ensure we keep British companies based here. We are told that there are lots of instances of foreign companies taking over British industries because it seems more attractive on occasions, but what is it that you think is encouraging businesses to go abroad? What more can be done to ensure that they flourish in the UK?

Sir Peter Williams: I will comment on that briefly. I am sure David wants to come in on this one. It is questionable whether they "go abroad". Let's take Autonomy and Mike Lynch, which is a brilliant success story. He comes straight out of Cambridge, grows to stardom and FTSE 100 status and so on, and sells off to an American parent. Autonomy has not been packed into containers and shipped to California; it remains British. Moreover, Mike Lynch, if I make a top-of-my-head guess, is going to become a serial entrepreneur; he is going to do it all again several times over in the next few years, with Hewlett-Packard money in this case. This is not a bad thing; it is a good thing for the British economy and for life in this country. I am pushing back on the fundamental precept behind your question.

Sir David Cooksey: I want to take a slightly different line. Going back to the life sciences, you get a company that has gone through in vitro testing. It has picked up a discovery from a university laboratory, formed a company, gone through in vitro and probably animal model testing in this country. It then wants to do in-human trials. The sheer cost, bureaucracy and difficulty of getting that done in this country means that, of the portfolio of companies that I have been involved with, probably more than 75% of them have given up in this country and have gone to do their trials in Philadelphia, Boston or North Carolina, because they can get it done quicker and cheaper and with a system that delivers more coherent results. It is quite difficult to get everybody to work to the same protocol in this country for various reasons.

Q115 Gareth Johnson: Can you give any examples of that bureaucracy? Is there a particular bureaucratic element we have here that you do not have abroad?

Sir David Cooksey: It is because, if you want a multi-centre trial, at each centre you have to go through, first, a separate acceptance that they will do the trial. Then it has to go to the R and D committee to decide whether or not they are going to accept it. Then it goes to the ethics committee at each of those centres. I know Sally Davies and NIHR are trying to get this right, but we are still in a position where it is very bureaucratic, and each of those committees wants to tweak the protocol. This is why I am talking about different protocols and so on. At the end of the day, you can find that the trials are not valid because they have not all been carried out to the same protocol. If you have a single portal to go through, once you have persuaded a senior group of reviewers that this is the appropriate thing to do, means you can get out to five or six centres and not go through the same process time and time again, with huge wodges of paperwork involved in every one, which small companies just cannot manage. It is just beyond them.

Q116 Graham Stringer: I think there is a consensus that Government cannot pick winners; it can create a financial, tax and cultural environment to encourage innovation and business success. There is an exception at the moment with graphene, inasmuch as Government have decided that they are going to put large sums of money into it. Are they right? Are there particular lessons that can be drawn from that? Is it a one-off? I would just be interested to hear your opinions, because it does stick out as a very different approach by Government from the general approach to other companies.

Sir Peter Williams: To answer that, I take you back to the 1980s and something which I guess you might have heard of but probably will not have encountered. I refer to the Alvey report and the Government money that resulted from it, which coincidentally was also £50 million of the day; it was the same in nominal terms. As to whether it is desirable, I will come back to that. Let me talk about process and mechanics. In the typically British style of risk aversion, because it was then a large sum of money, Alvey was scattered in small pieces so that nobody could blow a large sum of money on something that was high risk. The net result is that I suspect for many in this room the name Alvey is entirely new. I commend that you go back and look at the evaluation reports on Alvey. You will see that it made no difference whatsoever to the electronics and IT industries in the United Kingdom in the subsequent decades. If you like, it is a warning signal to Government on graphene.

Should graphene be singled out in this manner? It is a remarkable substance. I used to do research on two-dimensional structures for about five to 10 years of my academic career, so there is no doubt whatsoever that it has the potential to do a lot in everything from biomedical devices, unique catalysts and possibly even ultra-fast electronics. The danger is that, because nobody quite knows what it is going to do and we are risk-averse, we will chop it into quarter-million-pound pieces and scatter one piece per university across the whole of the United Kingdom, and it will vanish without trace. While you are correct in your assertion that Governments can create a taxation, financial and cultural environment and should not pick winners, if you are to do a £50 million graphene programme, I am sorry, Government, you are going to have to try to pick two or three winners and give them not sub-critical but super-critical financing, so that you do enable them to be a leader in the facilitation and deployment of this remarkable substance in new applications. You will not get there if you scatter it to the four winds.

Q117 Graham Stringer: Sir David, did you want to add anything?

Sir David Cooksey: No. I totally endorse that.

Q118 Jim Dowd: One reflection on one of the things you said is that in Germany, for example, it is much more likely that you would have engineers rising to the uppermost level, even becoming CEOs, and to the higher levels of management of very large companies certainly in the technological field. That just does not happen in this country. In Germany there is not a separate discipline of accountancy, for example. That is something a manager has to acquire anyway, but, here, companies are run almost entirely by accountants, CEOs, company secretaries and so on. First, do you think that is true as a generalisation? Secondly, do you think that accounts for the fact that R and D in Germany is so much more advanced than it is here?

Sir Peter Williams: Answering your first point purely factually, when I chaired the Engineering Technology Board we ran an annual survey of the FTSE 100 boards. You will be surprised to learn—I have not refreshed this exercise since 2006—that at that time in 20 to 25 of the FTSE 100 boards, the leading executive, sometimes chairman and CEO, sometimes CEO and executive chairman, trained originally in science or engineering. That contrasted with lawyers and MBAs in small single figures and accountants in the low teens. So, as a professional class, scientists and engineers in the FTSE 100 as the leading executives do rather well. It is something that, again, somebody could very simply do the research on and you might be pleasantly surprised. It is a moot point. Somebody doing a first degree in engineering does not make them an engineer, as we all know, but it is a good start.

On the German point, I had the great pleasure a month ago to entertain Hans-Jörg Bullinger, president and CEO of the Fraunhofer-Gesellschaft. He was invited to a seminar at the Royal Society. We had an interesting audience. People from BIS and Hermann Hauser, with his TICs, catapults, or whatever you now call them, came along. It was very revealing to listen to the fount of all wisdom in this whole sector, Hans-Jörg, how the Fraunhofer came about in the first place and how it operates. I will not bore you or detain you today with the details of the story, but I commend it to you. Down the decades everybody, from John Fairclough onwards, has said to Government, "Look at the Fraunhofer-Gesellschaft; there are lessons to be learned." It is a fact that they do not have to debate the issues that we are debating today because they have been through the valley of death as a nation, as it were, and they prosper by valuing and backing engineering with their Länder, federal government, financial institutions, Mittelstand families, scientists, engineers and business folk playing like a team, which is why they are going to win the European championship as well. They are a model, but please, please, check, before we go away reflecting negatively about it, the constituency of FTSE 100 and you will be surprised pleasantly.

Q119 Jim Dowd: So we could have all these benefits as well if all we did was change every single piece of our social structure.

Sir Peter Williams: We might win the Euro as well.

Q120 Jim Dowd: I might win the lottery on Saturday; sure.

Sir Peter Williams: We are different. Let's play to our strengths.

Q121 Jim Dowd: We have listened to much of what you said earlier about the difficulties in this area in this country. Are there any specific advantages of commercialising research in the United Kingdom?

Sir David Cooksey: What should be an advantage is the City of London, which is a big financial centre, but the problem with the City of London is that it is too short term. Again, that is a big difference between the Germans and the Brits. Quite frankly, the City of London reacts to financial incentives. The problem with it is that it also tends to take financial incentives and apply them to applications for which they were not intended, and then we lose the incentives because of abuse. I think we have to work out a way of

incentivising much longer-term attitudes in the City for getting money into these companies.

Q122 Jim Dowd: What about the potential of the Government as a lead customer promoting it?
Sir David Cooksey: That is where we fall down very badly compared with all our European partners and particularly the United States. The United States requires 25% of all Government spending, direct or indirect, to go to SMEs. You see with the Department of Defense, Department of Energy and various other activities in the United States a huge amount of commissioning of prototypes from these valley of death-type companies. If one looks at, say, the National Health Service, these companies have to wait until they have grown by exporting their products until they qualify to supply the NHS. If you turn that on its head and require procurement from these smaller companies, it would make a huge difference to the economy of this country and to the success rate of these companies in shallowing the valley of death. It would make a massive contribution.
Sir Peter Williams: I talked about the science base right at the opening. Within that, the stereotypical image of the engineer as the lab-coated scientist or mathematician could not be further from the truth. We Brits are an idiosyncratic bunch; we are rebellious by nature. I think that among the scientific community there are literally tens of thousands of bright scientists and engineers who have this kind of off-the-wall characteristic that would lead them to take this leap into the unknown if there was just some additional carrot, and to me procurement is the low-hanging fruit that this Government can seize and do something about.

Q123 Jim Dowd: On universities generally, should they all attempt to commercialise R and D, or should we be looking to concentrate on a few centres of excellence that specialise solely in that?
Sir David Cooksey: If you go back to pre-1985, the old National Research and Development Corporation—NRDC—had a complete monopoly on any output from Government-funded science, and the universities depended on it. Quite frankly, it suffered from being part of Government and non-entrepreneurial. Yes, it did foster certain things, like magnetic resonance imaging and so on, but so much got lost through the cracks of bureaucracy in the whole thing. I do not think that every university in the country has enough exploitable technology coming from it to justify having a technology transfer department of its own. Some of the big ones do. Oxford, Cambridge, Kings, Imperial and UCL all have plenty to exploit. I think you should see that syndicates of the intermediate universities are coming through and using expertise across a broader horizon of universities to get the best of both worlds.
Sir Peter Williams: To add a comment, you will doubtless have heard the words "academic freedom" from others in this Committee. I think you should encourage the pursuit of excellence in science, and that is not uniform and egalitarian across the United Kingdom; it cannot be. There will be what some would term an elite. I just simply term them universities who have a different function. There are other honourable functions of a university than becoming a world leader in some research field. So focus on the research but then try to inculcate in those leading research universities an ethos that says to any individual academic that he or she may indeed focus solely on the lofty intellectual heights of their discipline, if that is what they so wish—that is what I mean by "academic freedom"—but each and every one of them should nevertheless be conscious of the way in which society might benefit from the fruits of their research and scholarship. Do not press it upon them but create an environment where demand pull-through is always better than push. If you attempt to designate universities as technology-rich, research-rich or teaching-rich, you are trying to force artificial distinctions that the natural evolution of excellence in research will take care of for you. What you need is to get ingrained in the psyche of the young that research is not only inspiring and fun, but it can be damned useful and wealth-creating as well, and then let nature take its course.

Q124 Chair: Letting nature take its course means that that list of universities will not be a static one.
Sir Peter Williams: No; it fluctuates with time. We have seen it in our own lifetime.
Chair: Two weeks ago we spent some time in Warwick, for example; 25 years ago you would not have thought that would have been possible. There are some extraordinary achievements there.

Q125 Pamela Nash: Gentlemen, do you think that the abolition of the regional development agencies was the right decision at the time?
Sir David Cooksey: If we are talking about the valley of death, it probably was. The truth of the matter is that the regional development agencies started by helping young technology companies, but their performance in that area was woeful. As a result one could say it did not work. What we have got to do is replace that with something that is more effective and not just forget it. What they were trying to do initially was fine. Most of them walked away from it to a great extent. What we need to do is use those same resources much more effectively.
Sir Peter Williams: Declaring an interest, as it were, I had a Scottish mother, Welsh father and I was born in England. There is one thing that I think could benefit from regionalisation. I admire a number of the things the Scottish Government are doing in fostering a climate, which we have ascribed to Government as one of their main roles. Likewise, the Welsh in the past have done something similar. The issue of the RDAs and their abolition is, if you like, an English question. As David has just said—I agree with him entirely—there was little evidence that the RDAs were prospering in terms of this agenda of the valley of death, which we have been going on about for two or three decades. We need something better.
I also remind people that Britain is about the size of the state of Texas. Why is it that we feel we have to have something different? I was brought up in Yorkshire. For Yorkshire, the south-west and London are so radically different. Can we not work out

sensible, adult mechanisms that do not inevitably focus on that which takes place inside the M25 and deploy to strengths, where they are manifest and evident, without erecting structures, committees, regulations and red tape—I am sure there is a better way of doing it—and encourage the Scots, Welsh and Northern Irish to get on with doing their own thing, which by and large they do pretty well?

Q126 Pamela Nash: Do you think that the new LEPs are going to be able to provide a valuable contribution?
Sir Peter Williams: I do not feel competent to comment on that.

Q127 Pamela Nash: Okay; I will let you off. To move on to the Technology Strategy Board, the Government's support for innovation is now centralised in the TSB. Do you think that is the right approach from the Government?
Sir Peter Williams: I am a fan of the TSB in concept. In fact, in my SET and the City report, I single them out as being worthy of receiving more Government funding and having more clout and influence. I always fear in this country when things become centralised—this goes back to your regional question—that they become risk-averse at the same time. I do not want to trot out anecdote here. The last thing that you want to hear as a committee is anecdote, but I have just a tinge of a fear that they could be doing with—dare I say it?—a touch bolder. It goes back to the picking-winners question. There is such an aversion to picking winners in this country. I say to myself that we are being disingenuous because at the end of the day we want a load of winners. Are we just going to wait until they emerge? The TSB should, surely, be given the luxury and responsibility of placing its best bets wisely, and, if we are here criticising Government for becoming timid and the City for being risk-averse, we have got to show by what the TSB does that it is bold, brave and is not risk-averse. That is my only fear.

Q128 Pamela Nash: What is preventing the TSB from being more bold and taking those risks at the moment?
Sir Peter Williams: It is structured like a plc, which is fine; I have sat on plc boards for four decades. In a sense, it is the right role model. I do not feel the central executive have enough absolute power to just get on with the job. What you want is a CEO and team, backed by directors who both challenge them and support them, who will take these bold moves that all of us, viewing it from the outside, want them to take. They have to be brave and risk failure.
Sir David Cooksey: To my mind, the TSB has been very slow off the mark in the life sciences area. It is only in the last few months that it has put together a team of people to address the life sciences area; so one huge part of the responsibility it had was not being tackled.

Q129 Pamela Nash: Do you think that is just about the rules and set-up of the TSB?
Sir David Cooksey: It is the way it has evolved. It did start with a physical sciences responsibility. Having been given the broader responsibility, it should have got on with it a lot quicker.

Q130 Pamela Nash: Is it your impression that the TSB is adequately resourced to do the work it is doing at the moment in terms of both human and financial resources?
Sir Peter Williams: You can never have too much money in this sector. It is small by comparison with, if you like, the private equity players in this space, and, therefore, being brutal about it, its impact will be commensurately small if we are not careful. So, being risk-averse, which is a potential hazard for TSB itself, and certainly a hazard for Government, will not get us through the valley of death. Government have got to be braver, and that might equate with redirecting more money into the TSB from somewhere else with a zero sum game, TSB has to be braver and bolder and particularly take care of David's life sciences point. David is not alone in being critical of their slowness off the mark in the life sciences.

Q131 Pamela Nash: Finally, we received various pieces of evidence that praised the return of the SMART awards under the TSB. Is this something that each of you supports? Do you think it would be beneficial if we expanded this programme?
Sir David Cooksey: The great success of the SMART awards is the fact that they were simple and easy to apply for. You knew what you had got and what was expected of you, which is exactly what a small emerging company wants. I thoroughly commend bringing them back for that reason, as long as they stay that way and do not get wrapped in more bureaucracy.
Sir Peter Williams: Make a bit more razzmatazz when you are giving them away; have a big flash do at the Dorchester with lots of media and the press, the great and the good, and Members of Parliament of course.

Q132 Pamela Nash: Are we not part of the great and the good then? We are separate.
Sir Peter Williams: You don't know us two.
Chair: Gentlemen, thank you for a very frank exchange this morning. It has been incredibly helpful. When you see the transcript, if you feel there are additional pieces of information you would like to feed in, we would be extremely grateful. Thank you very much for your attendance.

Examination of Witnesses

Witnesses: **David Sweeney**, Director (Research, Innovation and Skills), Higher Education Funding Council for England (HEFCE), **Professor Ian Haines**, Executive Secretary, UK Deans of Science, and **Professor Nick Wright**, The Russell Group, gave evidence.

Q133 Chair: Gentlemen, thank you for joining us this morning. I would be grateful if you would introduce yourselves for the record.

David Sweeney: I am David Sweeney. I am director of research, innovation and skills with the Higher Education Funding Council for England—HEFCE.

Professor Haines: I am Ian Haines. Among other things, for what is supposed to be one day a week, I am the executive secretary of the UK Deans of Science.

Professor Wright: I am Nick Wright. I am the pro-vice chancellor for research and innovation at Newcastle university. I am here to represent the Russell Group universities.

Q134 Chair: With introductions like that, my next comment is: your starter for 10. All the university charters I have seen have some sort of reference to the role of the university in terms of the local economy. How does that work? Is there a conscious effort within the university structures to work with local entrepreneurs and businesses and try to create centres of excellence that work within the regions they are located in?

David Sweeney: Every university, of course, is firmly located in a place. It is typically the second largest employer in the area. Many of its graduates look for jobs in the local area, and engagement with local companies is just part of the scene. Different universities have different missions. Cambridge is quoted as saying, "Research excellence and return to the UK economy should be a common goal." I think that, generally, for Cambridge that involves interaction with large companies and many multinationals, but still with a concern for the local area. So I think we have a diversity of institutions. Some are more focused on the local area than others, but all of them have demonstrated a keen enthusiasm for the benefit of the university and the economy in engaging with business.

Professor Wright: I would support David's statement. What the Committee should really understand is that over the last 15 to 20 years there has been a considerable transformation in UK universities in respect of the commercialisation of research. The landscape now is very different from what it was 20 years ago. Most research universities, like the Russell Group, have invested significantly in infrastructure to support entrepreneurial things. For example, almost all the universities have incubator suites for staff and students who want to start their own companies. I think most of the big universities have specialised staff whose job it is to go round talking to local companies, to understand their needs and to try to address their needs either through research or more applied work. It is a very diverse landscape, as David alluded to, but huge progress has been made.

Professor Haines: To add a little to that—I think you have covered a lot of the points—it is quite difficult for an international research group necessarily to relate to the local unless they have particular kinds of companies close by. Most universities attempt to have local people on their governing bodies. I would go down to the undergraduate and postgraduate level as well. Part-time students, who are always coming from the local area, tend to give a huge amount of contact between universities and the local companies.

I can think of examples. I have been round universities doing all kinds of jobs in the past. In one materials technology department, I saw a part-time class being run. All these people were working in companies in the polymer materials sector. The tutorials were being run where students were able to bring problems that they had into the tutorial class. I remember that in one particular case an inspector was wandering around the class. At the end of it, he said, "That student got more consultancy value out of it than they could possibly have been charged as a university for what the member of staff told them about how to solve the particular problem they had raised."

Professional doctorates are beginning to grow in the science area; they have certainly grown significantly in the health and psychology area. There is another area where local people can go, at a higher level than the usual undergraduate programmes, and begin to use the interest and knowledge they have gained inside their companies and other organisations and do a doctorate, and finally realise how much further some of their ideas can be developed, commercially as well as academically.

Professor Wright: That is an extremely good point and one that we do not often think enough about in the UK. A lot of the big international success stories of which one is conscious where technology firms have come out of universities—Microsoft, Facebook—came from students, not staff. It is important that people realise the productive role that students have in these sorts of things. I think all universities now offer entrepreneurial modules that students can do as part of their degree courses, for example. That is encouraging a whole wave of student entrepreneurs. In my own university, students form about 40 to 50 companies per year. All of those are in the local economy—in my case, the north-east of England—but this is happening across the whole of the UK and is very important. We have tended in this country to ignore the contribution that students make.

Q135 Jim Dowd: Is it really that surprising, given the fact that the staff are invariably by definition academics? It is not the first thing they look at. The student body is replenished certainly every year, if not more; God knows how often the academic staff are replenished. So it is a dynamic of the organisation, is it not?

Professor Wright: You are absolutely spot on. It is completely obvious, and you can do the maths on it. My university has 5,000 new students a year. We are a medium-size university, but we have a few hundred new staff a year. It is likely that you will get much greater churn. You also have a group of individuals

who are at a stage of life when they can afford to take risks, particularly immediately after graduation. They tend to have very little in the way of family encumbrances and so on. So they are in a position in life; they have often got an attitude that encourages risk as well. Actually they are a very productive group of people. But the whole debate in the UK—the frame of much of the evidence you have received—has been about staff-led entrepreneurship and spin-out companies. It is a shame we do not do more in the UK to support students starting companies.

Q136 Chair: I think you were sitting at the back when we were talking to the previous panel. You may have heard us refer to our informal session at Warwick a couple of weeks ago. The relationship that has developed there between the Warwick Manufacturing Group and regional business has obviously been incredibly important, not just to the university but the regional and, indeed, the national economy. Is there not a responsibility on the university sector to look for synergies like that?

Professor Wright: I think there is, but that is already widely understood. Of course, different parts of the UK have different types of industrial clusters, don't they? I am sorry to talk about my own area, but it is the one I know best. In the north-east of England there are two predominant industrial clusters. One of them is the chemical industry, where I believe that, as in the north-west, we have a very significant proportion of the GDP of the chemical industry in the country. Our university, Durham, Teesside and Sunderland work a lot with local chemical companies. There is a lot of stuff going on.

The other big sector in our area is the marine and offshore sector. Again, our university has a big department in marine engineering. We support the local economy very deeply. It is the same in the south-west. Bristol university set up the National Composite Centre to support the aerospace industry in the south-west. You will see different clusters, but now that every major university is involved in some kind of activity of that ilk, and that is a tremendous thing to happen over the last 20 years.

David Sweeney: I would absolutely take it for granted that in the mission of every university is a commitment to work not just with business and industry but the social and cultural sector. We also have a stream of funding that is hypothecated to support that in the higher education innovation fund. On measures of success, the income to universities has shown a tremendous, 50% increase over the last six years. I think it is absolutely embedded in universities that there is a commitment to society. That has been reaffirmed in the contribution to society of research being taken as part of the method of assessment. It is part of the commitment to students on employability. Student enterprise is very attractive. We have funded NACUE, a charity that supports student enterprise societies and young entrepreneurs, to provide infrastructure, so that universities and students with their enthusiasm can have that harnessed and channelled to a profitable end. I think the incentives for universities are there to do what you describe, and I think universities are enthusiastic about it.

Q137 Sarah Newton: I would like to come back to what Professor Wright said. I represent Cornwall. The University of Exeter has just become a member of the Russell Group. In my lifetime, the community in Cornwall has been transformed by having a university. There was no university when I grew up there. I would very much endorse what you say about the importance of working with renewable energy companies and deep geothermal in the marine environment. It has been enormously beneficial both to the university and the students but also those businesses, because they say that the university is their R and D department and they could not develop without that. So, I can see, even in a very remote part of the UK, away from the golden triangle, world-class Russell Group research going on. That is quite an unusual situation in Cornwall. The Russell Group does attract the vast majority of research funding. To what extent do you think that those institutions have a responsibility in their wider regional economies to enable different sorts of organisations to work in partnership with the Russell Group and benefit from some of that research funding?

Professor Wright: There is a responsibility, and that responsibility is now quite openly acknowledged. Most Russell Group universities have modified, for example, their mission statements and corporate documents. If you read those documents, you will find embedded in the corporate thinking of the university an acknowledgement of that responsibility, which is taken quite seriously. I would like to speak about universities now rather than in the past. In the past, perhaps that was not the case, but my experience now is that that is very much acknowledged. It is good for the universities as well. While it is very important that universities are part of the global research game that you heard an earlier witness speak about, you can float, a bit disconnected, on that global market, if you are not careful. Some degree of regional rooting is quite healthy for the universities as well, so a local connection based on pursuing interesting and excellent ideas, like the ones you talk about, is very helpful as a balancing force with the global push that you also see at big universities. I think it is good for us, but I hope it is also good for the local economies.

David Sweeney: The Russell Group does a tremendous job and it works in partnership, but I would not see that as the focus of the work in Cornwall, for example. The University of Plymouth, with its very strong enterprise offering, is the right university to lead. Exeter is part of that. University College Falmouth, as well as combined university colleges, is involved. You have to be alert to the particular regional needs, rather than trying to craft the regional needs to fit what the Russell Group might offer, and that is exactly what is happening. Plymouth is active in co-ordinating work that no longer happens because the regional development agency is not there. It is active in Brussels looking at opportunities for structural funds in Cornwall. The university has taken on a tremendous role, led by Plymouth but in collaboration with others.

Professor Haines: I agree with both responses. If I can throw in one negative point about regional issues, I think that London, or the M25 area, is a problem in relation to universities of all kinds working together. The regions have got some reason to do it. In London, there is a tendency for the largest universities to plough their own furrow and not do the same sorts of things as both these—

Q138 Chair: To whose disadvantage?
Professor Haines: I think to the disadvantage of all, including UK plc.

Q139 Jim Dowd: What about the economic health sciences outside the initiatives of Imperial and King's? Surely, that is a local thing, particularly in an area where, as we heard from earlier speakers, we are lagging seriously behind, largely because of the monolithic nature of the NHS?
Professor Haines: I would agree.
Professor Wright: You are right. In life sciences and wider health sciences, the economic benefits of medical research are not just drugs; they often come out in other ways. The NHS is both an enormous boon to the UK in that respect but also, to a degree, something which inhibits innovation. The NHS itself has got better. There are many initiatives within the NHS to try to encourage innovation, ideas brought both from universities but also from within their own staff, but it is a very big organisation and is very slow to move. I did not hear all the evidence given by the previous witnesses, but I would echo the point made about procurement in the NHS. It is quite bizarre in the modern age that we do not use both NHS and MOD procurement, for example, as an effective tool to encourage innovation.

Q140 Sarah Newton: Going back to the theme of my questions: you are absolutely right that there is a unique partnership in Cornwall between Plymouth and University College Falmouth. I am glad you have reminded the Committee of that. They are in my constituency, so I know them all very well. It is a partnership effort. That is a very good model for us, but it has been suggested to us by other witnesses that it would be better if universities in particular areas were designated with responsibility for the commercialisation of science into companies. You would not have every single university trying to do the same thing, but lead universities in particular areas would be doing that. What do you think about that idea?
David Sweeney: I do not think we do have every university trying to do its own thing. Although all of them have a commitment to supporting business and the economy, they do it in different ways. We already see collaborations happening: Aston, with Oxford's Isis Innovation and Cranfield with Imperial. We already see universities keen to cut their costs by sharing activity. We have funded collaborations through our higher education innovation fund. Some of them prosper where the universities see mutual benefit, but some of the structural collaborations we have encouraged founder because the objectives of the universities are different. I am all for universities sharing services; we do a lot to support that, but we have to let those grow organically where universities see benefit to themselves and business coming from shared activity.
Professor Haines: Incidentally, that is not to say—this was one of the points made by the earlier witnesses—that having technology development centres that work across universities is not a good idea. To think of every university, especially those that are not terribly active, having a complete office to look after its commercialisation seems to me to be quite a good idea.
Professor Wright: There is an obvious problem as well, which is that universities do research across a broad spectrum. We might one day have an idea in life science and on another day in aerospace, but we have only a very small number of technology transfer staff, so we cannot really maintain the expertise across that broad spectrum. Some kind of collaborative working helps a great deal, and a lot of universities are doing it either formally, through the partnerships that perhaps feature with HEFCE, but also informally. You will find that the universities in your constituency are meeting regularly and sharing information and best practice among themselves in a way that is probably quite surprising to people.
Sarah Newton: Oh, indeed.
Professor Wright: That helps them maintain a breadth of expertise, which I am sure they find very helpful.

Q141 Sarah Newton: Following on from that, it has been suggested to us that the caps on funding by HEFCE for those institutions that are fostering this collaboration should be lifted. I am just wondering what you feel about that.
David Sweeney: I have absolutely no doubt that the cap we have on the higher education innovation fund would, if lifted, lead to more activity, but we have a fixed pot. We gave great consideration to how we allocated the funding. We did withdraw funding from about 30 universities which we did not feel were demonstrating sufficient performance to justify funding, although I have to say that was performance in terms of income; they were doing some great things that were not represented in income. If we want to support the breadth of the UK economy, we want to support the kind of thing that happens in Plymouth and Cornwall and we want to support work with small and medium-sized enterprises, we have to have some kind of cap, given there is a limited budget, to ensure money flows across the breadth of universities. At the moment, on the evidence we have, we have got that right, but we review it every three to four years. If only we could have more money and release that cap, we could stimulate more activity. We know there is a return of roughly £6 for every pound invested in Higher Education Innovation Funding. The highest performers return about £14 for every pound invested in HEIF. We would love to invest more, but times are tough.
Professor Haines: You are talking about the cap at the top and bottom of the funding. Looking at the list of amounts of money awarded to different universities, it would be very unfortunate if an increase in the cap at the top end were to reduce the

amount of money going to some universities. Just once, I shall be parochial. My ex-university, the London Met, where I was director of the graduate school—I admit it is not a research-intensive university—was receiving something like £1.5 million from the HEIF, and a university like Coventry receiving something like £2.5 million. It would be a great shame if universities falling into that part of the sector were to lose a significant amount of the money they get to deliver what they are doing, in different ways from those that are at the £2.85 million cap.

Professor Wright: In general, most of the sector believes that HEFCE has shown quite good judgment in HEIF over the years. The important thing is continuity. We cannot recruit technology transfer officers if we have to make them redundant three years later, so continuity is very good and helps everybody. I am not going to embarrass David, but HEFCE has done a very good job with HEIF.

Q142 Caroline Dinenage: Professor Wright, I would like to pick up what you said one question ago about the fact that a lot of ideas are coming up, and there is a lot of potential research fodder there for your students to get involved in. Is there pressure on them to focus their research on the things that are going to be more commercially viable and financially profitable, rather than the things that might purely increase the UK's research standing?

Professor Wright: Pressure on the individual research students or young researchers or academics?

Q143 Caroline Dinenage: Yes, and the academics.

Professor Wright: I do not think so at individual level, and that is probably right as well. It is entirely reasonable to expect a research university that has a substantial grant income to be regularly producing good commercial outcomes, either spin-out companies themselves or, more importantly in many ways, transferring technology to existing UK companies. If you put that pressure on individuals, I am sure that is not right. If you compare international best practice, I do not think that is an approach followed by any of the competitors we hear favourably spoken of. The system is balanced at the moment. Individuals have the freedom to pursue their research, but universities have the responsibility to find the golden examples among that portfolio and make the very best of them. That is probably the best approach.

David Sweeney: In terms of the incentives behind the science budget, the research councils, funding councils and indeed the TSB talk frequently about the balance of incentives that we are providing. We are all agreed that excellence in research, delivering the seed corn for the future, is the priority. However, it is not the only objective. It is clear from the research councils' policy and ours on research assessment that the highest quality world-leading work, much of which is theoretical and will lead to a contribution to society well down the line, is the priority for universities and funders, but that is backed up by recognition that more applied and immediate work is often good and will be rewarded.

Q144 Caroline Dinenage: Do you think there is an imbalance between the investment that goes in at a low level of technological readiness stage, or the research stage, and almost a lack of available funding when it comes to the bridging of the valley of death later on? Would that be an issue?

David Sweeney: The way that our dual support system works, with roughly half the money being spent by the research councils on projects and programmes, where it has considered what the grand challenges are, and roughly half the money going to universities as a un-hypothecated block grant, is intended to deliver flexibility to universities in chasing what they think in their engagement with research users—business, industry and the cultural sector—is the most sensible way forward. No one person is taking a decision about the balance. This is a devolved decision between the research councils taking disciplinary views and universities taking views which we insist are informed by the engagement with research users. There are mechanisms in place to achieve a reasonable balance, and I do not think anybody has produced any evidence that our balance is significantly awry. We continue to perform exceedingly well in world-leading research, as measured in citations, and we see multinational companies repeatedly rolling up to this country because of the strength of the research base and wanting to work with us. Although one must always question what we are doing, at the moment there is quite strong evidence that we are in the right area.

Q145 Caroline Dinenage: We seem to hit above our weight in terms of basic research internationally but not necessarily always in commercialisation activity. You do not think that the balance of funding is in some way awry.

David Sweeney: We have to tease out that oft-quoted view. We have done a lot of research. We have had the Centre for Business Research at Cambridge, PACEC—the Public and Corporate Economic Consultants—Library House, as was, and also the OECD working on this. In terms of incentives to universities, the UK ranks alongside the US. We have more spin-out companies per pound of investment in the UK than in the US. Certainly, the US is ahead on licensing; the UK is ahead of the States on building recognition for business engagement into promotion procedures, and both of us wrestle with very similar problems with technology transfer offices. The US complains about inflexible technology transfer offices, as crops up in this country. In terms of the incentives to universities, we are competing with the US. Taking work through to commercialisation is certainly not just about universities and public funding. You have to look, as indeed you are, much more broadly at the environment for taking ideas, as the TSB puts it, from concept through to commercialisation. I am not sure that at my end, the university end, we have an imbalance.

Professor Wright: I agree largely with what David has said. You have to see it in a much broader context. I have spent part of my career in industry—I am an engineer by background—and part of my life in university, so I have seen the problem from both ends. When I was working in industry, the technologies

were much more developed than the kind of ideas that typically come out of a university research lab. If I was investing my own money or my company's money, I would look pretty sceptically at some of the propositions put to me by university research teams, because they are at too early a stage, too preliminary. Most large economies have understood this problem quite well and put in place what you might call a national innovation system of some description. It varies between different countries. In Germany, it works differently from the way that it does in the US. We seem to be the only major economy that thinks we can make this work on fairy dust and good intentions. It is quite perverse. Most countries have put in place a proper system. It does not have to be heavily prescribed; it can be an informal system, but there is a national innovation system of some kind, and we desperately need that in the UK.

Q146 Caroline Dinenage: What form does that take elsewhere?
Professor Wright: It can vary. The Fraunhofer system in Germany is well acknowledged; the US system works quite well. We have to think very carefully about our national characteristics and the way that we work in the UK and tailor that to our needs. I think the previous set of witnesses said much the same thing. This is desperately needed in the UK. We must first understand the necessity for this first of all. It is not an impossible problem to solve; we can easily do it. The Russell Group universities have a pretty strong view about what we would like to see as part of a national innovation system, but unless we put in place a system, we will suffer these problems. The components you would expect to see in that system are definitely support at the early stages from public finance, as David has alluded to, from HEFCE and research councils, but you also need to bring into play things like government procurement and, for example, military procurement, which is what happens in the US. Most small US technology companies receive an enormous amount of money from the American military through various programmes. That is their support mechanism and national innovation system.

Q147 Stephen Metcalfe: You have been talking about a national innovation system. You mention the Fraunhofers. The Government have taken steps towards creating the catapult centres, under the guidance of the TSB.
Chair: We know about the catapult centres. We do not like the name.
Stephen Metcalfe: Yes. It is supposed to be based on the Fraunhofer model, but do I take it from what you said that it is not going to fulfil that role?
Professor Wright: The comparison between the catapult centres and the Fraunhofers is a big topic. There are many more Fraunhofers in Germany than the catapult centres. One observation that Russell Group universities would make is that there is a much closer interaction between Fraunhofers and German universities than between catapults and UK universities, for example, so that is an open question.

Q148 Stephen Metcalfe: But are not catapult centres that have been established so far all established around universities?
Professor Wright: A small number of them have been.
David Sweeney: I do not think the objective is to establish them around universities. These are business-focused organisations, where universities will be stakeholders and will contribute. We have got half a dozen catapults in development. We have different models for the different catapults that reflect the different structure of the industries involved. Good progress is being made in setting them up, but until they have had an opportunity to deliver, it is difficult to say whether they are a significant or small part of the answer.

Q149 Stephen Metcalfe: The jury is out.
Professor Wright: I would disagree with that. I do not think good progress has been made. They are too disconnected from universities. The Technology Strategy Board is not talking to universities about the alignment of strategies. For example, every year we invest in new staff and researchers. That is not being done in a co-ordinated way with the TSB.

Q150 Chair: But if you went down the route of the German Fraunhofer model, you would redirect resource from the research councils directly to the Fraunhofers and not to the universities.
Professor Wright: I do not think we should go for the German model. The German model works fine for them, but they have a very different system. The way that they have designed their national system puts different functions in different parts of it.

Q151 Chair: You want to bolt both bits together. I am all in favour of more money going into research, but you want it to go through the research councils to universities and a separate sum of money to go through the TSB into the catapults. You are inviting a still larger sum.
Professor Wright: Of course. It would clearly be a mistake for the nation to cut off its future by shutting down research funding. That would be a calamitous mistake. At the same time, we need to make much better use of the very large sums of public money that are going through procurement in things like the MOD and NHS, for example. If you are looking for an extra source of revenue, it is staring you in the face.

Q152 Jim Dowd: You were talking about the national approach to innovation. I just want to look at a national approach to providing the correct balance of courses across the higher education sector. Whose responsibility is it—this is a question for anyone who wants to answer it—to ensure that the balance across the nation as a whole in the different disciplines, particularly engineering, science and technology, is provided by the higher education sector?
Professor Haines: Can I start by reminding the Committee that it is demand-led, and the demand is student demand?

Q153 Jim Dowd: So, your answer is nobody.

Professor Haines: It is students who create the demand. There have been a small number of initiatives to support STEM degrees. Amounts of money have been given to professional bodies to press the case and to advertise the opportunities in science and engineering. But we do have an issue, because students are loaned money by the Government to go to a university and apply for a programme. Every science department and faculty I know works incredibly hard going to schools and other places to try to convert people to study science, but, frankly, it is led by student demand. It is very unfortunate at the postgraduate end because such a significant amount of student demand is international, rather than home-based.

Q154 Jim Dowd: This is chicken and egg, is it not?
Professor Haines: Absolutely.

Q155 Jim Dowd: They apply for the courses that are there.
Professor Haines: No, absolutely not. Universities are putting on courses for which there is a demand. Universities are continually closing down courses for which there is not a demand.

Q156 Jim Dowd: So this is not a strategic question; it is just a market question.
David Sweeney: It is a strategic question as well. We have always had student choice as the key element in the courses that universities run. However, we are putting a good bit of effort at the moment into informing students about employment opportunities, wage outcomes and success in getting jobs, in all disciplines, so they can make wise choices. We have had a campaign running for six or seven years working with STEM people in schools, working with universities and professional bodies to try to stimulate students to choose science and engineering subjects at school, and supporting capacity in universities, where perhaps in the short term there is a drop off-in numbers, so they can maintain that capacity until numbers flow again. We have seen some significant successes notably in maths and some areas of engineering, although not in others. There is a strategic approach to encourage universities, who are working with us—I speak very highly of them—to provide opportunities for students. There is a strategic approach, with schools, to persuade students to do STEM subjects, but it is up to students to choose that. We have had some success in this over the last five years, and we need to keep at it for the next 25 years if we are going to produce the skilled graduates in the number and disciplines that the nation needs.

Q157 Jim Dowd: That is exactly what I was aiming at. Individual higher education institutions just work with the funding council on the general strategy of producing students who can make the choice. There is no guarantee that, even if they have got the qualifications to move into science and engineering when they go to university, they will actually do it.
David Sweeney: Nor is there any guarantee if they achieve good science degrees, as many do, that they will go into employment in that area. Indeed, our business scene is considerably enriched by people with numerate skills who go into management positions. We are absolutely determined to stick at encouraging universities to offer a broad range of courses and students to choose to do that, but you cannot keep running courses if repeatedly nobody chooses to do them. There is absolutely a national strategy on this, but it is not directive of individual students.

Q158 Jim Dowd: How much can you factor in the vagaries of one year's intake compared with the next? Just because in one year there is a fall in the numbers, so there is a financial question for the institution, you cannot simply say that you are going to close down a department simply because you have not got enough students this year.
David Sweeney: There is a shared responsibility with universities. It is in their interests to support things over the medium term, as Nick has pointed out, because stability in research goes alongside teaching. Teaching and research are inexplicably linked. I do not think there is any danger from very short-term fluctuations. There is a danger from medium-term fluctuations. That is what we had, for example, in maths and we set about doing something about it. In computer science, we had a big bubble, and now we are in the rather tricky position that there are poor employment outcomes for computer science graduates. The key question is: do you make this information visible to prospective students in a way that they can understand, and also visible to schools so that careers advisers in schools can help prospective students? In publishing our key information set, which we hope will be available and accessible to those groups as a way to help, we think we are going to help students come to wise decisions.

Q159 Jim Dowd: Is it your estimation that we do have enough science, engineering and technology graduates at the moment, or is it a reflection of the job market, in that it is the market that determines what courses students sign up to? If there are unemployed science and engineering graduates, are we producing too many?
David Sweeney: Science and engineering graduates offer a wide range of skills beyond the particular knowledge in their discipline. I think we need more of them, but it is quite difficult to analyse at the moment, given the state of the economy, what the continued need will be. We talk a lot to the CBI and businesses generally. We have the Council for Industry and Higher Education, where vice-chancellors and captains of industry meet, and we are getting a consistent view from business that they want more STEM graduates. Although there are limits to what we can do to achieve that, that is our intention, recognising that arts, humanities and social science graduates also have fantastic skills and many end up in very senior positions.
Professor Wright: Perhaps I might add one thing. One of the issues is that sometimes it is quite difficult for universities to respond quickly to changes in the demand for graduates. Sarah Newton talked earlier about work in her area around renewable energy.

There is a big global boom in renewable energy. Almost all of that renewable stuff is connected with electricity at some time, so there is a big demand for electrical engineers. If you talk to any major infrastructure company, they will tell you that they are desperate for electrical engineers. It takes more or less five years to go through a degree to come into that. You then have to have professional training, and there are not enough people coming through the system quickly enough. It may be that particular industrial sectors industry can make a coherent case to somebody, perhaps David, to encourage a faster response in terms of training more people more quickly. The big danger is that if the companies cannot get the people they need, they are forced to move operations overseas because they simply cannot find enough electrical engineers.

Professor Haines: I realise that the Chair wants to move on, but let me add: I think we have answered this question on the basis of thinking of graduates doing their standard bachelor degrees and further up the scale. There is a major issue about the training of technical staff for a whole range of careers, which we have not touched on.

Q160 Caroline Dinenage: Sorry to jump in, but this is one of my pet subjects. How much are universities doing to communicate with the schools at an early stage to educate kids as to what GCSEs they should take to pursue STEM subjects, for example? In my constituency, we have an issue, where schools are encouraging kids to take a combined science GCSE and that prevents them from taking any of the STEM subjects further up the food chain. At the age of 13 they are almost writing themselves off from some of the careers that you have mentioned, because of a lack of good advice from teachers and other staff around them. At that age, potentially, they are not going to think about their future and what kind of career they may want to go into, but it cuts off a whole lot of other careers.

David Sweeney: Every university I know is substantially involved in schools outreach, and some of that we have funded directly where we have thought—for example, in physics—that there are limits and we need to encourage more. This week, we have seen potential developments with university involvement in A-level curriculums. These things are there. I suspect we could do more of it.

Q161 Caroline Dinenage: It has to be earlier, I think.

David Sweeney: Yes. It is really great to get into primary schools. There is some wonderful work funded by foundations, but it is just an issue of scale.

Q162 Chair: Absolutely. I am going to really push you on this. There is undoubtedly a weakness in our primary schools. We have some fantastic, well-motivated primary schools but a massive shortage of primary school teachers with any science or engineering experience. Last year, I did some work with the Royal Society of Chemistry and the Chemical Industries Association to produce a DVD for primary school teachers to help them explain basic scientific concepts to children. Why not are the universities doing it when they are training our teachers? It is their responsibility.

Professor Wright: I am not sure I understand your point.

Q163 Chair: We have a lot of very inspired young teachers who have no qualifications and training in science and engineering, but the university sector trained them. Why do they not do that work with young teachers to help them manage and inspire people about things around them?

Professor Haines: Part of the reason—it is a rather trite answer—is that there are too many things in teacher training courses that need not be there and need to be removed to make space for this sort of thing. It is a very difficult thing to do. I would not fancy trying to do it, with my experience of teaching science in all kinds of different ways, but that is one of the major issues. Let me throw in one more thing. As well as many more primary school teachers understanding science better and how to teach their pupils, we need much better training of careers advisers in schools, most of whom have an idea that if you are going to do an A-level in chemistry the only thing you can do is be a chemist or use it to get into medical school and become a doctor or get into a veterinary college.

Q164 Stephen Mosley: Changing the subject a bit, we have heard of some blockages that stop academics interacting with business. One is the Research Excellence Framework. Do you think the REF encourages academics to be involved with business, or does it prove a hindrance and, if so, what would you do to change it?

David Sweeney: I am responsible for the Research Excellence Framework. We have incorporated, for the first time, an explicit recognition of the contribution that research makes to society, although there always been recognition. We have pitched the level at which we do that to reflect the importance of basic research alongside work that makes a contribution to society. I look round the university sector now, as people are in the middle stages of preparing their submissions, and I think universities have been galvanised by this, not to alter their research programmes, but to dig out the work that they have done and celebrate it, and to stimulate greater engagement with business and industry, so that research programmes are better informed. I see a more positive attitude, which was the intention, but we have to do the exercise. We have to see what the outcome is and get feedback from the universities on how they felt it was helpful to this agenda, and whether there are issues that we need to resolve. I think we have considerably adjusted universities' attitudes to research.

Professor Wright: I think that there are some side effects from the REF, but I do not think that is one of them. The REF in itself does not create any obstacles for academics interacting with companies. Generally, successful academics generally see themselves as having a portfolio of work. Some of that work will be fundamental and produce pure blue-skies research papers, which they might submit to the REF, and often they will have a portfolio of more applied work. The

important thing is that people need to understand that most successful academics are doing all of these things at the same time; they are both doing pure research but also working with companies. What we really need to do is free up as much time as possible for those people to do productive work, but I do not think the REF in itself is an obstacle to any of that.

Q165 Stephen Mosley: There was quite a discussion with the previous panel about intellectual property. In some ways there is criticism of the universities in not fully using their IP potential. What responsibility do you think universities should have for assessing the value of their IP and making sure that it is out there for use?

Professor Wright: There certainly should be a very strong moral obligation on universities to do so. That situation is one of the things that has improved a lot over recent years. For example, several members of the Russell Group universities banded together into what is called the Easy Access IP consortium. That is quite an innovative arrangement created by Steve Beaumont, a very forward-thinking guy, at the University of Glasgow. It is a system whereby UK companies can access IP from member universities for free, provided it is to the benefit of the UK. That is an excellent scheme. There are other schemes. In the north-east, we have a similar scheme, allowing collaborative working between Newcastle and Durham universities, for example. That has probably been one of the biggest changes in the last five years, but we need more of those kinds of initiatives.

David Sweeney: It is an incredibly strong responsibility, because most of the research is publicly funded, so the intellectual property ought to be deployed for taxpayers' benefit. We have established over many years, and internationally too, that there is no single model for managing IP that provides an optimal solution. We are very interested in, and support, the Easy Access IP option. You triage the IP at the start and treat that which you think has very high potential differently from the bulk of IP. It depends on the industries you are working with and the way they want to manage their IP. We see universities that work with commercial partners to manage their IP; we see universities that do it themselves. If we could identify an optimal model, we would be further ahead, but nobody internationally has done that. I am pleased that universities are choosing different ways of doing it, so that we can learn from each other.

Q166 Graham Stringer: Professor Wright, if I may, I shall go back to the answer you gave earlier about academics spending half their time with industry and half the time on academic activities. When I have talked to vice-chancellors, they have often said that one of the problems of getting a transfer of good ideas into business and technology is that there is a conflict. Academics want to get their research out and publish it, and you need to be quite secretive if you want to make bags of money out of a new idea. We have not heard that said once in this inquiry. Has the culture changed, or is it just something we are not bringing forward because it is too difficult?

Professor Wright: Those kinds of issues do occur at the level of the individual academic who may have a strong collaboration with a company and the company wants to be more secretive about the work than the academic does. I have been involved in discussions trying to look for a negotiated agreement between the academic and the company. I do not know whether it is a systematic problem. It is a problem that occurs on individual projects.

Q167 Graham Stringer: If you are an academic, you are going to get your reward by citations and lots of papers showing that you are the first in that particular field, aren't you?

Professor Wright: Earlier you or someone else brought up the example of graphene, which is very interesting. If you look at many of the latest results now coming out where the technology is being applied and people are publishing papers in the top journals in the world—*Science* and *Nature*—you will find that a lot of them are being published by industrial companies. Very few of them are UK industrial companies; they are mostly Korean and American. It is clear that many companies consider it to be to their advantage also to publish their results. It is good for the company. Investors in the company want to see that, and it is a form of public relations, if you like. Many companies also want to publish. I know that Rolls-Royce, with which I have worked a lot, is keen to publish papers on its work, and many other big UK companies are as well, so the idea that companies want to hide everything is not really true. A lot of companies want to publish, but what you get are occasional difficulties, which usually can be solved by discussion, and an agreement can be reached. I do not think it is a widespread, systematic problem.

David Sweeney: Nor would I like to stereotype all academics as getting their reward through citations. One of our successes over the last 10 years has been to unlock entrepreneurial instincts in many academics. Where we have academics who want to behave like that, surely we want to encourage it, and they ought to see some of the fruits of success going to them. It is a shared responsibility between the academic, the university that has employed them and, of course, business. We have got to have vehicles for that to happen. I do not think we have a systematic problem. I agree with Nick that occasionally there are tricky issues where we need legal help to find the best way forward.

Q168 Chair: Should that not be reflected in the way academics are assessed?

David Sweeney: It is.

Professor Wright: For example, the promotion criteria in my university are about research and teaching but also about engagement with either companies or the local community in some way.

Q169 Chair: Is that sufficiently reflected in the way the research councils operate, for example?

David Sweeney: I think it is. The research councils are very enthusiastic about academics behaving entrepreneurially.

Q170 Graham Stringer: Researchers are increasingly being asked to justify their work by impact. We have had academics here who say that is particularly difficult to do. Do you think that that emphasis on impact, which nobody can really know—because you do not know what is going to happen in one, two or three years' time—is in conflict with excellence in research and a focus on absolute academic excellence?

David Sweeney: I do not think individual academics are generally asked to demonstrate their success through impact.

Q171 Graham Stringer: But they are when they apply for research grants.

David Sweeney: No, not at all. The research grants are awarded primarily on the basis of excellence. The research councils have been very clear on that. You will have an opportunity to ask David Delpy.

Q172 Graham Stringer: That is not the evidence we have had here. We have had evidence that people have been asked when applying for research grants to assess the impact. We have had very different evidence about how that is evaluated.

Professor Wright: If you apply to the EPSRC, you provide details of your scientific vision, but you are also asked to fill in an accompanying document which describes the pathway to impact, in the sense of how you are going to help any impact that may be there to flourish. That is probably a reasonable approach. It is not asking the academic to prove there will be impact, it is just saying, "What will you do to encourage it, if anything is there?" That puts an obligation on the academic to disseminate the information and encourage local industries to come and learn about it, for example. This has gone on in the US for a long time. In the US, you will see quite commonly an academic group will have an open day one day a year to which they invite local companies. They will write to 100 local companies and those companies will come and tour the labs for an afternoon. One afternoon a year is not a big burden on a research group. That is the sort of mechanism the EPSRC is asking for. There has been a change, and there are some academics who are choosing to see that in the way that you describe, but what the EPSRC is asking for is something different; it is asking for people to provide an explanation of how they are going to encourage that kind of thing.

Q173 Graham Stringer: This is a real problem, and I not think you can dismiss it. I have heard organic chemists, physicists and all sorts of people complaining about it, so it is a real issue in the academic world. What I was trying to get at is whether that is distorting the work that is being done.

Professor Wright: It probably plays out differently in different disciplines. Some disciplines are more naturally aligned to it than others, aren't they? There are strong opinions among discipline groups. In particular, organic chemists are well known for their view; other groups are less worried.

Q174 Graham Stringer: Let me finish my point and Jim's point, which you may want to consider. The largest impact I have seen in encouraging people to get into physics is by having a sexy professor who presents good programmes.

Professor Wright: Absolutely: it works.

Graham Stringer: The demand for physics in Manchester at the moment, particularly from women, is through the roof, so maybe you should think about that.

Professor Haines: From the perspective of UK deans, when I was preparing our response to your consultation exercise, I was quite heartened by the fact that everybody who responded to the particular issue of impact and commercialisation indicated that they would be only too happy if any of their staff said to them, "Look, I have an idea but I need two years to work through it. If it works it will be worth umpteen millions to the university, but it may be that in that time I will not be able to publish in the same way as is important to the REF and the research councils more generally." I do not think there is any discouragement; in fact, there is quite a lot of encouragement to people to look into the commercialisation of their work.

Personally, I do not think the impact agenda is going to have a serious effect on research excellence, but only time can tell. There is no doubt that the last 10 years have seen changes in attitude and in what happens in universities, which right now we would say is all to the good in terms of IP and commercialisation. If you had asked academics 10 years ago if they would have been comfortable with where we are now, quite a few would probably have said no.

If I may make just one plea—we put it in our response, but I make it publicly here—I ask you to ensure that whatever you suggest makes allowance for mathematicians who, however they do their work and however they try to commercialise it in the short term, quite often have a great deal of difficulty and commercialisation is way into the future. I say that as somebody who is not a mathematician.

Chair: The Chairman has a vested interest in mathematicians. We are extremely grateful for your evidence, gentlemen. Thank you very much for attending.

Monday 2 July 2012

Members present:

Andrew Miller (Chair)

Stephen Metcalfe
Pamela Nash
Hywel Williams

Examination of Witnesses

Witnesses: **Rees Ward CB**, Chief Executive Officer, ADS, **Professor Keith Hayward**, Head of Research, Royal Aeronautical Society, **Henner Wapenhans**, Head of Technology Strategy, Rolls-Royce, **Dr Ruth Mallors**, Director, Aerospace, Aviation and Defence KTN, and **Sir John Chisholm**, Engineering the Future, gave evidence.

Q175 Chair: First, may I thank you for coming to see us today and thank those responsible for inviting us to your superb facilities here? It would be helpful if, for the record, the five witnesses would introduce themselves. We have quite a few questions that will overlap, and we are trying to get opinions from all of you. It is going to be quite difficult to do it in the allocated time, so if you get squeezed out and have got something to say, it would be really helpful if you could pass us a note afterwards—send us a note of your thoughts. If anyone violently disagrees with something somebody else says, please indicate to me that you want to speak.

Sir John Chisholm: I am John Chisholm, and I am representing Engineering the Future today. I have been asked by my colleagues to do a little bit of coordinating in case we run out of time.

Dr Mallors: Good morning. My name is Ruth Mallors and I am the Director of the Aerospace, Aviation and Defence Knowledge Transfer Network, which is a programme of the Technology Strategy Board.

Henner Wapenhans: Good morning, my name is Henner Wapenhans. I am the Head of Technology Strategy for Rolls-Royce.

Professor Hayward: I am Keith Hayward, Head of Research for the Royal Aeronautical Society, which is the learned society representing aerospace and aviation professionals.

Rees Ward: I am Rees Ward; I am the Chief Executive of ADS, a trade organisation representing aerospace, defence, security and space.

Q176 Chair: This goes for all of us around the room: if your mobile is on, it would be helpful if you switched it off, as it interferes with the system.

We have been provided with examples of why big firms are important—that is fairly obvious—and small firms. A recent letter in *The Times* pleaded the case for people in the middle, and I was privileged last weekend to be at a brainstorming session on precisely this subject in Ditchley Park, where there was quite a wide-ranging discussion about the people in the middle. What is the truth, in your sectors, and where is the UK failing to create wealth and jobs?

Sir John Chisholm: Perhaps I can start with that, Chairman. Obviously all parts—big, small and middle—are important, but in different industries they play different roles. You had the pharmaceutical industry here quite recently. In the pharmaceutical sector, science is hugely important and SMEs play a key role. The pharmaceutical companies then buy them up. In engineering, on the other hand, systems are enormously important. Having the big systems integrators—who can pull through what comes out initially in science, often through SMEs, into bigger companies and into the systems integrator—is enormously important. If we had more companies like Rolls-Royce, you would see that happening more often in the economy. Perhaps I can ask Henner to say a word.

Henner Wapenhans: Quite simply, innovation is the process of taking a new bright idea to the market. The bright idea might come from anywhere, but it is important to have a structured approach so its chance of success is maximised. That structured approach has three elements to it: basic research, technology demonstration and advanced manufacturing. In particular, the latter two require a large amount of investment. This is where we see that large companies have the ability through the complex systems to drive the innovation, to bring SMEs and their innovation on to the vehicle—on to the systems we create—so that they can come to market through our products and services.

Q177 Chair: So you would see it as your responsibility to pull through medium-sized companies in the area?

Henner Wapenhans: We see that on technology demonstrations or in advanced manufacturing, as on this site here, that is the prime place to bring suppliers in to pull them through, yes.

Professor Hayward: It is a very valid point Sir John has made about the notion that aerospace is, par excellence, a system of systems. I could also describe it as a system of supply chains, where you have a whole nexus of companies which contribute, often at a very high level, to the scientific and technological component of a system or a subsystem. One of the particular places where—I would call it—the big/small or the small/large companies can be found is the avionics industry, where you have considerable amounts of research and development devoted to creating a significant part of a subsystem. For example, some of the engine control systems that, if you like, help drive the Rolls-Royce engine require a huge technology input. It also requires a company of sufficient size and research intensity to support independent research to provide that product.

Dr Mallors: The only point I would add to that is that aerospace and space are very highly regulated environments. The barrier to getting into that is quite high. One of the key aspects the KTN assists with is the brokering of an engineer-to-engineer-type conversation at the right part of the development chain. The reason a small company like CPI Technologies is now engaged in three business interactions and three potential business interactions is because, through the KTN, they were introduced to the head of engineering design or the head of technology in the primes and tier ones at the right part of the development cycle, not at the end when they are just trying to procure a product and capability.

Q178 Chair: Is there any policy gap that you would like to see filled to help the task of pulling through those bright ideas from the small and medium-sized companies?

Sir John Chisholm: The first thing to do is have a clear strategy.

Q179 Chair: Is that a broad plea for an industrial strategy, full stop?

Sir John Chisholm: Yes, but particularly in particular sectors—to have a clear strategy in that sector, and getting coherence in-country so that people investing understand what the game plan is and have the connections with the big, medium and small companies, so that the technology can flow through and you do not end up with a great pile of technology that goes nowhere.

Rees Ward: Certainly on the aerospace side, the dialogue that is going on between Government and industry at the moment is very good. It is developing extremely well through the Aerospace Growth Partnership. Those are discussions that are in part developing those supply chains, which are so important to ultimately delivering the full product. In defence, the issue is one of understanding where the Government and the Ministry of Defence want to go in 10 and 15 years' time. As Sir John says, it is clarity in where that direction is going. Once you have that clarity and that position, you can work your way back to the kinds of technologies that are required. That is when you can start bringing SMEs in as well as the whole supply chain. Different sectors require slightly different approaches here, but the broad picture is that we need to understand, in highly regulated and Government-dominated sectors, where the Government wants to go in the long term.

Q180 Chair: If we take, for example, the biosciences sector, there are several interesting partnerships, but let us take the one that is being built at St Pancras, the Francis Crick Institute: publicly funded science and money from Wellcome Trust and others are coming together to create a centre of excellence that will, I think, have a significant impact on our success in that sector. Is there any parallel that ought to be looked at in terms of the aerospace sector and, indeed, defence?

Sir John Chisholm: Perhaps I can make a point on that. I go back to what I said earlier about the difference with the biotechnology sector. In that sector, the science is hugely important. The problem is having an efficacious molecule that does the job, and the understanding of that and making that work is enormously important. The pharma companies tried to industrialise that process and it did not work. That is why everyone is going back to investing in the fundamental science and working up from that to individual products that work.

In the engineering sphere, although the science is important, it is only a contributor to the overall system. It is bringing that together in the total system that makes the difference. That ecosystem—which has science and SMEs in it, and medium-scale integrators and the total system integrator working together—makes the difference in the engineering sector.

Professor Hayward: There is also a fundamentally different approach to the whole notion of the innovation cycle. It is true to say that bioscience—particularly pharmaceuticals—tends to be a linear process, where you can put a lot of time and effort into understanding the basic science of a molecule that, after a long period of testing and proving, eventually might be turned into a drug that can be taken safely by a human being. In aerospace, as a high value engineering sector, the process is much more iterative. It is a generational exchange of ideas and concepts that are subject to a period of evolution—even, perhaps, passing out of aerospace into another sector for development, and then coming back into the aerospace sector some years later. The history of carbon fibre composites in the UK is a classic example: having been kicked off by research at the old Royal Aircraft Establishment, it went into Rolls-Royce, had perhaps something of a blind alley for a while, went out into autosport, and has eventually come back into complex aerospace structures. That, in a nutshell, is the way innovation works in aerospace and other related engineering sectors.

Henner Wapenhans: We, of course, have long-range investments we have to make. In order to compete effectively, we have to work with partnerships: with suppliers, academia and the Government. An effective model we see in that is the advance manufacturing research centres, the AxRCs, that have now been formed together into the High Value Manufacturing Catapult. We see this as a very encouraging opportunity to scale and increase the pace of drawing technology as innovation through to the product. We are very encouraged by the Catapult and would like to see increased investment and the long-range stability and understanding that one has access to funding over a consistent period of time through this type of catapult.

Dr Mallors: I would add that, for the space community, what you are now starting to see is not necessarily a bespoke centre but a clustering of capabilities in centres around Harwell. You have Diamond Light Source; ISIC; ESA has committed to an agency in Harwell; it is attracting the primes like Astrium to set up offices there; it is clustering SMEs together. Again, it is the fruits of a long-term strategy committed to by the industry and the Government, with its Space Innovation and Growth Strategy. That is now spawning a clustering and an evolution of

capabilities for engineering system-of-systems-type sectors, which is space, aerospace and very much defence.

Q181 Chair: In this fantastic facility, the role of the big prime contractors is fairly obvious; I see several famous logos around us. How do you engage, in terms of the organisation of an institute like this, with the smaller players? How do they get brought in to the decision-making process?

Henner Wapenhans: This is a very good question. If we look at the evolution of the AMRC, the first one took quite a long time to get off the ground. The second one after that was three years from that. What that has shown is large companies like Rolls-Royce need to take a leadership role and be there in the early part of creating these large centres. When they become more effective and larger, that is when the smaller companies are prepared to invest themselves, because they can see the certainty that, if they come into a centre here and have co-funding as well, they can get a return on their investment. It is a question of their risk profile; the risk profile goes down when one has a larger system integrator involved with it. We are seeing that we can attract more and more suppliers at this time. We obviously bring them together into proposals for research work; it can be done either individually by the SMEs or through larger programmes. We are quite pleased that recently we had the approval of the SAMULET continuation programme, which does include SMEs and also universities that are partnering. Jointly we came up with a proposal for that funding.

Q182 Hywel Williams: Can I ask a couple of broad questions? Firstly, it is a truism that we live in hard times. What I would like to ask you is, is the balance between curiosity-driven research and commercialisation activity right?

Sir John Chisholm: Can I start with that? Of course, both are crucially important, but you need to have a balance. You need to have processes to draw the results from the curiosity-driven research into the real world. An element of curiosity-driven research is crucially important. I will put on my hat as Chairman of the MRC for the moment: all our evidence is you get the best value output from research by giving the responsibility to researchers themselves to find the researchable problems and apply their minds to them. Having said that, you can direct the funding into areas that are most fruitful in output terms; that is possible, provided you allow the researchers their head to apply what they know to researchable problems. That is crucially important. Having said that, you then need to make sure you do not just pile up a load of IP that goes nowhere. You need to have avenues to draw that out into the real world. I guess what would be common amongst the people in front of you today would be the thought that that is something we should do more of in the United Kingdom.

Rees Ward: If I could just take that one on, the balance is between the Research Councils' budget, in terms of the £2.6 billion, and the TSB's budget, which is variously £317 (2011–12) million plus £200 million for Catapult. A recent £24 million call from the TSB on manufacturing was 10 times oversubscribed. That seems to indicate that there are a lot of companies out there eager to get in this pull-through mechanism. The TSB, on that particular data point, would appear to be somewhat underfunded in the broad balance. If I judged your question to be where the balance is between all of this, I would suggest—certainly from this kind of evidence—we need more pull through. If it is a zero-sum game, that has to come from the other portion.

Henner Wapenhans: I would endorse that view for the low-level technology readiness—the kind of work that happens with the early scientific investigation. There is a warranted balance there between curiosity-driven and impact-driven research, but as soon as one gets closer to demonstration in advanced manufacturing, it must be more heavily focused on actual commercialisation. This is where we believe the TSB is not properly funded. It is making the right decisions, it is effective in how it is going about making the decisions, but it needs to be more focused on the higher level technology readiness to pull through those innovations.

Dr Mallors: I would concur. I have to be careful because, being funded by the Government, I am not allowed to lobby the Government, but on the flip of it being a scientist and being very logical—

Chair: You can be very logical in front of us.

Dr Mallors: Very, very logical.

Hywel Williams: We are not the Government.

Dr Mallors:—there is another slug there in terms of the imbalance. You have the research base, over £3 billion, over £300 million around the TSB, and then round about £1 billion in the regional growth fund, which is about the growth agenda. It is another aspect of the innovation landscape and pulling it through. It just does not feel right that there is this funding dip at a time when it should be lifted up.

A couple of other points I would say are that the mechanisms are phenomenal, they are really good, but KTP, SBRI, collaborative R and D, Smart, RGF, FP7 and Horizon 2020 are really confusing. The metrics between those mechanisms do not join up. In terms of a CASE award from academia, a measure of its success should be becoming a knowledge transfer partnership. That should be deemed successful by becoming collaborative R and D. It is not that innovation there is not linear, but the mechanisms could be seen to be a bit more linear. My final thing about this is there is a lot of corporate knowledge within the Technology Strategy Board. That creates an opportunity for other sectors, not necessarily aerospace, defence and space but those sectors that have much shorter term timescales, to attract venture capitalists: creative industries, some of the CENSA capabilities, the IT communities. That corporate knowledge is not necessarily being leveraged from within the TSB out, which would take some pressure off the TSB to invest in longer term industries, such as aerospace and space.

Q183 Chair: Is it not a bit optimistic at the present time to expect any real response from the venture capitalists?

Dr Mallors: I do not know whether it is optimistic; I just do not think they are being given an opportunity to see the opportunity of pull through at the moment. It is a very interesting market, and it depends on whom you talk to as to whether it is up or down, but the reality is that I might suggest that venture capitalists are a bit like head-hunters—possibly a bit lazy. If they were given the insight as to where something may well be available for them to invest in, they would look at it. There are companies out there that do corral that kind of content and then present it as pitch material: companies like Omni do that. The TSB house a phenomenal amount of knowledge and insight, and yet it is not made available.

Sir John Chisholm: As someone responsible for a venture capital fund, I would not say they are terribly lazy; they work incredibly hard at looking at investment opportunities. There are things that, from a policy point of view, one can do to encourage more investment into this Valley of Death arena. One of the key things that the Government can do is create good markets, which you can do through regulation, but of course the Government is a huge procurer in the market. One thing that all start-up businesses know is a customer's pound is worth 10 times an investor's pound. It is crucially important to have a market that start-up companies can sell into. It is the big advantage you get in the United States, and it is something Government can really help through its procurement.

Q184 Chair: Would, for example, the Israeli model incentivise the VC industry to be a bit more proactive, where you have the confidence of at least some matched funding coming from some sort of Government source?

Sir John Chisholm: There are such sources already in the UK. The Government has put money into various venture arms—the Innovation Investment Fund and things like that—which are enormously helpful. The Israelis have shown that is a very fruitful way of developing and fast-tracking new companies into the market. The Israeli companies have done extremely well by having markets—particularly in the United States—that they can sell their product into. I make the point again: the markets are even more important than capital.

Q185 Hywel Williams: Can I just ask you another broad one? At what point should public funding stop being about excellence and move on to what might be commercially successful?

Sir John Chisholm: Do you want to take that up?

Professor Hayward: To some extent, there has been a long, well-established track record in the aerospace sector of repayable launch investment, which is a classic instance of Government assuming a shareholder role in the development of a new programme, primarily an airframe or an aero-engine programme in the United Kingdom. This has taken great ideas, such as an airbus wing or the technologies that Rolls has developed through the triple spool engine, into producing families of aircraft and families of engines. That has been a classic example. However, there are certain issues related to that form of direct investment. It is now potentially outlawed by the WTO, and thus the importance of supporting generic research that can apply to a sector or to a raft of companies, as opposed to one or two individual companies or projects, is becoming even more essential. In principle, that sort of partnership—and it has lasted now nearly 30 to 40 years in its current form—has been an extraordinary success in rebuilding and creating a world-class UK-based civil aerospace industry.

Rees Ward: If I may, the new manifestation in terms of the Aerospace Growth Partnership, which has been worked on jointly between Government and industry over the last year or so, is going down a very good path in terms of sustaining a civil aviation industry that has captured some 17% of the global market. That market is increasing at something like 5% to 6% per annum, and for value to the UK economy, that joint partnership is focused absolutely on the right kinds of things.

Henner Wapenhans: If I may add, there is also a very big importance in terms of infrastructure for tests, large-scale test rigs and things like that, which are not project specific but very important. If we were doing international comparison with other countries that are very largely aerospace driven, we have competitors that have access directly to Government facilities. That is something that is not the case here in the UK.

Q186 Chair: I was asking your colleague Paul Stein about this sort of thing at the weekend; he was at the same event I was at. He was specifically asked how the testing facility just outside Berlin was funded.

Henner Wapenhans: That was with German government funding support.

Q187 Chair: Directly or through the Länder?

Henner Wapenhans: I would have to go back and check that. I do not have the accurate data.

Chair: I would be interested to know.

Q188 Hywel Williams: Just one specific question, if I may, Chair: what does the Energy Technologies Institute do that the TSB and the catapults cannot?

Sir John Chisholm: Well, they all occupy the same space.

Henner Wapenhans: Could I take that one, please? We see a big advantage to having a construct like the Energy Technologies Institute, in the sense that there is a large commitment—10 years—to have a programme to develop technologies in renewables, where there is a commitment from industry to pledge a certain amount, £5 million per annum, which is matched by the Government, and gives within that horizon flexibility to operate and also predictability in terms of projects to fund. To an earlier point I made, it is very important to our long-range technology development to have those kinds of constructs. We are very supportive of these joint technology initiatives,

JTIs, or public-private partnerships. The Catapult can act in that same way. We are hopeful that it will do so through a combination of Government support and industry support.

Sir John Chisholm: It is an good example of coordination on the strategy and bringing together the various elements in the whole value chain so that they can work together. There are different funding sources that come together to achieve something that could not have been done separately.

Q189 Stephen Metcalfe: I particularly want to pick up on the role of the customer in all this. We have had some evidence that says customers are more important than funding. First of all, do you agree with that statement? Secondly, there is also the role of lead customer. As I see it, there are lead customers throughout the supply chain, starting with the very smallest company and feeding up to the next layer. Could you just tell us a little bit about your experience around those, and whom you see as your lead customer?

Sir John Chisholm: Can I just start by repeating what I said before? I absolutely agree that customers are hugely important. Going back to my experience in the venture industry, a company coming forward asking for money that has customers lined up is far more likely to attract a good slice of funding than somebody who is just coming forward with a great idea. Having customers is hugely important. Of course, if you are a small company, you are not actually addressing the end customer. There is a supply chain you are part of. Getting that chain working and having a lead customer—particularly in the United Sates, the Government plays a hugely important role as the lead customer for advanced technologies—then pulls through at various levels in the supply chain, and enables the funding of that to be drawn in from the private sector.

Q190 Stephen Metcalfe: So in the American model, it is pulling the technology through. If the American Government will identify a need and then look for someone to provide that need, that is driving innovation, is it?

Sir John Chisholm: Exactly so, exactly so.

Professor Hayward: Rees and I also arm-wrestle for this one. In that sense, it is clear at least half the business of the United Kingdom aerospace industry is, in some respects, directly related to a Government procurement exercise. Although a significant proportion of that these days is somebody else's government doing the buying—either directly or indirectly—nonetheless the UK MOD is still one of the paramount customers for a large element of the UK aerospace sector. We certainly have some concerns about the default position of the MOD to compete globally and to treat value for money in a particularly narrow way that certainly excludes any real, meaningful inclusion of externalities for national welfare or technological benefit. That is explicitly an element that American procurement policy, where there is a clear determination: A) to buy national; B) only to buy foreign if there is absolutely no alternative; and certainly C) to encourage a whole raft of research and development activity through a whole plethora of dedicated research establishments. The simple answer is Government is important to this industry.

Q191 Chair: Can I just tie together the point that Stephen has made and Hywel's earlier point? What then is the difference between launch aid and the US Government operating as a lead customer?

Professor Hayward: A huge philosophical difference on which the whole of the WTO dispute over the last 15 years has hung is—

Q192 Chair: In terms of the impact on the industry; I am not being legalistic.

Professor Hayward: As an observer and historian of the launch investment process, I would say the repayable launch investment system is a much more efficient and effective way of drawing technology into commercial use. The United States has historically used high levels of defence budget and defence spending indirectly to support civil aeronautical activity, either by encouraging people just by putting money into a Boeing or a General Electric through a large domestic defence budget, or of course enabling some specific research, either through NASA or through the DOD.

Q193 Stephen Metcalfe: I think I understand from what you have said that the Government as a lead customer in its own right has a slightly narrow view. If you were able to write one of our recommendations that would come off the back of this inquiry—I do not want to put words in your mouth—what recommendation would you like to make to Government in how it may change its view and its role as lead customer?

Professor Hayward: This is one for the trade association. Writing a recommendation for a Committee: life does not get any better than this, does it?

Rees Ward: In the way that the MOD views its procurement policy and its recent, if you will, focus on buying off the shelf, it really does play to a very narrow value-for-money proposition, i.e. for the department itself in terms of performance, cost and time. But from a trade association's point of view, because this is Government money, taxpayers' money, that is too narrowly defined. I would suggest that the definition should be much broader on a national basis, taking into account jobs, high-value employment, taxes that are being paid, Jobseeker's Allowances that are not being claimed, and, and, and. There is a much broader view here for UK plc that should be taken into account.

Q194 Stephen Metcalfe: Thank you. Is defence looked after as an industry rather than as a product for support? Is the balance between MOD and BIS interest correct, or do you think you need more BIS input to view you as a business that can help support UK plc, and then hopefully support some of those

small and medium-sized companies to come up through the supply chain?

Rees Ward: Yes, I would agree with that. The MOD is voted money from Parliament to equip and train Her Majesty's armed forces. Those forces then do the bidding of the Government of the day. In terms of defence, the industry has felt itself kept at arm's length, because that is the way the MOD wishes to have that relationship. As I said to a previous question, I do believe that the industry must have some view of the long-term nature of where the MOD and indeed the Government want to go. The investments that are made in defence matériel are long-term investments; it is very difficult for an industry to make those investments if they have no idea where they are going.

Having said that, the MOD has taken up that notion of the long-term view very recently. You have seen their commitment to publish the 10-year programme, and what detail comes out is anybody's guess; we all look forward to the NAO report sometime in the autumn. There is also an agreement to work jointly with industry to review what capabilities Her Majesty's armed forces require in the 10- to 15-year period and work our way back down roadmaps to identify the kinds of technologies and, therefore, the kinds of investments that are required. At that point, when we have more clarity and visibility, then industry and Government can have a much more informed debate about who does what and where.

Sir John Chisholm: Can I make a general point about this, about the innovation process, which is hugely important to this? I do not think that anybody will dispute that, for the UK to survive in the 21st century, we have to be innovators. We have to be lead innovators, because that is one of the things that will keep us competitive in the world. Innovation is clearly good for the UK as a whole.

The problem with individual innovators is the question of who gets the benefit of it. The benefit of the innovation will be captured somewhere in the economy; it is not at all obvious that the financing of an individual innovation will itself pay off, if you see what I mean, because the benefit spreads out through the economy. This particularly relates to Government-funded projects. There was a Government-funded project that I remember well because I was around at the time, in the 1980s, called Inmos, which was going to revolutionise the microprocessor industry. It did not and it failed. Therefore, it is a failed project, is it not? However, if you look around Bristol now, which is where it was, you find a plethora—a whole architecture—of companies that spun out of it. The project itself might not have achieved its end, but the innovation that was created there spread out into the economy.

Therefore, going to the issue of major projects: a major project may well be castigated by the NAO for not doing exactly what it was supposed to do. However, that happens in major technology projects. If it is going to be a genuine step forward, you are going to launch it not knowing all the things you are going to discover. You may, therefore, look in retrospect and say, "We thought it was going to cost £2 billion; in fact it cost £4 billion." But in doing that you will have created value that will have spun out elsewhere in the economy.

Q195 Stephen Metcalfe: Well, you hope it will have created value; that is what you have to be able to measure, isn't it?

Sir John Chisholm: You can measure in retrospect; you can go round and look at the infrastructure that has spun out of it. If you are going to do anything serious in technology, you are going to discover things you did not know to start off with. You could call that a failure, but typically it is not a failure; it is a discovery. It is skills that go out into the economy that enable you to solve other problems further down the line. Taking too narrow a view of the outcome of technology projects can lead you into too risk adverse a strategy.

Q196 Stephen Metcalfe: Do you think where the Government as lead customer is located at the moment is taking that too risk-averse view?

Sir John Chisholm: I defer to my trade association there.

Q197 Stephen Metcalfe: Finally I suggested BIS as perhaps a better location for the Government as lead customer; someone suggested the Cabinet Office. Does anyone have a view perhaps where as a buyer the Government should sit?

Professor Hayward: In fairness to the Government and the MOD, it seems probable—if not inconceivable—to put the responsibility of the customer for the UK armed services anywhere other than the MOD. What Rees and I have in common is a belief that the MOD's view of how it selects programmes and brings forward UK-based technology needs to have a broader understanding of the impact this has on national welfare.

Dr Mallors: The only thing I was going to say was the role of the Department of Business, Innovation and Skills—to repeat the message yet again—is of long-term strategy that enables a whole stack of Government departments to be intelligent and lead customers, whether it is the Department of Health, the Department for Education, the Department for Transport or the MOD. We are seeing some of this confusion going on at the moment with the announcement made in March around UK aerodynamics. It has been a product of the successful Aerospace Growth Partnership, the early success strategy of that, and it has a sort of civil aviation focus, and the MOD is going, "Well, what about us? Where are we on that? What about our requirements and how are we trying to filter those in?" It pops up as, "We have not been asked." BIS being able to be a strong leader on those long-term strategies on behalf of multiple Government Departments would be valuable.

Henner Wapenhans: I would echo the comments on the MOD, but also we operate in many sectors. We do not see the Government as being a lead buyer for the civil sector. The Government does not buy civil aircraft, power generation or nuclear power plants. For

those large technology-driven areas, the Government can assist by providing the frameworks to enable the technology to be pulled through into the product.

Q198 Chair: In the small business sector in the US, for example, the Department of Defense still have to engage through the SBRI schemes.

Professor Hayward: I think you are right; it has been a while since I have looked at the specific detail, but I think both NASA and the DOD are enjoined to let a certain proportion of contract to what they define as the small-business sector. My brain is scratching around for citation, but I also think the United States—parallel to the size of American dinners—tends to have a larger view of what a small and medium-sized enterprise should be. To some extent they have a more liberal interpretation of what constitutes a small company.

Dr Mallors: The SBRI project is alive and well through the TSB here. It is in economies of scale, and it is also about the certainty. In a lot of the US programmes—and again, I have seen it a lot in Canada recently—there is certainty. It is just a given that year on year that programme will be in place, so businesses can plan and shape around it.

Q199 Chair: The evidence here suggests that neither the Ministry of Defence nor the Department of Health have exactly switched on to the scheme here.

Dr Mallors: Not in scale.

Henner Wapenhans: We also see the difficulty here in the UK of the Small Business Research Initiative being applied to larger projects. If you look at the US, they encourage sponsorship to be sought with a large company, which has two benefits: it creates strong relationships, and it creates the route to market. We think there is definitely something that can be learnt from the US system.

Q200 Pamela Nash: In the written evidence that several of you have provided, we have examples of technology that is not being manufactured in the UK due to an inhospitable environment here. I wonder if any of you can expand a bit on the issues that companies are facing. Two of the problems raised were prohibitive taxation and inability to scale up. I would appreciate a bit more detail on those problems. Also, to what extent do you think new Government policy is going to be able to look at these problems and fix the issues that we are seeing here?

Sir John Chisholm: I think each of us covered some of this in our evidence. I know you did Henner. You mentioned the taxation issue. That was to do with Raspberry Pi, which in turn was in our evidence from Engineering the Future. That was simply an issue where Raspberry Pi had to pay tax on the import of components, which put them at a disadvantage in manufacturing in the UK as opposed to manufacturing elsewhere. Henner, you made some comments from Rolls-Royce's point of view in terms of where you put your plants.

Henner Wapenhans: One of the examples we gave we touched on earlier, which was the test facility that has been established in Brandenburg in Germany, which is one of those examples of infrastructure where the company that operates globally has to see where it can compete globally. When other governments provide frameworks that are attractive, then it is something that we cannot not do. Another example that we have is about our fuel cells business, which is still in the pre-production phase, where we managed to attract Department of Energy funding in the US, which led us to transfer the activities into the US for that business. These are all examples of creating a level playing field between what other industrialised nations are doing to attract R and D and what the UK is doing to attract R and D.

The strength here in the UK is if we can build on the starting coherency of making sure that all those three elements that I mentioned, going through technology demonstration to advanced manufacturing, are all looked at as one whole. That then creates the delivery mechanism for the technology. Again, I would raise the subject of infrastructure. Another subject that has been brought up by the Government is e-infrastructure and giving companies and academia access to computer power, which is a very important enabler for technology development.

Professor Hayward: It is important to always appreciate in this that the UK does not have a national aerospace industry. We have the UK cluster of a global aerospace industry, and the point that Henner has made about having a supportive government for national industry is really about ensuring that the UK elements of this global industry are no worse off than other parts of that global industry. I have particularly in mind here, in a sense, that the destiny and future of Airbus UK is decided by investment policies made in Toulouse and elsewhere. Thus, when a multi-national board is looking at where they are going to place the next manufacturing infrastructure, they will look around all of the options available and say, "That is a much more favourable place for us there," say North Germany, "than the South West of the United Kingdom." It is essential for any Government to appreciate the global context of this national industry and to review and continually analyse our standing, our regulatory position, our financially supportive position, not in absolute terms but vis-à-vis our major competitors and what they are offering our share of the globally operating companies located within the United Kingdom.

Q201 Pamela Nash: How would you rate the current Government's capability to respond to that?

Professor Hayward: It has as good a record as past Governments. It has not yet been tested by a large repayable launch investment request, although it has supported Westland's attempt to civilianise some of its military helicopters, a very important part of ensuring the survival of rotary craft development in the United Kingdom. The support for technology partnerships reflects several decades of support for generic technology in aerospace and aerospace-related industries. It falls, as past governments have fallen, on the defence side. It fails to recognise that it does have an active responsibility to support UK-based defence industrial enterprise. In a sense, you could say there

has been a whole series of curate's eggs of governments over the last 20 or 30 years. What is nice about this is the recognition that the industry does have a value, but one more push and Government would become a sophisticated 21st century partner.

Q202 Pamela Nash: Throughout the evidence we have taken so far, it has not been a great surprise to anybody that we are constantly told that the Government has to put more money into R and D, but there is also an issue in the UK with private investment and research and development. Do you think there is anything more the Government should be doing to encourage companies to invest in their own R and D?

Sir John Chisholm: If I can start that again, it comes back to having good markets. Companies are not reluctant to invest because they want to give the money back to shareholders. They will invest if the circumstances are right. It is true to say that in the last four or five years there has been a retreat in innovation investment in the UK. Putting my Nesta hat on, it looks to us like there has been something like a 20% retreat in innovation investment since 2008, which is a lot. It looks like it is probably worse here than it is elsewhere, but these are very preliminary figures. There is something to address here. On the other hand the Government has begun to do things, like the Innovation Investment Fund, where it is putting money up on the basis of matched funding coming from elsewhere, which will encourage more investment. If you get the right markets, which is what we have been saying here, that is the most important thing that you can do.

On the general subject of money, there are other potential sources that you might like to look at in your committee, particularly the 4G auction monies, which are coming along. Our view would be that innovation in the UK would be an extraordinarily useful recipient for those monies and would pay off handsomely for the nation.

Henner Wapenhans: It is not just the amount of money that is being invested by the Government; we could see an improvement by speeding up the decision process for making capital investment available. We do see that there are other countries around the world where that can happen very rapidly. We invest quite a bit. Last year we invested £900 million of R and D, and it has been consistently that high. The TSB has been very effective in being timely, but further improvement is possible by making quick decisions possible when opportunities come up.

Rees Ward: To finally cap that, the aerospace and defence industry figures indicate that they put back about 8% of their turnover, which is high when you look at the industry sectors here in the United Kingdom. That is at the top end, probably in the top two or three. I would like to re-emphasise the point that an awful lot of the industries in the United Kingdom are global, i.e. they have footprints in a large number of markets and a large number of countries. Therefore, their boards will be looking at where to invest to get the best return. If the Government is not providing the right conditions here in the United Kingdom then, inevitably, that investment will go elsewhere. To your original question about industries' private investment in the United Kingdom, part of that decision-making process is how attractive it is to do business in the United Kingdom. Of course the Government's reduction in corporation tax is excellent. The R and D pilot scheme, which is going in the right direction, is also excellent, but the broader piece about making the UK open and attractive for business is absolutely essential if we are going to attract inward investment.

Q203 Hywel Williams: Going on from this—you have answered my question to some extent—looking at the national innovation system, we have been told that the UK wants commercialisation of research work to be on the basis of fairy dust and good intentions, putting it very succinctly. What gaps do you see in the national innovation system, and does the engineering base sector of the economy suffer specifically from a lack of coherent funding, as well as facilities and also with respect to regulation?

Sir John Chisholm: I think the point has been made before that it is a bit bitty at the moment. There are lots of virtuous elements of it, but it lacks a coherent strategy that everyone can relate to. That is our principal point here. There is a lot of argument in the press about the national economy, about Plan A or Plan B. We are quite keen on a Plan I, which is instead an investment programme in relation to innovation as the key driver for the economy of the future.

Dr Mallors: I would agree there is a fragmentation issue. Some work carried out by City University a couple of years ago looked at the academic aeronautical-related facilities and showed their quite substantial degradation. The really worrying thing about some of those facilities is that a decision is made at the local level—the university level—and not against the national agenda. There are lots of facilities in there, but there is not an overarching understanding of which bits we need nationally to create a national capability. Adding to that is that there is the need to be able to take that academic research in a very small wind tunnel and put it in a really big industrial-type facility and see how it works, and then to be able to take that kind of data into those high-level TRL stages with academia to test it. That overarching strategy and facility approach is not there, particularly for industries where physical and virtual testing is so important because of safety and the regulatory environments. It is becoming an increasingly big issue for those sectors.

Q204 Hywel Williams: Can I ask you a broad question about defence innovation? Is it more restricted by a lack of cash or a lack of strategic direction?

Rees Ward: I think that we have to understand the position the Ministry of Defence has been in up to this point. It is heavily over programmed. The armed forces need a lot of equipment and systems, and there is a very constrained cash profile. When you are in that sort of constraint, then I suspect—I cannot speak for the Ministry of Defence, but one observes from

outside—a rational set of choices would be, "I will not do any research and development. I will buy it off the shelf, put it in the hands of the Armed Forces straight away and I will have achieved my remit, which is equipping and training Her Majesty's Armed Forces to do the Government's bidding." I would suggest, and I would say this as a trade organisation, that is a very short-sighted view. The whole business of research and development is continuity and sustained investment. A lot of it is contained in people's heads and it is investment in people and skills. If you start turning the tap off, those people will go and you will never get them back. That will be a complete waste of the investment. Well, it will not be a complete waste, but it will go somewhere else in another sector.

The Ministry of Defence is getting itself out of that particular trap of too much in terms of programme and not enough in terms of cash, but I still detect a downward trend. For example, in R and D the numbers have come down over the last decade, or just under that, from about £2 billion down to £1 billion. In S&T, which is much more clearly defined, it has come down over the last 10 years from £800 million to £400 million. You will not see the effects of those reductions over the last few years. You will probably see the effects of those reductions as we go forward. The fact that the MOD has put a floor in at 1.2% of the defence programme for S&T is very welcome, but is that sufficient to sustain the kinds of technologies that the Ministry of Defence will require in future? That question is still open.

Professor Hayward: I would agree with everything that Rees has said and make the basic observation that, whilst there has been, over the years, a shift away from the classic spin-off from advanced defence technology into the commercial sector, there is now much more evidence of spin-in—the way that streams of commercial technology are now incorporated into complex weapons systems and other military equipment. But there are still areas of specific defence research that do have, or could have, significant commercial value to the aerospace sector. I am not talking here about stealth airliners as a solution to getting into Heathrow early, but it would certainly apply to certain aspects of gallium nitride display technology, which will, conceivably, create much thinner, much lighter civil avionic equipment. There are also the integrated power systems, which I suspect is Henner's area of expertise, that are being developed for unmanned systems—because you need a lot of power in a small space to fly the aeroplane but also to power the sensors and all the rest of the equipment—which will have significant value in generating power for commercial airliners.

Dr Mallors: To supplement what Keith was saying, a lot of the documentation out of the White Paper will talk about the MOD reaching into non-defence supply chains and pulling that capability back in. There are two issues there; one is that they do not know where to go, because they are used to working with a defence industry or supply chain. The second thing is they talk in a very strange and unusual language that is fundamentally difficult to understand for the non-defence supply chain. The KTN is leading what we believe to be quite a unique programme, which is co-funded by Dstl and the Technology Strategy Board, which is aiming to start that process of facilitating introductions of Dstl-type capability requirements and where their research programmes are going, and articulating that into the Knowledge Transfer Network networks. I run one of 15 KTNs, but plugging them into people like energy generation and supply KTN, because they were not plugged in and they were not plugged in to those supply chains. It is that connectivity. They just do not know how to do it, because they have not had to do it before.

Q205 Chair: Sir John, going back to your Plan I, was that a subtle way of calling for the re-invention of the original purpose of 3i?

Sir John Chisholm: Well, no.

Chair: Not as it is structured now.

Sir John Chisholm: It was specifically a venture capital operation and, by the way, a very successful one originally. However, my notion of Plan I is that it is possible to construct, I believe, a comprehensive plan from the UK perspective, which would have immense advantage to industry in general, and particularly to the engineering industry.

Q206 Chair: So this is a sector-specific industrial strategy?

Sir John Chisholm: I would say it is a strategy for the economy, which would help this sector enormously.

Q207 Chair: The second part of that is that, increasingly, there are massive crossovers between disciplines that used to be wildly disparate—the overlap between work going on on this campus and, for example, in medicine. There are massive overlaps these days. How do you ensure that in that great encompassing strategy, you make those things continue to work together so that the spill over to other disciplines can work effectively? You are in charge of Plan I now, Sir John.

Sir John Chisholm: Plan I would inevitably have maybe 15 components to it, things like the innovative procurement we discussed before. It would indeed have exactly those sorts of spin-offs in it, because it would encompass a lot more than the Ministry of Defence. It would encompass the NHS, the Department of Energy and others. Within that, it would encourage sector strategies to emerge. Through various stimulant measures, it would encourage a greater flow of private capital into the innovation space. All of these things are important stimulants for exactly that sort of broadly based, technological response.

You are exactly right that a lot of the most important breakthroughs in technology come at the intersection between sciences. If you look at the way that academia now organises itself, it goes out of its way to try to encourage that. The kind of thing that you see here, of bringing together parties, is exactly in the same space. All of that should be part of a comprehensive Plan I, which is not just one

component but brings together a number of initiatives into a coherent picture.

Dr Mallors: I would concur. One of those elements would be this translation issue, so we know what is appropriate for aerospace and how to translate that, whether it is into Formula 1 or into the automotive sector or outside. Bizarrely, you do not know where that translation is going to come from. You may well recall the BBC's *How To Build… A Nuclear Submarine* or *How To Build… A Satellite*. Astrium is now having conversations with GSK; even though they are in buildings next door to each other, they did not have an understanding of the clean-tech facilities that were bring deployed in Astrium to use their satellites. The key aspect of the KTN is translating those competitions and the funding that is available or where the sectoral opportunities are, in and out of the sectors.

Q208 Chair: That was also a weakness not just between industries but within the Government machinery. How do you ensure, using the networks that we have through the research councils and through TSB, that there is some feedback upstream, so that bits of the Government machinery understand the potential of exploiting technologies that come from another sector?

Sir John Chisholm: It is a good point. We are making progress, exactly as Ruth suggested, through programmes such as the Catalyst Programme, which the MRC and the TSB have together, which draws in the biotech industry, in order to bring together funding streams that were previously entirely separate. That is definitely a direction of travel. As we have all suggested, it can be better integrated, and I certainly hope that would form one of your recommendations.

Q209 Chair: Now, the final question: the last time I was on this site was a rather long time ago, when a rather significant political event was occurring just over there in the early 1980s. Things have transformed out of all recognition here. There must have been some catalyst that brought together this fantastic cluster of world-class industry, small and medium-sized companies and academia. What was the big driver?

Sir John Chisholm: Do you know that—do you have the history, Henner?

Henner Wapenhans: I can have a go at the history. The big driver was a realisation that we had to do more in manufacturing. We have always been a technology company, and scaling in terms of size—and we have grown quite significantly over the last 10–20 years—made us realise that a lot of attention needs to be given to manufacturing. We are quite proud of being one of the early partners in creating this new model. It has been a good model to show how, between industry, government and academia, it has managed to work. It has created a critical mass so that we now see a lot of international interest in what is going on here and people are looking to the UK and this advanced manufacturing park to see how they might emulate it. It is a fantastic example.

Q210 Chair: At the time, what role did the Regional Development Agency play?

Henner Wapenhans: I do not know that specifically, but I think that they played quite a considerable role. If I look at the kind of funding that has come through and the kinds of activities we have had over the last few years, the RDA has been a source of funding. A big concern of ours is how that source can be replaced and by what mechanism. Will it be through the TSB or by which mechanism?

Q211 Chair: I want to push you on that, because we are a relatively small country geographically—the size of some individual states of the United States.

Henner Wapenhans: Texas.

Q212 Chair: Do we really need a regional policy to make this work or can the centre do all of this?

Professor Hayward: I detect a certain political undertone here. I will comment having seen, when I was working for the trade association, the emergence of the RDA process and also, as an academic, observing the development and evolution of aerospace clusters in Europe and elsewhere, there was indeed a significant input of the appropriate regional-level funding. The Midi-Pyrénées, for example, is a mixture of the prefecture and the region. The City of Toulouse also contributes investment and various forms of infrastructure. All of this has helped to create a very impressive, generalised, aerospace/high-technology cluster in the Toulouse, Midi-Pyrénées region. You will probably find the same input in the Länder in Germany, who will contribute. Historically, Bremen owned part of their local aerospace company. That has now become a contribution to infrastructure and local research and development activity, whether it be funded through the local universities or some other intermediary body. There is still a role and a function for a regional organisation or agency of some description.

Sir John Chisholm: It is clear from all of the academic work that clusters are hugely important as a stimulant for innovation. If you have been to Aberdeen, there is a magnificent example of a cluster that has sprung out of nothing, because the people in Aberdeen clustered around the university have looked at the problems that they were facing and created entirely new industries. It can be done. Clusters are highly important, and therefore there is a local element that is very important in terms of encouraging innovation.

Dr Mallors: The stuff that we could see with the RDA model, and the point that you made, was that it was creating an internal competition across the regions on some of these things. The supply chains may well be clustering, but they are global. It is about the mechanism and how the mechanism is deployed to foster national growth and international growth, rather than creating an internal debate about which region is better than the other region and who is winning on funding and who is doing all those things. It is about what is best for UK Plc and driving that. The shaping and clustering is really important. We are seeing it in Aberdeen, partly with oil and gas, and then

recognising that we are on a bit of a dead duck here if we are not careful. There is space stuff going on in Harwell, the South West and North West. Aerospace and defence clustering is very important.

Chair: It has been an extremely interesting session. Dr Mallors, gentlemen, thank you very much indeed for appearing before us this morning.

Wednesday 5 September 2012

Members present:

Andrew Miller (Chair)

Caroline Dinenage
Stephen Metcalfe
Stephen Mosley
Pamela Nash
Sarah Newton
Hywel Williams
Roger Williams

Examination of Witnesses

Witnesses: **Tim Crocker,** SME Innovation Alliance, and **Dr Tim Bradshaw,** Head of Enterprise and Innovation, Confederation of British Industry, gave evidence.

Q213 Chair: Welcome to you, gentlemen. You are familiar with the terms of reference of this inquiry. We are going to be asking you a few questions in a moment. It would be helpful if for the record you would introduce yourselves.

Dr Bradshaw: I am Tim Bradshaw and I am here representing the CBI.

Tim Crocker: I am Tim Crocker. I am here representing the SME Innovation Alliance. Maybe I ought to add that I am a committee member, but we don't have any salaried people, so in my day job I am an R and D engineer.

Q214 Chair: Thank you very much. You will probably be aware that later on this morning we are hearing from some of the folk who spend Government money. I notice that one or two are in the room. Do you think they have got the balance about right so far as big and small S and T-based businesses are concerned?

Dr Bradshaw: Yes, by and large. We have to remember that the majority of the R and D activity that happens in the business community happens with large companies. They are the anchors for R and D activity, not just within their own companies but within the value and supply chains that support them. There is probably a two-thirds/one-third split, in terms of where the money from Government goes, particularly if you look at things like the R and D tax credit, so supporting those large companies is absolutely essential. It anchors R and D here and then allows that to filter down through the supply chains to other smaller companies. On top of that, we have very good support for SMEs through their higher rate R and D tax credit and with things like SBRI, which the Government supports through the TSB. Roughly the balance is probably okay, but whether the quantum is right is perhaps another debate.

I know the inquiry is about the valley of death. I suppose it is a difficult question, because there will always be a valley of death no matter what you do. There will be more R and D ideas than you could possibly ever commercialise, and it is a case of trying to flatten out, perhaps, that valley of death so that most of the really promising ones get their chance of getting further through to commercialisation, be it with small or larger companies.

Tim Crocker: We could always say that we need more money, but we are aware that that is not the game on the table. I would take issue with some of the points that have been made. Where the money goes in and where it is spent are slightly different things because of the way the supply chain works. Quite a lot of small companies are doing work on behalf of bigger companies and the numbers will turn up in statistically different places. The main problem that the SME community has, which is different from that of the large companies, is that traditionally most of the funding support from Government has been on a matched funding basis: a 60% grant with 40% being found elsewhere. The assumption has been that the 40% comes from venture capitalists and private investors—that is where the problem lies. It does not. The investors who are available have very short-term aims and want to sell the companies out faster than the design cycle practically allows.

Q215 Chair: Does that apply to particular technologies, or are you talking generally?

Tim Crocker: There are sectoral differences. We are aware that the biotech and pharma sector works far more like the Government model or, rather, the Government model seems to apply to biotech and pharma very well, but in what I would call the hard industries—computing, mechanical engineering and electromechanics—it is entirely different. There is a quantum difference between SBRI funding, which is basically 110% funding, and 60% funding. If we could move all the TSB funding to SBRI, it would be transformational; it would be a night-and-day job because of the way the investment community behaves.

Dr Bradshaw: We like SBRI. We have said a number of times in the past that it is not as large as it should be. If you compared it with the US equivalent and scaled our economies, the UK system would still be six times smaller than the US one. Yes, we would agree SBRI is a very good vehicle. It is underfunded and could be expanded. We would take issue with moving all of the TSB's funding into SBRI, though, because it does an awful lot of very good work in other areas, but, if Government money was available, increasing the overall budget for the TSB so things like SBRI could be increased would be good.

Q216 Chair: So that I have got this right, the two of you are basically agreeing that there aren't any major gaps in the Government intervention mechanisms, but there is a slight difference between you in how it is managed and targeted. Is that right?

Tim Crocker: I would say the fact that 60% to 75% funding, depending on the scheme, has persisted for 20 years shows that there is a gap. I have spoken to senior officials in DTI and BIS about this; it is recognised. The other matched funding is not available. The major reason why SME projects that have merit crash is that you do the technical work and maybe spend a few hundred thousand pounds, and the follow-on funding that would match the Government funding simply is not available. To us, the mechanism of funding is one whereby SBRI procurement funding pays the whole bill. You do the job and your company is no worse off at the end of that, and you can move on to the next phase. That is probably a difference that won't appear in the large company sector, where they largely have ongoing product income and revenues from other sources that can bridge those gaps.

Dr Bradshaw: That is one of the reasons why we have been very supportive of things like the Enterprise Investment Scheme being expanded, in terms of the rates and limits, as well as venture capital trusts and the ECF, which was given another £200 million in the last spending review. There are other mechanisms for getting money into that space.

Q217 Stephen Mosley: Technology businesses tend to be very mobile and are able to move technology around the globe. What makes one decide to invest in a new technology in a particular location? I guess it will be different as between big companies and small ones, but why would someone start investing in a certain technology in one particular place?

Dr Bradshaw: Most companies would say that the most important factor would be the knowledge—the people—and that can often override some of the other costs involved. If you have an established community of academics, other researchers or businesses making a cluster where you can build and develop that idea and take it further, that is probably the primary reason, and then you look at other things. Have you got the building space where you can set up a lab? Have you got the other support infrastructure you might need to be able to take things further? Have you got business partners who can come in and help you?

Tim Crocker: One of the important things about our membership is that they are largely people who have come out of R and D in a big organisation, a university, and set up in the private sector previously. Where those people who have particular expertise end up tends to be driven partly by family circumstances but also by a lot of previous schemes where you could get rent-free space in the peripheries of a country. A lot of businesses were attracted to the west country because they would be given a factory. The Welsh Development Agency ran a lot of things like that. The policy of the 1990s and the early part of this century probably dispersed the small companies around the country.

On the question about investment, probably most of our member companies start with a technology idea, but they are in the commercial world so they are not starting this in vacuo. They are thinking, "This is an idea that can take off but it is bigger than our scale of business. Therefore, if we can get some Government support, we will take it forward." Then the matched funding element drops in. You then have to find the investors, so the proposition to the investors is, "You guys are investors. There are angel networks and so forth around with a lot of family and friends. This looks like a good idea. I can get £100,000 from the Government. Will you find us the other £60,000?" It is very organic in that sense and driven by the match of a new idea with a potential market.

Q218 Stephen Mosley: Assume that someone has set up and come up with a good idea. They are becoming successful and beginning to prove that the idea will work. How do we make sure that that new idea stays in the UK and doesn't get taken elsewhere?

Dr Bradshaw: That is why it is nice to have things like the proof of concept funding and the return of Smart awards within the TSB. That is something that can help anchor the next bit of research and development to keep it in the UK. Beyond that, there are all sorts of other good things we can do. We can link them up with the universities, maybe to get more people that they require and the skills to develop things further, or access other R and D that might be needed to add to what they have got to make a commercially viable product. Then you scale it up at the other end where you might have initiatives to support corporate venturing. Some of the larger companies are looking at these innovative new technologies and might want to be able to help them advance further. In the past, we have had schemes that would support corporate venturing activity. I think that shut down in 2010 or 2011—I forget exactly when it was—and maybe it is time to have a look at some of those things again.

Tim Crocker: This is where divergence really opens up. Most companies manage to get to the proof of concept stage. If they are successful in getting large-scale venture capital backing, there is really only one business model in town. In the last year I have been to a number of investment events and have seen this. The standard business model is to get a few million pounds in Government grant, out of the TSB mainly, and a few million pounds out of the venture capital community. Then, because of the needs of the venture capital community—the angels behave almost exactly like venture capitalists now, the organised networks—the company is sold on. The business model is: three from the TSB; three from investors; sell for 20. You can sit in an investment network and see that business model churn, and the numbers change a little bit. The effect of it is that these companies, at the point where proof of concept has been passed, go into the hands of large corporations. The IPO in the public market is almost discredited now. I can't find anybody who has done it recently, and I can't find a single business adviser who will tell you it is a good idea. There are companies languishing in the junior markets that can't get funds, so a sell-out for 20 million quid is the business school model, and most of those buyers will not be UK buyers. That is where the rub is.

Dr Bradshaw: I take issue with the emphasis put on "sell-out". Business life is like that. There will always be times when companies will want to develop that next stage further. They can't afford to do it themselves, and maybe the best way of doing it is

with a larger company helping them take things forward. There will be those who do grow themselves and do it organically; there will be others where the best route for them may well be to have different management brought in, to have funding from another source, or maybe to be taken over by a large company. That is just the way business works. They are commercial organisations. If you have a technology which is really good but to make a difference you have to get a market scale, which means global penetration pretty much straight away, it is very difficult if you are a small company to do that on your own. Quite often, the best solution may well be to do it with large company back-up.

Q219 Stephen Mosley: But the key thing for us here in the UK is to make sure that the skills, jobs and technology stay in the UK, even if the company is sold on elsewhere. How would you try to ensure that happens?

Tim Crocker: I disagree fundamentally with what you said. I just have to register that that is completely not the way we see it. I can promise you that there is only one business model in town for small companies: to get to £20 million and sell out. There has been a lot of research on building what has now become recognised as the equivalent of the German Mittelstand and how we grow medium-size companies from a sell-out value of £20 million to something with a revenue of maybe £100 million, which we are really short of in this country. To do that, you have to have longer-term finance that will buy out the VCs and keep the companies in this country. It may be in partnership with a UK company, but the statistics show that most of these companies are sold overseas because the Americans, Indians and Chinese all have their chequebooks open. We have pretty much stopped visiting members of the CBI to sell things out, because the first thing is that we haven't got any money and we don't do that.

Dr Bradshaw: Last year we produced our "Future Champions" report about mid-size businesses. One thing we looked at in there was the lack of a bond market in the UK for smaller bonds.

Tim Crocker: I absolutely agree with that.

Dr Bradshaw: Excellent. Finally, we agree.

Tim Crocker: If we had a bond market and other financial instruments, this disagreement between ourselves would disappear, but it is the absence of that medium and long-term money in the UK market that controls all this.

I have to add one other thing that is relevant here. In this "only one business model in town" there is also weakness in the patent system. When a small company in the UK files a patent you can get very good quality patent work done, if you can afford it, and the TSB is supportive, but you cannot exercise the rights of those patents unless maybe you have got a fighting fund of half a million quid; and that would be a minimum sort of fighting fund, as lawyers would advise you. Therefore, when you sell out a company to a large corporation and you have good patents, those patents have value. If you try to hang on to them, you cannot exercise the commercial rights of those patents if you are a £20 million-worth company. You can't continually fight half-a-million quid battles to enforce your commercial rights.

Q220 Hywel Williams: This is a matter of curiosity on my part. For as long as I can remember, there has been concern about the brain drain. A moment ago Stephen Mosley made a point about companies migrating overseas. I wince at the term, but is there a brain pump? Do we attract in good and interesting small companies, or take advantage of those sorts of ideas from abroad? Are we as good as other countries in doing that?

Dr Bradshaw: That is a good question. I am sure we do attract them; just look at the "brain drain" bit as well. Don't forget that we have a lot of good UK companies that are winning market share in places like the US. Okay, they are bigger companies, but the likes of QinetiQ and BAE Systems are doing very well overseas at the moment. Do we attract other good companies to the UK? I think so, and, yes, we have smaller companies that are managing to win big business with large overseas corporates. A good example recently would be ECO Plastics, which is working with Coca-Cola. They got private equity funding to develop a system for turning post-consumer plastic waste into food-grade plastic bottles again for Coca-Cola. That is now going to be rolled out much more widely than just in the UK. There are some really good success stories of what you can do. We would like to have more of them.

Tim Crocker: I cannot answer your question directly—I don't know the answer—but there are some asymmetries built in, which we are not very happy about, on the same lines. For instance, UKTI has a budget to get overseas companies to invest here and set up their own company, but it can't help you get investment into a UK company, which seems to be an own goal. It could be 100% Indian, but it can't be 50%. On the other side, an awful lot of people look at the greener grass on the other side—Germany and America—and weigh the fact that they have family and lifestyle issues here. There are lots of pluses for the UK, so they stay out of a fairly solid allegiance. They would simply like some structural change made so that it is easier to do what Government want us to do. These are structural changes that I do not think have Exchequer cost. We can simply change some rules and do better.

Q221 Hywel Williams: I should say that I have a Siemens plant in my constituency of Arfon. One of the reasons the previous company moved there from the United States was lifestyle issues, because, as Mr Crocker said, it is a very nice place to set up, and it is free.

Tim Crocker: Yes. We view the world for medium and large companies in the UK as being quite benign, so a lot of the points made here by Tim I would not disagree with at all. That community is good. It is just the funding issue for SMEs which causes the difficulty.

Q222 Hywel Williams: I would like to get on to that point. It is said that the UK is very poor at growing small companies to medium-size companies, and

medium-size companies to large companies. Tim Crocker has already referred to the finance provision. Is it just a matter of finance, or is it a matter of providing customers, and perhaps the Government as customer as well? Is it an either/or, or is it both?

Tim Crocker: In my view it is definitely both. SBRI, as we have it, is not quite the same as the American SBIR. The American instrument is probably quite crude, but it is the one that works best. That is what most of the survey information says. The reason we have matched funding is that Government wanted the investment community to make the business judgment and then come in alongside it with Government money. The fact that the investment community don't want to engage and be in that early means that that judgment is not being made. If you then move to 100% or 105% funding, which is what would drive it on, you generate a very difficult decision, which is: who gets the money? Panels of what we call the great and the good, for perfectly natural reasons of human nature, always put the money in the safe and well presented, and not in the ones that retrospectively would have been the successes.

What they say in the States is that they get round that because they are not afraid to fail. If you have blanket SBIR funding, the exciting projects, which may have been hidden, will still come out. If we moved to 100% funding, it is better that it is procurement funding, because then it is at least decision making around Departments of Government, each of which has some expertise in the subject, is statistically more likely to put the money in the right places and, more importantly, is less likely to get stuck in a big institutional handout system that always winds up on itself and ends up looking expensive. I think the Regional Development Agency story tells you what can go wrong if you go down that path.

Dr Bradshaw: There is a two-sided story to this: the push side, where Government is helping to do things through the Technology Strategy Board or supporting skills development etc, and the pull side from the Government procurement line. Looking at the push side and what is available in terms of Government grants and aid that makes a difference, it is useful to look back to a piece of work the Centre for Business Research at Cambridge university did probably five or six years ago, but it is still valid. They did a matched sample of high-tech small companies in the UK and the US, so they were very comparable, and looked at whether they received Government funding, how much money and whether it made a difference. The UK came out quite well in terms of whether they received Government funding; it was about two to one in favour of the UK. But those companies that received funding in the US got five times as much as the UK ones. The story was that the money in the US was transformational. It wasn't just a little bit of money for skills or a little bit of money for a project on R and D; it was money that could make a difference in building up their innovation skills and perhaps leadership and management skills, and helping them to access finance and do some R and D activities. It was everything they needed in one place. That is the difference, often, with the picture in the US versus the UK. We do a lot of little things all over the place, but we don't bring it together to make a real, critical difference.

Q223 Hywel Williams: How do they pick the winners, then?

Dr Bradshaw: I don't know. We will have to go back to the story and look in a bit more detail at which ones got that money. They are setting the bar a bit higher, perhaps, in terms of what their market and technology potential is to get that money to start off with. In straitened financial times maybe you do have to set the bar a little higher, but, if you do that, make sure you give a critical mass of support that will make a difference.

If you look at it from the pull side—the Government procurement side—yes, absolutely, that is what can really make a difference. Despite what I have just said about grants, aid and things, most companies would bite your arm off for a contract rather than a grant. The more the Government can do to encourage innovation through their procurement lines the better, be it through SBRI or maybe making sure that all the public procurement space is also looking at innovation so that we transform it. We look at things like outcome-based procurement and whole-life value; we encourage those involved in procurement to look for innovative new ideas that might save them money long term, rather than short-term upfront costs. When you have some really good things in the public estate, showcase them. If you have got them in, show them off to the rest of the world and show what can be done. Make sure you are demonstrating to overseas buyers that we have done this in the UK: "They've got a fantastic contract with the UK Government, and now they can go and supply Australia, Canada or whoever else might need it."

Q224 Hywel Williams: It is said that Germany is better than us. We have compared ourselves with the US already. I do not know whether you are familiar with the model in Germany, but, if they are better, what are they doing better than we are? How do they do it more successfully?

Dr Bradshaw: The KfW bank is one of the things we have looked at, and we think that is very good, in terms of being an industry support structure. There is perhaps a little difference in culture, in terms of growing companies more organically for a longer period of time. It would be worth looking at that in more detail to see what the cultural difference is.

Tim Crocker: I would agree with that. The thing that I noticed in doing business in Germany is that the universities and businesses are integrated in a two-way flow system. Implicit in Government policy now—you see it in all sorts of policy documents—is that the game is to get the technology out of the universities and into the commercial companies. In the bio and pharma sector I think that is the way it works, but in other sectors it doesn't. To me, it is bizarre that I have closer bilateral relations with German universities than I can have in the UK.

The signal of that is that in the UK we have the KTP finance system—knowledge transfer—which assumes transfer of knowledge from the university outwards. If you are on a peer-to-peer basis—in lots of cases

our companies are more advanced than universities—there is no funding mechanism at all by which we can engage with the universities and our time and theirs can be paid for. All we can ever do is use TSB money to subcontract to them, and that is a very unsatisfactory relationship. There is very little walk-back of Government scientists, or research scientists, from the big corporations back into the universities after an industrial career. If I speak to people in Germany, these guys are in and out of the universities—five years here and five years there. Visiting professors spend half a day a week teaching, and the integration between universities and industry is entirely on a peer-to-peer basis.

Dr Bradshaw: We recognise that. This is a hands-on, people-based activity. A two-way flow of information back from industry into the universities and vice versa is essential. The more we can do to support that, the better, definitely. The KTPs do work quite well. One of the issues is the speed at which these things can be set up, and that is a particular issue for SMEs. It is a relatively bureaucratic process. Later, Iain Gray will probably tell you that it is not bureaucratic and it is all lovely, but we know there are smaller companies in particular who would like a shorter KTP activity and to be able to set things up straight away. I think there could be mechanisms to give money to the universities that we know have a good record on KTP, and say, "Look, we'll trust you to set things up quickly", and then do the bureaucracy after they have been set up, rather than the current system, which means you have to go through all that process before you can do anything. The speed of delivery of some of these mechanisms would make a difference.

Tim Crocker: I would agree with that wholeheartedly. My point is not that KTP is bad, but that it is intrinsically one-way. If KTP were a bilateral deal and faster, it would solve an awful lot of problems inside the same funding.

Q225 Chair: Mr Crocker, earlier on you used a phrase I did not fully understand. You said that if we looked at the RDA story we would understand that. I think that was the phrase you used. What story do you tell?

Tim Crocker: I am based in the south-west. I do not think there is any favourable press for the south-west RDA, so I have probably the most jaundiced view. I know that the one in the north-east did fantastic work, but what we observed, which I think is the median story of the RDAs, is that they spent an awful lot of Government money on what I would call current account spending. It built up an infrastructure that was supposed to support the whole of industry, particularly the SME community, but it spent it on its own activities. I have been to a lot of events that are completely useless.

Q226 Chair: In the south of England.

Tim Crocker: Yes, except that I have met some useful people. What we would advocate in all this is to take one lesson from the past, which is that, whenever you set up a big bureaucracy, it tends to consume a lot of current account money; it is just spent that year, and no benefit is coming to our members. That is what everybody says.

Q227 Chair: This is the curious thing I find. Dr Bradshaw, when making a comparison with the Germans, used the phrase, "It's cultural." I personally don't accept that it's cultural. There is actually a bureaucracy there, but it is a bureaucracy that works.

Tim Crocker: Yes. We have not managed to make our support bureaucracies work, and that is because we do different things.

Q228 Chair: Your criticism was not of the principle, but the mechanics.

Tim Crocker: I am holding up a red flag: be very wary about setting up another institution that on the current account spends a lot of public money supposedly supporting businesses. I would give you this germ of an idea. One thing that frustrates a lot of people in the small sector is the way that we have set up some of the technical standards. We are more private—this is done by private companies according to pro forma standards—whereas these things are done in Germany by the federal states at local government level. I would be greatly in support of spending public money to bring back into the public sector some of these regulatory activities at a detailed level, which then implicitly give support, because there is somebody to talk to who knows the answer to a particular technical problem.

What the RDAs did was to put in a vast senior management of people who were good at putting on events, shows and so forth, but if you asked them, "How do I pass regulation such-and-such?, the answer would be, "I will find you a consultant." We suffered deeply from that, whereas in Germany it would be, "You will go to TÜV and talk to Dr So-and-So, and he will tell you the answer." The state would charge you a fee for that, but it will be the definitive answer.

Q229 Caroline Dinenage: As I understand it, in Germany it is compulsory for a business to be a member of its local chamber of commerce. I have been a business owner since I was 19 years old and have never engaged much with a chamber of commerce because it was too large to feel that it was very good for me to grow my business. Is there any mileage in businesses getting support from others, particularly at the intellectual level?

Tim Crocker: I do think there is, but the approach of the last 30 years, during which we have progressively privatised this, is backfiring in an unintentional way. What you want are definitive answers to questions, so that you can say, "This person told me that", and that answer stands for the purposes of law, rather like the relationship we have with the Inland Revenue where, if you get a tax inspector to say, "That is how it is; I agree it", it is done and dusted. I cannot get that for technical regulations, which for us are real barriers to entry for products. If chambers of commerce became more and more semi-official, with true partnerships between businesses and local government, as they are in Germany, I would think it a very good idea. If they were the local government kissing off that form of

responsibility so that it was only an opinion, it would work entirely the other way.

Dr Bradshaw: I very much support businesses learning from other businesses, and there are lots of ways of doing that. I don't necessarily support compulsory membership of chambers; that is probably not the way to do it, but there are lots of mechanisms out there. The CBI does a couple of things. For example, we set up some clubs for medium size businesses around the country so that they can share ideas and learn from experts on innovation, access to finance, exporting and things like that. We have run a business-university collaboration group at the CBI for well over 20 years, in which we bring predominantly large but quite a few small high-tech companies into the room to discuss and share ideas and best practice about working with universities, and the best way of tapping into knowledge and expertise in the UK and overseas. That sort of thing is probably better; it is more of a technical thing that companies might need and that might make a difference, rather than some of the very general things you might get from just the chambers perhaps.

Q230 Caroline Dinenage: That is interesting. You have talked a lot about the lack of long-term risk-taking by equity investors. Do you see that as something the Government can influence? Do you think the banks could have more involvement? Do you see that the banks understand the needs of growing small and medium-sized technological businesses?

Dr Bradshaw: There is always a knowledge gap. The companies themselves are the ones that probably know best where their technology is going. Do the banks have all the expertise? Maybe not. There may well be a need for better expertise in certain areas. That is why it is very useful to have things like the Green Investment Bank, where there is a focus on a particular sort of technology or technology area. Should the Government be doing more to support equity investment? We have lobbied for a long time for the cost of raising equity to be normalised with the cost of raising debt. At the moment there is a difference between those two. We would far rather that businesses were taking investment decisions based on what they need to grow their companies, rather than on their tax position and their profit and loss account.

Tim Crocker: There are lots of elements to that question. The question sometimes gets simplified to: should the banks be involved in financing R and D? I don't think there is any way you can use debt finance to finance R and D. There is an implicit risk there; if the R and D activity fails, who repays the bank? Therefore, you need some of the funding to do R and D.

One thing that is fundamental and unavoidable is that the UK is in the equivalent of an arms race on R and D funding. All the competitor nations that we aspire to be as good as are spending lots of public money on R and D. There is an EU study by Professor Mazzucato, who is now at Sussex university, which spells this out in total detail. It is the most recent study I am aware of, and it fits with all the facts that I have ever observed about this. If we pose the question of whether, to get more R and D done in the UK and make it stick longer, we should do something to raise more equity or put in more Government funding, the only rational answer is to say that you have to put in more Government funding, because nobody has ever done it any other way. Our competitors are doing it by Government funding in the here and now, so we would be taking an enormous risk, even if we could do it.

If you are going to move to putting in Government funding, the question becomes: how do the taxpayers get back their funds? If you look at the way the VC community works in the United States, it pays an awful lot of corporation tax back to the Government. When the US Government do their accounting on SBIR, as it is there, they find that it is a virtuous circle. They can afford to spend this money because the finance community is paying back the taxes, the profits are appearing on the stock markets and so forth. I am very doubtful that technically you can do anything about equity funding more than the initiatives that are going on with organisations like Crowdcube and so forth, which are pushing it along. I think Government have to bite the bullet and say that getting R and D through to commercialisation is, in our competitor nations, basically a state-funded activity, and then set up the tax system to make sure that it comes back in.

Dr Bradshaw: Don't forget the pull side of that equation. I go back to that again. That is the thing that makes a real difference—getting a contract. If you are using the public procurement system, not just through SBIR but more widely, to try to bring through innovation, and you have a better market where there is an open dialogue between potential suppliers and Government procurers about what is possible for the future, looking at new capabilities and new technologies coming on line, you will get a better environment for those technologies and ideas to be developed further, because there is then a potential route to a customer.

Q231 Caroline Dinenage: If I may ask you about the business community, is there sufficient support and encouragement among the larger businesses for smaller businesses within their supply chain? Is there anything that the Government can do to encourage that?

Tim Crocker: Our supply chain is very discontinuous. Many of our members will have contracts with big companies, and that is their best way forward, but it is very binary. You might or might not, but it is very hard to get the first one.

To add something on the issue of banking, I think the Committee, BIS and the Treasury need to look at the conditionality of banking in the high street, rather than the rates that they see. One of the things that comes up time and again is, "We applied for this Government grant and then we are asked for personal guarantees", with people being wheeled in to sign off on £100,000 worth of Government support—soft funding—for clean tech or one of these things, and then the directors are asked for personal guarantees. The problem with personal guarantees is that they limit

the scale of ambition of the company to the financial resources of the directors, if they are brave enough, and turn it off if they are not.

I know we had an answer from the DTI 10 or 15 years ago that, with the Government-backed guarantee schemes, 75% of the loan was guaranteed by the Government and the bank had to pick up the other 25%. The banks made the borrowers pick up the other 25%. Nobody from the Government side is looking at that conditionality. If you walk into the boardrooms of the banks, they know nothing. Mystery shopping and inspecting deals is the only way it is going to happen. When I started my business, I was paying 2.5% over base; on very small short-term loans, I am now paying 9.5%, and I know some people who are paying 20% over base. There is no point in the Bank of England setting the rate at 0.5% if the banks are still lending as they were in the mid-1990s. This is just running on and on.

Q232 Roger Williams: We have had written evidence that the UK needs a clear national innovation system, but what do businesses need most of all? Is it the right people, access to equipment or access to cash?

Dr Bradshaw: I don't want to sound like a broken record, but it is a push-and-pull thing. It is the innovation system, industrial policy, which you can wrap up into the same package, and public procurement. I think the No.1 ask from business is long-term strategic focus from Government. If you are looking at an R and D investment and the time it takes to bring that through to commercialisation, obviously it is different for different sectors, but for the aerospace industry it could take 20 to 40 years to realise a return on your investment. So having confidence that the Government will still be interested in the aerospace industry and will support the activities you are doing over that time frame with the R and D that is required to bring that through to market is essential—making sure that the overall environment is good, in terms of universities, R and D tax credit etc. These things take a long time to pay off. Consisitency is what companies are looking for: is it going to be stable in the UK? Do we have a good environment for the long-term future that will get those projects through, get the money and get a potential market?

There are all sorts of other things beyond that. On the people side, yes, definitely, we know there are particular shortages in engineers. The Institution of Mechanical Engineers looked at that and said we needed to treble the output of university graduates that are coming out at the moment with engineering degrees to be able to meet the demand we know we will have. That is an issue.

In terms of equipment and facilities, the universities themselves have a lot of that on offer. There are more schemes that we can use to encourage companies to have a look at that and see what is available. The innovation vouchers are being brought back in again to encourage the first contact between SMEs and universities to see what facilities are available to them. I think the catapult centres, as they are now called, fill that same slot. Last time I called them the "Andrew Miller centres", didn't I? We were debating the name then.

Chair: We preferred "Alan Turing".

Dr Bradshaw: That is right. There are lots of mechanisms out there now that have facilities, expertise and equipment. Can we make sure that the community is aware of those, and that you can best match up what the companies need and what is available in the UK? That is something we still need to work on. It is an ongoing problem. We are getting there, but we are not there yet. More emphasis needs to be put on that.

Q233 Roger Williams: Mr Crocker, you did say right at the beginning that more cash would be a good thing but it is not an option at the moment. A senior member of the Government said that he was going to give 110% to growth. I don't know whether you can understand that, but what I understood by what he was saying was that, if there was some Government spending that isn't delivering growth, it could be taken to another sector where growth could be better achieved. The case has been made that investment in science and technology is a real element of growth in the national economy. Is it that politicians are not making the case for more investment in science and technology, or is it business or the universities, or is it just the Government who are resistant to that argument?

Tim Crocker: I think our membership has been invisible to Government for a long time. The universities sometimes do come across as if they are the only source of innovation. That is simply not the case; the statistics say otherwise. When I said we understand that cash is short, I absolutely agree that the factor 6 figure is the ballpark of the per capita increase in Government funding that we need if we are to compete with the United States. I take it that it is a decision for politicians where you are going to get that factor 6 from. My plea is not to spend it on salaries of advisers, because this becomes wishy-washy money. That is not a plea for not spending it in the public sector. I would like to see EMC inspectors, or whatever the equivalent is in biomedicine, so I can get decent, instantaneous answers to questions.

Is it money or any of the other things? It is all the things that have been said, but for our sector, it is the length of the money that is the absolute big thing. Four or five-year horizon money does not allow you to do anything other than sell the company. People say there are no medium-sizes companies because they have all been sold to big companies, and it is just an inalienable truth.

The point made earlier about us needing to package the money in bigger slices is absolutely true. If you receive £200,000 of R and D money it seems a lot, but the lawyers who do the deal will want £100,000 of that. So we need bigger packages; we need to think bigger. One idea arose earlier that we have been looking at. The bond market is the only route forward where, as far as I can see, the Government have to stand by some sort of growth bond. That growth bond has to go predominantly into some sort of procurement funding.

Q234 Roger Williams: Often, the universities have provision for high-technology machinery and equipment. Is that always available to the companies that really need it and would make best use of it?
Tim Crocker: No. There is no lack of willingness; these things are done with good intention. The mechanisms at the detailed level are not there.
Dr Bradshaw: The facilities are there, but often it is the matching of the need with the facility, and finding routes to do that is difficult.

Q235 Roger Williams: Can you give us a view on the catapult system and whether it is going to be a good one for smaller to medium size companies?
Dr Bradshaw: I think it is still too early to say. These things are only just being set up properly now. A few of them—the advanced manufacturing ones—have been going a little longer. We need to see how they evolve with time. If you pull the roots up now to try to examine them, you will do them no favours. We would like to see them settle down a little, and let's ask that question again in a year or two and see what success they can show. We always said, when they were set up to try to emulate the Fraunhofers, that the Fraunhofers had been there for many years and had built up that brand equity by having a long-term relationship and being able to demonstrate success over time. Let's give them a little bit of time to settle down and show they can do something useful before we start to try to pull them up.

Q236 Chair: When you undertake your review of the catapults and how they are performing, I would recommend that you look at the Fraunhofers. One of the reasons I picked you up on the word "cultural" is that, when I asked a senior German civil servant whether it was the triangulation involving the Fraunhofers that created the longer money that Tim Crocker is looking for, his response was, "Mr Miller, I used to be a banker. The answer is yes." I think the argument that it is cultural needs challenging, and organisations like the CBI need to ask themselves whether it is structural. If the answer is yes, I think you would agree there is a case for going further with the catapults. Is that fair?
Dr Bradshaw: Do you mean expanding the catapults and doing more sectors and giving them more money?
Chair: Despite their name.
Dr Bradshaw: Despite their name. I don't think they have been there long enough to be able to see whether they are the right mechanism. There is a lot of good value in them, but they need to establish themselves. Let's not forget that they are also competing with some very good university centres and research and technology organisations, but they are fitting themselves into the innovation ecosystem in the UK and they have to find their space. If we find that they are just duplicating effort elsewhere, then yes, we will be vocal about that, but if we find they are doing a really good thing in bringing bits together and making a difference that is good, but it is a bit too early to say at the moment.

Q237 Sarah Newton: I am very fortunate to have the last question. This is your last opportunity to say anything you have not said before. You have given us an immense amount of useful information and food for thought. It has ranged across the medium and longer term and some short term. We have got complete focus now, with the reshuffle, on growth, so if you had the Ministers responsible here today, what would you want the Government to do right now or within the next 12 months to address the issues that you have shared with us today?
Tim Crocker: I think the need for long-term strategy is the absolute core of this, and the long-term strategy will then pick up the points we have been making in detail about money, patents and so forth. When you make the distinction between "cultural" and "structural", a culture develops from the structure that is there; it is an institutional process. I would say that at the moment we have the wrong culture and institutions that are probably not performing as well as they should. It is possible to fine-tune the institutions, but the trend that seems to have been continuous since the last war is that we do not find the means of doing technocratic governance very well. Other countries that we admire for their technology have state-run railways that run perfectly well.
I do not want to get into the politics of this, but our solution is different. My absolute gut instinct—I am a commercial person through and through—is that it is the interface between private industry and the state where the boundary has gone wrong. The state has shed a lot of low-level activities that are absolutely necessary and thrown them into the private sector, and that forces the divide between us and the large companies, because the large companies benefit from this; they can soak it up. They have accounts departments that can cope with 30-odd different national insurance rates and so on and so forth. The little companies are systematically disadvantaged by this. It is not just tax rates; it is every little rule and regulation. If I want goods signed off for sale in this country, I end up signing the certificate of compliance. If I go to a German test house, the test engineer, who is an employee of the German state, signs it off. That is a massive liability difference.
I know Mr Harradence is here later. I think it needs to be absolutely inside BIS. Government have to view BIS not as a spending Department but an earning Department, and they have to have the absolute lean and mean crack team that is going to work with industry, not on its own, to get this structure sorted, and then everything else will fall out. I would hope that out of that we will see a means of getting longer-term money, and moving grant support from Government away from matched funding, which is the real and immediate bugbear. Also—I have not said this sufficiently strongly—the patent system needs fixing for the small companies. The big companies love it the way it is; we don't. It is a Mandy Rice-Davies thing: they would say that, wouldn't they, because it's good for them, but it's really bad for us.

Q238 Sarah Newton: Could you expand on how it could be improved for small and medium-sized businesses?

Tim Crocker: At present, if my car is stolen I call the police, who try to get it back; if my patents are stolen, I have to go to a civil court, front up a few hundred thousand pounds and have a fight with a multinational. That means that my investors have absolutely no security over the patents we hold. In more than half of EU countries, patent infringement is now part of criminal law to fix this. In the United States they have triple punitive damages. In this country we have absolutely nothing. In the hands of a big company, those patents are perfectly powerful. As a bargaining tool for small companies, they are worthless; they have no value. We can only exercise that value by sale to a big company. That is the other pillar by which we do not have medium-scale technology companies. Dyson broke the mould, but his success should not be seen as the normal path. He did brilliantly well to break that mould.

Dr Bradshaw: I will limit myself to three things, although some of them are quite big. The No.1 would be to have a new approach to industrial strategy that is focused on our competitive advantage sectors and helps to make sure that they are being encouraged and supported to export and develop for the future. A lot of that could well be around developing their value chains in the UK. For example, there is a supply chain initiative at the moment that BIS runs. It is only for one year and it is for about £125 million, but what about the next 10 years? Could we repeat that again and again each year for the next 10 years to build the facilities, skills, and innovation investments required for the supply chains in the future? The first is an industrial strategy.

The second would be the changes I mentioned around public procurement. That is the big pull factor. I suppose there are three big areas around that. One is creating a better market environment, which is an open dialogue between suppliers and buyers about what is potentially possible. It is about capability reviews, like the tunnelling capability review produced recently for procurement pipelines. Those are all very good because they help to give companies confidence about what is needed for the future, but those need to look a little further out, because at the moment they are more about capacity than developing new capabilities for the long term. If we looked ahead up to 10 years rather than just five years, which is what the current plans look for, that would really help. Then there are wider changes within the outcome-based procurement, looking for whole-life value and being able to transfer money between revenue and capital budgets in procurement to help bring through some of those changes. Those would be very good.

The third and final thing would be around the funding for the Technology Strategy Board. We have always argued that it should have funding on a par with something like the EPSRC. That will effectively double its budget at the moment, but it has to work with business and focus on the things business wants. At the moment it does an awful lot of good things, but its money is spread very thinly. If we could bring a little more focus to and effort around some of the core competitive advantage sectors, we could make more of a difference.

Q239 Sarah Newton: If that budget was doubled, would you keep the ratio of expenditure about the same, or do you think it should be changed?

Dr Bradshaw: Within the TSB?

Sarah Newton: Yes.

Dr Bradshaw: Whether the budget is doubled is the biggest question. If we achieved that, we would be delighted, and then let's have a look at how we spend it.

Chair: Gentlemen, thank you very much indeed.

Examination of Witnesses

Witnesses: **Fergus Harradence,** Deputy Director, Innovation Policy, Department for Business, Innovation and Skills, **Iain Gray**, Chief Executive, Technology Strategy Board, and **Sir John Savill**, Research Councils UK, gave evidence.

Q240 Chair: Gentlemen, welcome to this morning's session. You are all familiar with the terms of reference of this inquiry. I notice that you also listened in to a significant part of the previous session. For the record, would the three of you kindly introduce yourselves?

Sir John Savill: I am John Savill, currently serving as chief executive of the Medical Research Council, but today I represent Research Councils UK, which is the collaborative organisation of the seven research councils.

Iain Gray: I am Iain Gray. I am the chief executive of the Technology Strategy Board.

Fergus Harradence: I am Fergus Harradence, and I am the deputy director for innovation policy in the Department for Business, Innovation and Skills.

Q241 Chair: Welcome to the three of you. The Government have told us that science is core to the growth of the UK economy. In your opinion, have the Government got the balance right between the funding of basic science and stimulating and supporting commercialisation?

Iain Gray: I think the answer is no. If you look at the responses we heard earlier, there were some clues to that as a direction of travel. The balance is wrong. The key question is how we address that balance, and too often the wrong ideas come forward as to how to redress that balance. To look at things in a total cross-governmental way is one of the ways forward to address the balance, but, fundamentally, I think the balance is wrong.

Sir John Savill: Can I qualify that view from the perspective of the research councils, though I would not disagree with it? The first thing to remember is that without fundamental research and discovery there is no translation. If changing the balance results in reducing the funding to fundamental research, there

will be less to translate for the nation and that has to be borne in mind.

The second point—I won't bore you with the detail but will happily go into it if you are interested—is that the research councils commit an awful lot of resource to the translational pathway. In my own area of biomedicine, where the valley of death is a very real phenomenon, we have changed our way of working over the last four or five years.

Thirdly, I would agree with Iain that the balance might appear to be wrong. It is interesting to compare the devolved nations of the UK. I live and work in Scotland some of the time. The balance there between Government funding through Scottish Enterprise to the research council funds that reach Scotland through competition is different.

Finally, all research councils enthusiastically engage with TSB. For example, in developing the cell therapy catapult, EPSRC, MRC and BBSRC have invested £25 million in a regenerative medicine platform to speed the transfer of fundamental research to the catapult.

Personally, I have been involved in thinking developed at the Office for Strategic Co-ordination of Health Research, chaired by John Bell, where we recognised a real shortage of funding available to TSB. We were able to press the case with Government for additional funding for TSB to partner MRC in the biomedical catalyst. I would agree that the balance might appear to be wrong. I think the most obvious imbalance is in the budget of the TSB to the research councils.

Q242 Chair: "Is wrong"; "appears wrong". Mr Harradence, I guess we are going to hear a slightly different version from you.

Fergus Harradence: I would try to agree with both points of view. I agree with Iain that, if you compare the budget of the Technology Strategy Board relative to the budget of the Research Councils, you would draw the conclusion that there is a need for more funding to go to the Technology Strategy Board to support innovation, technology development in business and the commercialisation of research, but I don't think the solution to that problem would be to say that we should crudely aggregate those budgets and decide to take some money away from funding basic research, which performs a tremendously valuable role, and not only in building intellectual capital in the country and supporting the early stage research that leads to translational research and technology development in business; it also trains the cadre of skilled people that we desperately need in the economy, who will become the innovators of the future.

Part of the solution is to seek additional funding from outside for the Technology Strategy Board to try and get a better balance. I also agree with Iain's point that there is a big need for us to become more joined-up across Government. A lot of additional funding for science, technology and innovation is held by various Departments and other public bodies, and that is not part of the simple TSB Research Councils' calculation when you look at the total budget for science and innovation. There is more that we could do to link up with Departments like Transport, Defence and Health to achieve a better and more co-ordinated approach to support for innovation that will draw on the investments we make in the research base.

Sir John Savill: I agree with the last point. I have lived in a space where over the last six years we have tried to co-ordinate the public sector research budgets involved in health research. They are not held just by the Medical Research Council but also by four national health service research and development systems. OSCHR is a model that has worked to co-ordinate spend across Government Departments quite effectively; indeed, as such it has attracted international visibility. In my travels within the European health research community I am often asked about OSCHR. It is an example of how you can achieve what Fergus has highlighted in other domains.

Q243 Chair: This could take us down the lines of an entirely different inquiry if we start focusing too much on the structure of Governments, but there is some common ground between you. Are there other budgets that could be refocused that would help release resources for commercialisation purposes?

Iain Gray: To give my perspective, first I reinforce what John said. The working relationships among the Technology Strategy Board, the research councils, universities and science bases are very good. While I gave a very blunt and straightforward answer, I would reinforce that it is not about redressing the balance by reducing investment in science and technology.

If you look at the overall investment in R and D across the big spending Departments of Government, we heard earlier this morning about SBRI. The procurement of research across different Government Departments needs to be drawn into this debate. If you look at the overall public sector expenditure across Government Departments, it is an order of magnitude sum of money greater than that invested through BIS in the Technology Strategy Board. I believe it is how we can tap the large R and D expenditures and public sector expenditures, particularly in pre-commercial procurement, to help assist in the innovation agenda, bridging the valley of death that we are talking about this morning. To my mind, that is where there is some untapped resource.

Q244 Chair: Is it your view that some other countries do that better? The obvious part of your answer is to look at the procurement side. For example, you would not see too many non-French police cars on the French roads, whereas in the north-west of England we have police forces buying Kias.

Iain Gray: There are examples. Probably, the most visible public sector example in the US is related to defence, SBIR and the DARPA type of scheme. Equally, you could look at other big spending Departments. You could look at health and how we do things in energy, but, from a US perspective, I would cite the way that the defence budget is used to stimulate innovation and growth through SBIR and DARPA as a prime example.

Q245 Chair: Mr Harradence, are there any projects under way that we ought to be made aware of where some of these issues would be addressed?

Fergus Harradence: Yes. I think we have made quite a lot of progress over the last five years in becoming a more intelligent lead customer in Government and putting in place some procurement mechanisms and processes that can help us use the power of public procurement to pull through products and services. One of the great successes of the Technology Strategy Board has been the implementation of the Small Business Research Initiative in the UK. We had two previous goes at this in the early part of the last decade. Both times the programme failed because it lacked focus, resource and active management.

Since 2009, when we relaunched the programme, we have been able to build it to a level of about £20 million a year of expenditure, which compares favourably with a lot of our other business support programmes that are focused on technology-based SMEs. So far under the programme we have awarded over 900 contracts worth £78 million, of which 55% have gone to either small or micro-businesses employing fewer than 50 people in total, which typically is the cadre of companies that the Government and the public sector more widely find it most difficult to contract with. There have been some successes, but the scale of the programme is still too small. In an ideal world, I would like to see it more than double, and we should be aiming to grow this to a level of about £50 million a year, which I think is feasible and achievable in a relatively short space of time.

I would highlight a couple of other initiatives. We have been doing some work on better supply chain management and how Government can engage more effectively to support the development of new products and services over the longer term through our Forward Commitment Procurement programme. We have used that to procure zero-waste mattresses for the Prison Service, which are more environmentally friendly and cost less, and to develop a new type of ward environment, this time for the National Health Service. We have got to the point where it has been demonstrated. It is in the Building Research Establishment in Watford. Most recently, in May of this year we launched our Public-Private Procurement Compacts. This is genuinely new and innovative. I am not aware of anyone else in the world that has done it. For the first time, the public and private sectors in the UK are coming together in areas where they have a shared interest in stimulating demand for new products and services. We are running them in low-carbon vehicles, biogas and zero-carbon catering.

Q246 Pamela Nash: Is that a UK-wide initiative or just in England?

Fergus Harradence: All the initiatives we run are UK-wide, but we work with specific local partners. In the case of the Forward Commitment Procurement programme, we are working with hospitals in England, but there is certainly no reason why hospitals anywhere else in the UK cannot participate.

Q247 Pamela Nash: Has there been an approach to NHS Scotland and Wales?

Fergus Harradence: They are aware of what we do, and the Technology Strategy Board works very closely with the NHS and Health Department in Scotland. They co-fund a number of TSB programmes, so, overall, Scotland is one of our bigger partners on the innovation side.

Sir John Savill: Perhaps I may reiterate that the OSCHR structure involves Iain and me, but the R and D systems are from all the four nations. Andrew Morris, the chief health scientist in Scotland, is a member of OSCHR, so in the health area there is very good communication. We have had many discussions, as Iain knows, about the importance of innovative procurement. We think we have seen movement in England in the Nicholson report. I was a non-executive director of Lothian Health Board for eight years, and I know this is an issue on the agenda in various health systems. The MRC recently made a visit to Wales; indeed, we are going to Northern Ireland in October. Again, I encountered interest in this innovative procurement agenda in Wales and hope to do so in Northern Ireland.

Q248 Pamela Nash: I appreciate that. From the evidence that we have received from the Shelford Group, which I appreciate is concentrated in England, I was pretty shocked by one of the quotes we have been given: "Currently the NHS invests more than £1 billion each year into primary research, but as an organisation it lacks an agreed structure to capture the value of that investment in intellectual property." Is there any evidence at all that this expenditure is benefiting life science companies and medical technology companies within the United Kingdom?

Sir John Savill: I am sorry. Any evidence of?

Pamela Nash: Is there any evidence that the money the NHS spends in England on R and D is being translated into business success within the UK?

Sir John Savill: It is important to explain that a lot of the research and development done in the NHS is late stage and does not involve the development of new intellectual property. I can refer to my Scottish experience with Scottish Health Innovations Ltd—SHIL—where there is a real effort by the Government to mine intellectual property that derives from NHS innovation. A good example of that is Touch Bionics, a company that makes artificial limbs, which came out of a Scottish NHS innovator.

I would like to move on and recount some anecdotal evidence. I went to an event that Iain organised for innovators. In this case they were from the English NHS. They had developed really interesting new approaches to improving health care. They had formed companies to try to develop that, but had found it impossible to penetrate the NHS in the shape of a lead customer. This is an issue in the English report. If the NHS were to be required to spend a very small part of its procurement budget exclusively in small innovative companies, that would help these innovators to penetrate the market and demonstrate worldwide that they can sell into health care.

Q249 Pamela Nash: Would you be able to share with us what the particular difficulties were in penetrating that market?

Sir John Savill: The particular difficulty is that the procurement system exists to drive down price, and therefore it favours the high-volume trader. The small company does not trade at high volume but gets enormous benefit from selling 20 bits of kit to a small part of the NHS. Iain will probably want to expand on that.

Iain Gray: To give you an example, the bottom line is that there is a huge opportunity. Some of the restructuring, with the commissioning board looking at things in a more central way around innovation, presents big opportunities.

Coming back to SBRI, Tim Bradshaw in the previous evidence stressed push and pull. It is the NHS providing that pull that is the key ingredient in this. If you take SBRI, I will quote just one company: Eykona, which is a company which essentially has been developed. It uses a 3D imaging type scheme to assess wounds remotely in the home and avoids regular trips to hospitals and things like that. It is a terrific piece of technology. It came out of defence and 3D imaging technology; it is a great spin-out from other sectors.

Coming back to previous evidence from Tim, Eykona won an SBRI contract. It has taken it to the next stage. The managing director of Eykona would say, "We would not exist as a company were it not for SBRI", but he has now reached the critical point John describes, which is: how does he move that on now into a procurement-type contract in the NHS? Ironically, the market he is now chasing to procure the technology that has been developed under an SBRI contract is overseas. He is chasing overseas contracts because, when it comes to the critical point of the next stage in the procurement contract, there is a risk-averse approach in the UK.

We have got great science and technology; we have got the SBRI in place, which is helping small businesses get their technology to the point where they can take it to market; and we need that pull at the next stage to act from a procurement point of view to move the technology into the NHS. I believe that has to be looked at in a much more holistic way.

Fergus Harradence: One of the problems across the Department of Health and the NHS is the lack of an obvious front door for small innovative companies that would be parallel to, say, the Centre for Defence Enterprise of the Ministry of Defence. As a small company you are dependent, in most cases, on finding an individual hospital that is willing to procure your innovative product or service. While there are certainly some hospitals in the NHS that have done that and been helpful in bringing products to market, you still lack that piece of central infrastructure that is able to brigade demand, prioritise, signal and market where the big strategic needs are in terms of health procurement. That is probably something that is lacking at the moment.

Q250 Pamela Nash: You mentioned the MOD. Is there evidence that the MOD is much better at this? Can I ask you to compare that with other Departments in Whitehall? Are they better at spending the money?

Iain Gray: We have just signed a charter with Dstl, which is part of the MOD. The chief executive, Jonathan Lyle, and I have signed a charter to work closer together particularly focused on SBRI, and the MOD is committing money to that. It is the same analogy. That is a small part of MOD expenditure. It is looking at how you connect that development side of things to the bigger operations side of MOD. How do you create the pull and demand from the big MOD spending budget? For me, that is where the connection needs to be made, but we are making good connections at departmental level on the R and D side. It is the pull that is the key to making this successful now.

Q251 Pamela Nash: Obviously, my experience is based on my constituency in Scotland. Visiting businesses over the recess, the main problems I found were for medium size businesses to go into any sort of public sector contract. They were going up against companies from the rest of the EU when it got to contracts that they might be going for, which is often unfair because those companies may have additional Government support in their own countries and lower wage bills and poorer conditions for their workers. For smaller companies, there still seems to be a lot of red tape in trying to get Government contracts. One company, without giving too much away, has a product that could help prevent hospital-acquired infections in Scotland, yet they have been told that it would be difficult for them to sell to the NHS because there is no one else in the UK with this product; therefore, there is no competition. I would like to know more about what the Government and their agencies are doing to try to cut through this and help British companies get these contracts.

Fergus Harradence: The Cabinet Office through the Efficiency and Reform Group has been leading a programme of work to try to tackle two of our big problems. The first is to simplify and streamline the procurement process and free up more time within procurement functions to enable them to go out and engage with the marketplace and businesses in a strategic way, combined with better signalling of Government demand in particular areas. The work that has been done on future capability needs in areas like tunnelling would be an example of that. We published quite a lot of information earlier this year about future Government needs.

Secondly, there is a big challenge in upgrading the skills and knowledge of people in the procurement profession. The difficulty in doing that is that procurement is not in most public sector organisations a centralised function; it is often devolved to a number of agencies or individual public sector organisations like local authorities and individual hospital trusts. Fundamentally, it is their job to pay and manage their staff and decide what they want to do. When you try to encourage people to go out and engage in the marketplace, it is very difficult to have the kind of strategic approach adopted in the US where procurement is much more centralised within major departments like the Department of Defense, and it is

a fundamental part of their operations. The culture, structures and the way procurement is managed in the UK are fundamentally different, and that makes it hard for us to procure in the same strategic way that you see the US doing. I would not say that these problems are insuperable; they could all be tackled over time, but, being realistic about it, it will be a process of long-term improvement and cultural change.

Iain Gray: To give a short answer to Pamela, I would be very interested in talking to you about that specific example. We were talking about hospital infections with the First Minister in Scotland and how SBRI could be a tool to help small businesses like that. It is a generic issue.

In a broader sense, I tend not to talk about procurement but the role of Government as a lead customer. Procurement is, "I want something and I want something now", and inevitably you have a value system that tends to focus on very specific criteria when you are going to procure something. You do that as an individual; Government Departments would do that. The role of a Government as a lead customer is to help to try to identify the needs much earlier on so you can help work with businesses to see what the potential solutions are.

We heard about standards and regulations and how they can help, not hinder, UK businesses win contracts. It is a matter of getting in much earlier to identify the challenges and problems that hospitals and public sector bodies face and using that need to engage with business and understand what the potential solutions and challenges are, and then have the mechanisms by which the R and D they develop to support those challenges can move into procurement contracts. It is not just about a one-stop procurement decision; it is about the role of Government as a lead customer early on in the process that I think is important.

Q252 Chair: Mr Harradence, I think that just before you came into the room Tim Crocker said that UKTI helps companies from abroad set up in the UK but doesn't help UK companies. Given your background, is there more UKTI could do to help in this space?

Fergus Harradence: You have to look at the role of UKTI. Its role is really twofold. First, it supports UK companies to do business overseas, including the public sector overseas. For example, when you have something like the Olympic Games in Rio and the Commonwealth Games in Delhi, UKTI will make an awful lot of effort to help ensure that British companies have access to those contracting opportunities. Secondly, it has a role in inward investment and bringing companies into the UK. One of the things companies look for when deciding whether to come to the UK as opposed to another location is their access to a customer base, whether that is in the public or private sector. It is not really the role of UKTI to provide support to UK businesses seeking to do business with the public sector in the UK. That is something that the Department for Business, Innovation and Skills would do working with the Cabinet Office, because we have a responsibility for procurement and innovation procurement respectively.

Q253 Chair: There is this concept of joined-up government that we were trying to encourage you to think about at BIS. Is there not a case for creating a parallel mechanism to make sure that indigenous companies are not disadvantaged in that process?

Fergus Harradence: I am not sure there is any evidence to show that British companies are disadvantaged in public procurement decisions. I agree there is some anecdotal evidence, but ERG has had a look at the award of contracts to businesses. Broadly, the level of awards of public sector contracts in the UK to British businesses compares with the situation that you would see in France, Germany and other countries.

Chair: I will leave Mr Crocker to bend your ear after the hearing.

Q254 Stephen Mosley: A couple of questions ago the Chairman was asking about the balance of funding between research councils and wider industrial incentives. Looking specifically at research council funding, what is the balance between the funding of blue sky research through to the proof of concept side of it? How do you decide where that balance of funding lies?

Sir John Savill: First, it is a difficult question to answer, but there is a feeling in the community that, very roughly, two thirds of the research is what you might call blue skies and one third right across the seven research councils is more directed research. Each research community has different opportunities to translate and different challenges. In informatics research might move very quickly into the market. The Committee will know that in biomedicine it is a very long haul, over at least a couple of decades. So the approach you take as a research community depends on the particular problem you face.

All the research councils have identified translation as a priority. I guess you could identify that at least 10%, or towards 20%, of the research funding is directed specifically at translation. If there is time, I would happily run you through a list of things that the research councils broadly share in the way they try to promote translation. We are definitely not ivory towers that just do discovery blue skies research. We want to see that research improve society and benefit the nation's wealth, and there are various strategies to do that. I will happily go through them if you would like me to.

Q255 Chair: It would be helpful if you could provide a note covering that. I would also be interested to know where that process overlaps and engages with the TSB.

Sir John Savill: I will happily do that and also cover in the note to you the relationship with the TSB.

Iain Gray: In the relationship between the Technology Strategy Board and research councils, both in a collective sense and on an individual research council basis, in our delivery plan we have agreed objectives and where we do work together. As John has said, different councils have different objectives. It is not

just about science in a blue skies commercialisation sense. There is a very strong emphasis on the role of social sciences and things like design and the behavioural side of things, which engage very closely with the commercialisation side of the agenda as well. For each of the research councils there is, as part of our joint delivery plans, a statement of those areas, projects and activities where we will work together. At the very beginning, we heard John talk about the good work we have been doing with MRC, particularly around the biomedical catalyst and the cell therapy catapult area.

Sir John Savill: One of the strongest arguments for seven research councils rather than one is that each looks to a pretty different but fairly well defined set of industries where the translational pathway has different barriers and requirements. It is definitely not one size fits all, but, as you will see, there are some approaches—collaborative PhD studentships and joint research centres—that really work for campuses and a number of research councils. So I will happily write in about that.

Q256 Stephen Mosley: That would be helpful. Have there been any changes in the balance of that funding in recent years, and what are the drivers for that? Are they economic or political, or is there something else?

Sir John Savill: There definitely have been. In the Medical Research Council's domain, a key stimulus was the report of Sir David Cooksey, who has given evidence to you. That highlighted that we needed to behave differently if we were to promote the translation of biomedical research. There have also been some very interesting differences from industry. If you look back 20 years, industries like Rolls-Royce had a monolithic discovery and development model, not unlike pharma. Rolls-Royce realised that it couldn't lead the world if it had a monolithic R and D model, and discussed with EPSRC the idea of joint technology centres in universities. So a push has come from industry to get into universities with collaborative funding of research councils. EPSRC has over 20 large companies involved in joint technology centres. We are beginning to see that in my domain in biomedicine as well.

You might say that some of the push is political—David Cooksey's report; some of it comes from industry; and some of it just comes from the stage which research brings you to. An example of that is graphene, which is a brilliant breakthrough. That is a new material that might revolutionise lots of industries. It is a great opportunity. It has been recognised, and the approach has been a collaborative one with public sector funding through research councils, universities and industry.

Q257 Stephen Mosley: I was interested that you mentioned the EPSRC. As a committee we have been lobbied quite hard on their shaping capabilities programme. Has there been much reaction? A lot of the research community out there tends to believe that funding should purely follow research excellence. Has there been some sort of push back, saying that perhaps you should not be changing the way funding takes place?

Sir John Savill: Different communities behave differently. What I have seen in biomedicine is that there is a grass-roots response to things like the Cooksey report, where the applicants themselves realise that they want to see the translation of their research, so it is different strokes for different folks. EPSRC has chosen to undertake the experiment of shaping from above. In the case of the Medical Research Council, much of it has been shaping from below—from the grass roots. Every community behaves differently. I don't think there is one particular method that works best across the piece, which is another argument for seven research councils, and any change always brings criticism. As we all know, there has been criticism of EPSRC's push to do this. There was very strong criticism three or four years ago of the Medical Research Council supposedly abandoning basic research. That is not the case. Any change brings criticism.

Q258 Stephen Mosley: On a different issue, last year we did a report into peer review. How many scientists do you have with an industrial background and experience working for the research councils doing peer review? Is it focused purely on academic subjects?

Sir John Savill: No. It is a very important part of the peer review process, but scientists in industry have a day job and it can be difficult to find scientists whose companies are prepared to release them to give time to public sector peer review. Again, I can speak about my own back yard. Every one of our standing boards has industry involvement and folk who are based in industry. We try to have as many of those as possible and find it very useful, but for small companies in particular it is difficult for scientists to give up the time to do peer review.

Q259 Stephen Metcalfe: The TSB seems to be given ever-increasing numbers of programmes and initiatives to deal with. I have a simple question. Do you have the resources, financial and human, to be able to deliver on those?

Iain Gray: The simple answer is that as an organisation we are growing and expanding to meet the needs. We talked earlier about a confused innovation landscape. The Technology Strategy Board does help to draw together these different initiatives. There are some things people are talking about that, frankly, are scaling up what we do already; there are some things that people talk about that are new initiatives and mechanisms that require additional finance and resource to do them. So the bandwidth of the organisation has to adapt to the needs that are placed on us in slightly differing ways. One issue is not so much the resources and bandwidth to do what we are asked to do but the bandwidth and resources to do what the community out there expects us to do. For example, post the world of RDAs, there was a lot of anecdotal stories about the Technology Strategy Board doing this or picking up that. What we do not have the resources and finance to do is to meet all the expectations that some of the outside world would place on us.

Q260 Stephen Metcalfe: How are you managing those expectations and communicating back to the outside world that these things are not your responsibility?

Iain Gray: We are in close engagement with the business community. One of the things we have tried to work at quite hard is how we build the links with local communities. In the north of England, for example, with the N8 universities we have established what is called the N8 Innovation Forum, which is a mechanism that allows us to talk with the universities and business clusters around those universities in a constructive way about how we can engage for the things that we do and things that we don't do. We can't engage with every single business, LEP or regional office of different professional or trade associations. We have to try to find the right mechanisms to talk to local communities and the devolved Administrations, to come back to an earlier point, making sure that we are regularly talking in Northern Ireland, Wales and Scotland as well.

Q261 Stephen Metcalfe: Is it right you said you were not talking to each individual LEP?

Iain Gray: I said we cannot talk to each individual LEP on a structured basis. How many LEPs are there?

Fergus Harradence: There are 38 or 39.

Q262 Stephen Metcalfe: That doesn't seem to be that big a number to be communicating with—at least to have a communication.

Iain Gray: If you add to that the 140 universities, 100,000 businesses, the trade associations and professional bodies that all want to talk to us, you could spend your entire life talking to people. What we have to try to do is find a structured way of engaging with business—large businesses, SME communities and small businesses. We have some good one-to-one relationships with large businesses; we have the leadership councils that have been established, which are business and Government working together. That helps us engage with the supply chain development. If you look at the SME community, quite often we have to find more local geographic cluster-based ways of talking to communities. We are trying to find the appropriate way to talk to communities. To have a structured relationship which says that on a detailed management basis you are going to build relationships with every one of those bodies is just not a practical thing to do.

Q263 Stephen Metcalfe: You don't think that the work you are doing at the moment is stretching you too thin? You have the resource to do that?

Iain Gray: I think we have the appropriate resource to do the work we have been asked to do. The scale of the Technology Strategy Board to meet the needs of innovation is at the very heart of the economic agenda. We have talked a lot about budget. We do not have the resources to meet what I think the country needs in terms of economic development, and there is quite considerable scope to increase the influence and mechanisms that have been put in place for overall UK benefit, but to match the budget and initiatives we have got there is an appropriate level of resource.

Q264 Stephen Metcalfe: Bearing in mind that budgets are under pressure at the moment—they will not be heading north any time soon in large numbers—you have to use the resource you have in the best possible way. There has been some criticism that perhaps the TSB has been a bit timid in the way it is using its resources. How would you react to that? Do you have a strategy to be able to be bold and innovative in trying to find areas to invest in, and how is that arrived at?

Iain Gray: I have not heard the use of the word "timid".

Q265 Stephen Metcalfe: I use the word "timid". I think Sir Peter Williams tentatively said that you could be a touch bolder.

Iain Gray: Maybe that is a separate conversation I need to have with Peter. What I do recognise and hear is that, in reality, with the resource available to us, a lot more businesses are unsuccessful in their grant applications to the Technology Strategy Board than are successful. With the budget we have got, we have to find better ways of making sure that businesses that are unsuccessful feel they have got something positive out of the engagement and that it is not just about money. We have talked a lot this morning about some of the other levers of Government: regulation and standards. There was a question in the earlier session about Germany and what Germany does. Germany uses standards at the very heart of its innovation agenda. There are a lot of non-financial ways in which we can help business so that the businesses that have been unsuccessful in applying for money can still be very successful in the kinds of things we can do in a non-financial sense.

I don't recognise "timid". I do recognise that there are some tough choices to be made. We have made choices. The reality is that everybody says they are happy that you make choices, but when you make them, sometimes those on the wrong side of that decision are less happy.

Fergus Harradence: If you are to make a reasonable assessment of whether or not you think the TSB is timid, you have to compare it with the situation prior to the TSB's existence, when support for R and D and innovation was run out of what was then the DTI. If you compare what the TSB is doing now with what the DTI was doing five or six years ago, you will see that the TSB has moved to make substantial commitments in new sectors or market areas of activity in innovation and technology that the DTI simply was not engaged in at all. It had a much narrower focus in its programmes. The TSB has developed new mechanisms specifically focused on small businesses, which are intrinsically higher risk than those focused on large companies or consortia. We have more of those programmes, and a higher proportion of the TSB's budget is allocated to SME-facing activities. We are doing work on emerging technologies. Again, this is intrinsically high risk.

Q266 Chair: Does putting those roles at arm's length from the civil service machine mean that the "Yes, Minister" syndrome and risk-averse nature of the traditional civil service mechanism is removed to the advantage of business?
Fergus Harradence: Officially, I couldn't possibly comment.
Chair: Exactly.
Fergus Harradence: The answer is almost certainly yes.
Chair: Thank you very much for being honest.

Q267 Stephen Metcalfe: You would refute that; you are taking risks in some areas, so some of the companies that are successful are exploring new areas.
Iain Gray: I am not sure what Peter was referring to if he used the word "timid". One thing we have deliberately not gone out of our way to do in the first five years of our existence is actively to promote the Technology Strategy Board having done this or that, because for us, what is much more important is what is achieved in business. Five years on, the story of what the Technology Strategy Board has done to support business needs to be told louder and more strongly, and, as we move into what I described as chapter two of the TSB, that is something we will do, but I don't believe we have been timid in the sense of making some difficult decisions.

Q268 Stephen Metcalfe: "Timid" was my word, not Sir Peter's, but it does mean that because of limited resources you have to prioritise; you have to make decisions and choices. As a final point, would making those decisions and choices be easier if there was an industrial strategy for the UK?
Iain Gray: I think the industrial strategy would help provide a framework. What you heard this morning in the first session were two quite contrary views representing different membership organisations. The industrial strategy would very much support the CBI and the large corporates, picking the races that we are in from a UK point of view. I think we have been doing that, working very successfully with the leadership councils of various communities, Government and business working together, but it will help in that framework. How we support smaller businesses is a different dimension from what we are about, particularly in a responsive mode sense. We have to find good ways of supporting the type of community that was talked about this morning, but you heard that we support that in a slightly different way. The answer is, yes, the industrial strategy will provide a clear framework to help us in some of our decision making. It might not help in other ways. We have to use it sensibly.

Q269 Caroline Dinenage: The feedback we have gathered on this Committee seems to show that a big problem is the low level of business expenditure on research and development in the UK. Is there any evidence you have collected that current policies have begun to address this?
Fergus Harradence: The existence of that problem is unarguable; the evidence is very clear. If you look at patterns of business expenditure on R and D in the UK, businesses in this country invest 1.1% of GDP in R and D and the OECD average is 1.6%. Even when you add in public sector investment into R and D activities, it pushes the total investment in R and D in the UK only up to 1.8% of GDP. If you add comparable public sector investment in other countries, it tends to push it up to about 2%. So, yes, there is a relatively low level of investment in R and D in this country, which is explicable through a range of factors, including our industrial structure but also a culture of risk aversion when it comes to investment in innovation and technology development.
As to what we have done to try to address that, over the last 10 and 15 years a wide range of different incentives has been put in place to encourage higher business investment in R and D, as well as increased expenditure in science, research, innovation, HE and skills. We have also introduced things like the Research and Development Tax Credit. There is some evidence that that has influenced decisions within businesses and made them more willing to invest in this area and to build their capability to conduct R and D, or their willingness to engage with universities or other research-based institutions that can conduct R and D for them. The fact remains that we have been increasing levels of business investment in R and D slowly and steadily, but only by degrees. What you have seen is that in competitor countries the same pattern has occurred, so the gap has not significantly narrowed despite 10 to 15 years of sustained investment in this area.
Sir John Savill: From my area, perhaps I may support that with some evidence that Government are taking measures to try to address this issue that are bringing benefit. In the publicity around the decision by GlaxoSmithKline to invest £700 million in Cumbria and two sites in Scotland in biopharmaceutical manufacture, specific reference was made to the Patent Box that the Government have brought in as one of the reasons that the GSK board decided to invest in Britain rather than Singapore, India or the USA. In my area that is one good piece of evidence that benefit is ensuing.

Q270 Chair: To press you on that, is that partly because business sees those developments as transcending political change in Government?
Sir John Savill: I think it sees them as advantageous to the UK.

Q271 Chair: Because they have a life that extends beyond the lifetime of Governments.
Sir John Savill: Indeed, the coalition Government have continued and developed policies that the previous Government put in, so it is really about the UK rather than each particular Government.
Iain Gray: Just picking the example of low-carbon vehicles and the automotive sector, five years ago it was generally believed that we had hollowed out the supply chain in the UK. We were doing a lot of assembly but not very much research. With the advent

of some of the new opportunities arising out of low-carbon vehicles, companies from overseas are now looking to invest their R and D capability in the UK and not just manufacturing or assembly; it is the total chain. I think that gives the stickiness that we are looking for in five, 10 or 15 years out. For me, there is evidence. It is a long-term game, and you have to get the right leading indicators to know whether or not you are being successful in that game, but I would cite that as a good example of where I see a quantum change.

Q272 Caroline Dinenage: To go back to the subject of the R and D Tax Credits, the Committee has had varied feedback on the stimulus provoked by these. One school of thought is that potentially the bigger companies just use that money to invest in the whole of their business expenditure, which is anything from dividends to marketing. Is there any evidence to suggest that if those tax credits were more focused on SMEs it would have greater benefit?

Fergus Harradence: The eligibility criteria mean that large companies cannot claim the R and D Tax Credit against anything other than the eligible elements of their expenditure. There is certainly a higher level of dead weight in the large company scheme—that is, expenditure on R and D that would have taken place anyway, regardless of the public subsidy. However, you have to take into account the fact that, now, almost every country that the UK is competing with economically has some form of tax relief on R and D. It might not be an exact parallel to our own. For example, in France they provide relief on employment taxes relating to people with PhDs, but there is some form of tax relief that relates to expenditure on R and D and aims to reduce that for companies. If we scrap this programme, it would have an impact on our competitive position and ability to attract high-value inward investment and retain high value-added business activities in this country. Given that 20%—or, to be specific, 21%—of all R and D in the UK is funded from overseas, we have to be very sensitive to anything that would worsen the UK's competitive position.

Q273 Caroline Dinenage: Some members of the Committee went to Warwick university, and they raised the issue that, while businesses can shop around for academic expertise, there is not really a facility for academic establishments to shop around for interesting industrial problems to solve. Is there any mechanism by which the TSB can communicate industrial research interests to the academic community?

Iain Gray: That is an interesting observation. In some regard I would link it back to the earlier remark about knowledge transfer partnerships and one-way communication. How do we get good two-way communication? I am seeing good evidence of that. I talked earlier about the N8 Innovation Forum, which is about universities and businesses coming together, with businesses defining the challenges that they are looking to resolve and the universities being able to participate in the potential solutions that exist. We do not have a one-size-fits-all-type mechanism, but there are pockets of very good practice being developed. It is something we need to continue to work at, but I wouldn't say it's not happening; it's something we need to build on.

Q274 Roger Williams: We have heard quite a bit this morning about the Small Business Research Initiative. Do you think it is the right model for the UK, and does it enable small businesses to become sustainable and grow?

Iain Gray: From my perspective, in the last two years we have demonstrated that it is a mechanism that can work and provide demonstrable benefit. It needs to scale up. We heard a couple of times today about the importance of a contract versus a grant. SBRI is a contract and therefore from a business perspective is worth something very significant.

Two things need to happen: one is a scale-up of SBRI itself across Government Departments; the second, going back to the earlier discussion, is about providing a market. SBRI is only the pre-commercial procurement element of procurement. There has to be the next stage. We have to get that right as well for SBRI to be really successful. My answer is, yes, we have a mechanism and it works. Let's now use it and make it work and find a way of scaling it up, but let's also find a way of providing that link into the end procurement market.

Q275 Roger Williams: Does it work best when it involves Government buying directly from small companies or putting a requirement on larger companies to use smaller companies in contracts with Government Departments?

Fergus Harradence: They are really different procurement issues. The aim of the Small Business Research Initiative was always to increase the level of direct contracting done between public sector organisations and technology-based SMEs, and to give those companies the opportunity to win a contract that would help them develop a product or service and take it to a point at which it was ready for market. With a programme like that it is very important that you have that direct customer/supplier relationship. I do not think SBRI would function effectively if you put in an intermediary layer, a large prime contractor, and got it to manage the programme. Interestingly, the evidence from the US with their SBIR programme shows that, where they have tried to use large prime contractors as part of the process and SMEs as a means of developing small parts of much larger projects for which primes are responsible, in general it has not worked very well. You find that these companies are not always attuned to the needs of the prime contractor; they don't see the bigger picture in terms of the scale of the project. I would not want to experiment with SBRI in that way.

However, more generally there is a question to be asked in procurement about whether or not we are effective in managing our relationships with large prime contractors and whether or not we do enough to encourage them to source innovative products and services from UK SMEs that are developing interesting new technologies. That is something we

need to look at through our contracting frameworks and policies.

Q276 Roger Williams: SBRI has not been used in terms of a large main contractor or subcontractor.
Fergus Harradence: No.
Iain Gray: From my perspective, there is real merit in looking at how we build supply chains through large contractors, but it is a different mechanism. Some of the things we are doing are already addressing that, but I would take Fergus's point. SBRI is specifically trying to address the challenges of Government on the one hand but providing the opportunities for direct contractual relationships with smaller businesses that have good innovative ideas but currently do not have a route to market to do it.
The other thing about SBRI is that 900 companies won SBRI contracts. That should be the first port of call for venture capitalists looking at the kind of businesses they should be investing in. That is what happens with SBIR in the States. We need to talk positively about it and about the companies that have been successful in it. We need to scale it up and provide the end market opportunities.

Q277 Chair: If I may give you an example of an event that occurred, can you tell me that because of SBRI it would not happen today? A company developed a GPS-based safety device for health workers working alone in the field. It was a relatively small company, and it was an innovation for them. When the final bit was flagged up on television by the then Secretary of State, Frank Dobson, it was a brilliant little device. When it came to the contracting process, Richmond House knocked back this company as a bidder and insisted that it go to bed with one of the large telecom companies because it did not believe that the company had sufficient financial security to manage. Are you saying that is now something in the past or will those events still occur?
Iain Gray: I said we have a mechanism and that SBRI really works, but we need to find the next stage—those routes to market. Even in SBRI terms, one is moving companies from what was a phase one SBRI contract into what we call a larger phase two SBRI contract and then into a commercial contract with a large spending department. Very few companies have gone that complete route. For me, we need a recognition that SBRI in phase one is all very well. Companies would stand up and say—I quoted Eykona—they would not exist today were it not for SBRI. The number we have taken right the way through that process is still very small, and we need to keep working on that. The outcome is the endgame.

Q278 Sarah Newton: We have been talking a lot about small and medium size businesses. There is a huge amount of effort to try to support them, and there are matters to do with regulation and all sorts of things. To what extent do you think Government is capable of distinguishing between the needs of small technology-based businesses and small businesses generally?
Fergus Harradence: Technology-based businesses have specific needs that they share with other small businesses. Obviously, you want efficient systems for things like managing tax, ensuring you comply with regulations and the provision of basic business information about the legal requirements of running a company and so on. But technology-based SMEs have specific needs related to their ability to access the support available through the innovation system, whether it is specialist advice on issues like design or measurement, intellectual property, or the ability to access funding streams through the Technology Strategy Board, Research Councils, Devolved Administrations or whatever.
We have a pretty good grasp of the needs of technology-based businesses. There are active trade associations; they are engaged in things like the TSB's Knowledge Transfer Networks. We have a fair amount of direct contact with businesses and their representative organisations. There are lots of service delivery organisations. It is not just the Technology Strategy Board but Capital for Enterprise, which supports venture capital investments, the Intellectual Property Office, which deals with IP registration, and bodies like the National Physical Laboratory. All of these have SME-facing outreach programmes of one sort or another.
Iain Gray: Sometimes we try to generalise things by referring to small companies and large companies. Life is more complicated than that. If we are talking about life sciences, cell therapy or aerospace, it is a 10, 15 or maybe even a 40-year game, whereas, when you talk about developing an app for a tourist application, if you have not resolved it in three months and got it to market you are dead, and yet small businesses are involved in both of those extreme sectors. To try to distinguish it by referring to "large" and "small" is to oversimplify the problem. Government has good links in with trade associations and leadership councils on various big picture items, but it is important that we don't try to generalise it as just large and small companies. There are different time clocks for different sectors. Even in the technology area there are different time clocks. We need to be responsive in different ways to those different needs.

Q279 Sarah Newton: From the work that you do, is there a perception in Government that the special needs you have talked about of technology companies, which undoubtedly are there, are properly recognised and valued? Is there a perception that the companies are worth giving this much support because they have a special place in the economy, or do they just have to compete alongside all the other types of companies?
Fergus Harradence: We have a lot of forms of support that are accessible only to technology-based SMEs. All of the grant support programmes of the TSB are not a generic tool for giving money to small companies. Only a relatively small proportion of the small company base—the ones engaged in R and D activities—can access them. Similarly, a lot of the investment funds that Capital for Enterprise puts money into are focused on supporting technology-based businesses. For university spin-outs, you have the Research Council funds, the universities' funds and the Higher Education Innovation Fund. These are

all targeted on technology-based businesses. We are expecting new initiatives like the Growth Accelerator, which is a mechanism BIS has put in place to deliver support to companies with high growth potential. One of the target groups for that will be technology-based SMEs as well as SMEs in other sectors that have growth potential. Yes, we do recognise and value the fact that these companies are an important part of the UK economy.

Chair: Gentlemen, thank you very much for your contribution this morning. That has been extremely helpful.

Wednesday 12 September 2012

Members present:

Andrew Miller (Chair)

Caroline Dinenage	Stephen Mosley
Jim Dowd	Pamela Nash
Gareth Johnson	Roger Williams
Stephen Metcalfe	

Examination of Witness

Witness: **Rt Hon Mr David Willetts MP**, Minister of State for Universities and Science, gave evidence.

Q280 Chair: Minister, thank you very much for coming this morning. I know you have another engagement shortly and other Members here are keen to be in the Chamber on time, not just for Scottish questions but for the Hillsborough statement and so on. It is very important business.

You know the terms of reference of this inquiry. We have taken some fascinating evidence over the last couple of months on this. Of course the Department is continuing to evolve the story, including with Vince's statement to the House following the Urgent Question on Monday and his speech yesterday.

I want to start with the statement that he made on Monday. There was considerable reference by several Members of the House to the role of the Technology Strategy Board, a body that has the wholehearted support of this Committee. Can you confirm that it is the policy of the Department for Business to allow the Technology Strategy Board to expand in the future so that greater support can be given to the kind of businesses that we have been talking about, either through the Catapults or the other mechanisms that Iain Gray and his team are responsible for?

Mr Willetts: First of all, thank you very much for the opportunity to answer your questions on this very important subject. You are right that the Technology Strategy Board is absolutely crucial in bridging the so-called valley of death. We of course inherited it from the previous Government and have been very happy to support and sustain it.

Q281 Chair: That is the Technology Strategy Board, not the valley.

Mr Willetts: Yes; the Technology Strategy Board. BIS's policy is to deliver our objectives within the framework of agreed public spending totals, but we recognise that many TSB programmes are oversubscribed. I get complaints from individual constituency MPs, when they have some horror story of a small business that has applied for funding, which has looked eligible for funding under Smart awards or something. TSB's problem has been that, although the small business has a great case, there just are limits on the amount of money it has to spend. Any organisation, but certainly the TSB, could always spend more money. What we are trying to do is to get absolutely the maximum bang for the bucks it has at the moment.

Q282 Chair: Do you agree with the point that I made to Vince Cable on Monday that, whilst it would be desirable to see the TSB expand, it should not be at the expense of the Research Councils?

Mr Willetts: Absolutely. The science ring-fenced protected budget is there as a protected budget. We made a cast-iron commitment on that and that has to be protected.

Q283 Pamela Nash: Minister, over the summer recess I spent a lot of time meeting with my local small businesses. One of the main issues that came up was that they have to risk a lot of their own finances when trying to bring new products to market. Even when they did get public funding, that was often matched funding and therefore they were still putting themselves at a lot of risk. Is reducing the risk of investors and small companies something that is considered in your Department when policy is being made?

Mr Willetts: Yes. If we can help small companies in that way, we will. A lot of small companies say to us, "Please will Government get out of the way?", and they are perfectly entitled to take that view. We are not trying to encumber them unnecessarily, but where we can work with them, both through advice and perhaps financial support—my right hon. Friend the Secretary of State is particularly good at this—and cajoling the banks into lending again, we are up for that, yes.

Q284 Pamela Nash: In terms of Government funding to small companies when grants are being given, is how you can reduce the risk for the company something that is being looked at in the future?

Mr Willetts: Yes. The kinds of schemes that I am particularly a great admirer of are the Smart awards, which we have brought back under their original name. They are start-up grants for companies that have a great new high-tech idea. Michael Heseltine originally set them up. Then they became one of the RDAs' responsibilities, and it is true to say that some RDAs were better at that than others. We brought them back as a national brand administered by the TSB. They are a great way of helping small companies.

Indirectly, we have also tried to get more flows of venture capital funding into small businesses. There is a question about how the venture capital business model develops in the future. We put in co-funding but the venture capital fund makes the decision. There is £300 million or £400 million of extra public money that has gone in to ensure extra funding for venture

capital, which they in turn can invest in small businesses.

Q285 Pamela Nash: We heard evidence that clusters are a way that companies help to reduce and spread the risk for them. Do you feel that the Government have a role in encouraging and supporting clusters, and how might you do that?

Mr Willetts: Clustering is a very fruitful way of thinking of all this. The economist's definition that I find most helpful is to say that clusters are a low-risk environment for high-risk activities. If there are lots of different companies in the same business sector, if you lose your job with one you have a greater chance of being able to pick up a job with another one without having to uproot your family and all that. We are trying to support them. There are some identifiable clusters around Harwell, Norwich and Daresbury, where there is a clear pattern of investment by us. That is one thing we can do.

A second thing that I have been very keen on and where we have seen the rules improved is that Research Council funding rules used to be pretty restrictive. An individual institution got the funding. We have tried to liberalise the rules a bit. If there is a network that has come together, and it could be a network of universities like N8 in the north or a shared project like the Imanova project out in west London in which UCL, King's and Imperial have come together, I think I have succeeded in getting the rules liberalised so that they will fund those types of shared projects and not just an individual institution.

Q286 Pamela Nash: Finally, as you mentioned, red tape is something that small businesses in particular usually struggle with, especially when it comes to regulations on health and safety, though they are often necessary. We heard evidence about the German model, where the Government take responsibility for issues for small companies such as electrical safety. That has been found to be very helpful. Are the Government looking at perhaps having certain regulations relaxed for a small company?

Mr Willetts: Yes. It is true to say that, in BIS, we were intrigued by this point made in an earlier evidence session. We didn't quite recognise the description of the German regime. Of course, the trouble is because it is such a federal system it may even differ from Land to Land. We weren't clear that the Länder were all quite willing to take on as much of the liability risk as was implied in your evidence, but I would undertake already something useful that has come out of your earlier inquiries. We have flagged an issue that we should do more work on to try to understand this German system, though as I say, we are not necessarily sure that the earlier evidence absolutely matches our understanding of how it works. But we will undertake to look into it further.

Q287 Chair: But it is the Government's position—correct me if I am wrong—that changes in health and safety, for example, are not intended to be at the risk to people? It is about process rather than removing necessary safeguards.

Mr Willetts: Yes. Sometimes some of the regulations have been cumbersome and perhaps excessive for people running an operation single-handedly out of the front room of their house. The German issue was particularly about measurement and assessment run by these regional centres that they have. We think that ultimately in Britain companies have to take responsibility for that. But, if there is something that they are doing better in Germany than we are here that we can learn from, I am absolutely up for learning from them.

Chair: We can move on to the Government as a lead purchaser—the customer.

Q288 Roger Williams: Because of the sheer scale of the Government purchase in the economy, both in terms of goods and services, by default that has an effect. The message that the Secretary of State has been trying to put out over the last few days is that, if that was better focused and structured, it could be a greater force for good in the economy than it is at the moment. BIS apparently will be the lead Department in trying to get that better focus into other Departments in terms of their procurement and purchasing. Do you think that BIS, you and the Secretary of State will have that effect in Cabinet to alter the purchasing decisions of other Departments?

Mr Willetts: I think we can. Obviously we will work with other Departments. One of the main messages in the industrial strategy, which is a point that Michael Heseltine has made in public and in private advising us, is that a lot of these industrial strategy issues can only be delivered by the Government as a whole and not by BIS on its own, but working with other Departments. In terms of procurement we work particularly closely with the Cabinet Office, which has important responsibilities here.

In my own area, life sciences is working very closely with the Department of Health on trying to ensure that the NHS becomes much more innovative in its approach to procurement. Of course the Innovation, Heath and Wealth report was published as part of the life sciences strategy last year. That is an example. So, yes, we are committed to using procurement to drive innovation.

Q289 Roger Williams: Perhaps you could expand on that a little bit in terms of the NHS and biomedical science in the UK. How does that actually work in practice?

Mr Willetts: One of the criticisms you sometimes hear from companies is that they have gone through an elaborate NICE assessment procedure and have passed all the hurdles—they may have a new drug or a new piece of equipment—but then they find they can't sell it into the NHS.

One of the proposals now as part of our life sciences strategy is that, in future, if identifiable and excellent innovations are not being purchased and used in individual healthcare trusts, there should be a budgetary penalty; and we have identified a first list, which includes everything from getting someone who has serious disabilities a wheelchair in a day through to a new heart monitor via the oesophagus, which has scored very highly as a cost-effective way of

monitoring people's heartbeat during operations. Some of their budgets through the CQIN procedure will be deducted unless they can show they are adopting these innovations. It is an attempt to push innovation through the health care system.

Q290 Roger Williams: One of the biggest Government Departments that has had criticism about its procurement is the MOD. How is BIS working with the Ministry of Defence? They have already said it is their intention to improve.

Mr Willetts: The MOD, for example, have been a significant user of the SBRI programme and have run 47 of these competitions in SBRI. That is an excellent way of driving innovation; so they are trying to play their part.

Q291 Roger Williams: In terms of the SBRI, one of the criticisms is that it helps small companies to bring products or services to a certain stage, but the carry-through or taking that on has been lacking. Does BIS have any ideas of how that could be improved on? The SBRI is seen as a good programme, but it just needs that extra in order to make the most of the investment.

Mr Willetts: Yes; that is a very interesting thought. I am not directly involved with that particular programme but I will certainly pass that comment back if there is something there we can learn from.

I will be frank with the Committee. We have talked about Health and Defence. The whole Bombardier episode was a bit of a wake-up call. I have to say that Bombardier was conducted within the framework that we had inherited and we all have to comply with EU rules. Post-Bombardier there has been a major exercise across Government as to how we run procurement. One of the lessons we have learned is to improve transparency on procurement, to be more open and to publish more evidence of what we are planning to do in the future. Indeed, in April, Vince Cable and Francis Maude published £70 billion of potential future contracts over the next five years to help people get sighted on what was likely to be procured in the future.

Q292 Roger Williams: It is two and a half years into this Parliament. Can you point to really significant changes that BIS have been responsible for in procurement across Government?

Mr Willetts: As I said, I would notch up as achievements a much more explicit sharing with industry of our plans for the future procurement pipeline. It is work in progress but we are already doing a lot. Secondly, there is a shift in the attitude of the NHS driven by the life sciences strategy. I would count those as two successes.

Q293 Chair: Can I just push you a little further on the framework for procurement? I don't know where you took your holidays, Minister, but had you gone to France you wouldn't have seen a police car that wasn't built in France. The four north-west police authorities here have now procured Kias, entirely built outside the EU. We are not accusing the French of being in breach of the procurement rules; they have just used them more smartly than we have. Why don't we? Don't you feel frustrated that major public procurement doesn't use the rules that are available in a wise fashion to protect British interests?

Mr Willetts: I do believe in free trade and BIS believes in free trade. All of us, especially Stephen Green, but Vince and me as well, spend a lot of time on trade missions. We go to other countries and try to persuade them to procure products that we have made here. We have to be very careful of protectionism.

As I say, that is why our approach has been information in advance and sharing our future plans. A police force is entitled to procure the equipment that will best enable it to discharge its public function. In the long run British businesses need the competitive challenge of winning in a competitive environment. If we can be smart, as you rightly say, about indicating where we are heading so they don't suddenly have a bolt from the blue of procuring a new type of police vehicle, whereas if only they had known a couple of years in advance they could have retooled and been ready, we can do that. Ultimately, open procurement is in our own national interest.

Q294 Pamela Nash: Minister, I also believe in free trade, but some of the companies in my constituency have told me that they are competing with companies in the rest of Europe that have Government subsidies in their sector or countries that might have much lower salaries or rights for their workers. Is it fair that companies in Britain have to compete with companies that are not looking after their staff and have ways and means of getting the bottom line down that we might not find acceptable?

Mr Willetts: These are deep questions now about trade policy. Again, as a free trader, I think it is in our national interest to be free trading, even if we are in competition with countries that aren't as free trading as we are. In the long run it is in our own interests.

Going back to the original example, I would argue that the British automotive industry is a great success story. As you know, this year, after all, we are net exporting for the first time for over 30 years. I just wonder, Mr Miller, if it is just possible that some of those cars that you describe as being French cars might not have been made, at least to a significant extent, in a British factory and had a French badge put on them before they arrived on the French market. I don't know; it's just possible.

Chair: I will test this. I think you will find that, in both France and Germany, my example will hold out pretty well and none of them will have cars from that far afield. Anyway, we will move on.

Q295 Stephen Metcalfe: I am sure you are aware of the Stevenage centre, which is a collaboration among academia, the biotech industries and pharma. It is based around one large company but to support lots of innovative small ones. Do you and the Department see that as a particularly pharma-based experiment, or do you see it as a template that could be rolled out for other sectors across the economy?

Mr Willetts: I have been there and it is a very exciting initiative. It reflects a big change in the culture of the life sciences industry away from just having great big

in-house research facilities and moving to what they call more open innovation, collaborating with external companies, creating an environment for SMEs to flow. It is very exciting. That industry can go a lot further in that direction.
Perhaps one of the themes that may emerge from your inquiry, as several witnesses have already said, is that these issues do vary sector by sector. It is hard to pick up a model from one sector and apply it elsewhere. The reason why the Stevenage experiment is so interesting is because it is novel for the life sciences sector. I don't feel confident enough to say whether that exact model could be deployed elsewhere, but one would hope so.

Q296 Stephen Metcalfe: I take it from your answer then that the Department is not encouraging any other large companies to establish similar sorts of set-ups in different sectors?
Mr Willetts: We are, in general, believers in the model of open innovation. Where we have a direct policy role, I say to universities, for example, that there are many ways they can raise their performance on innovation rather than simply counting the number of patents and thinking through IP. Open innovation is certainly something I want to encourage in universities. Initiatives such as those at Glasgow University are very welcome. If the Committee has observations on areas where you think legitimate public policy can do things, without intruding into genuine commercial decisions, we will look at that with great interest.

Q297 Stephen Metcalfe: You have said before to this Committee that the UK economy lacks mid-sized companies that have the ability to leverage up our research base. What are the Government doing to try and resolve that problem and help smaller companies grow into the medium-sized companies that our economy seems to benefit from?
Mr Willetts: There are medium-sized companies, and we have launched a Growth Accelerator scheme that is aimed precisely at helping those companies. A lot of it is essentially extra advice and assistance. It is to help them, for example, plug into the services of UKTI as they first get into exporting. Not enough of our medium-sized companies are big players in export markets. We can help them there and provide them with assistance. That is one area.
Another area, to be frank, is whether they need help in improving levels of management training. A company may need a bit of help upskilling their managers for the wider responsibilities they have. That is what our Growth Accelerator programme is all about.

Q298 Stephen Metcalfe: Is that based on you identifying companies and contacting them to say, "Are there things that we can do to help you?", or do they have to come and search for this particular advice?
Mr Willetts: We are publicly advertising this programme, but we are particularly working through chambers of commerce, LEPs, the IoD and CBI. We encourage them by saying, "If you know of a company, perhaps already heading from small to medium size and growing quite fast, that you think could benefit from the Growth Accelerator, do put us in touch."

Q299 Stephen Metcalfe: How much do you think finance is a barrier to growing a business at that point? Do you still see that as an issue—that banks are not willing to take that step-change risk of a small successful company trying to upscale to a mid category?
Mr Willetts: Sadly it is a constraint. I know all the problems that banks say they have. My right hon. Friend, the Secretary of State, has this as his special subject on "Mastermind". He is really the person who has been heavily involved in all this. Yes, there is a real problem with bank lending. It comes in lots of forms. One of the forms that particularly worry us is the collapse of local banking and the withdrawal of discretionary expertise at the local bank level.
If you are a large company, you can negotiate a major facility for hundreds of millions of pounds with people at head office. If you are an SME that wants to call at your local branch to have a grown-up conversation about finance for working capital as you have a new set of export orders, it is a real problem whether there are local staff who have local knowledge and discretion to lend you the funding in those circumstances. That is a real problem and it is why one of the coalition's priorities is to break down the barriers to new entrants into banking. We hope some of these new entrants—the Co-op or whatever—will revive those traditions of local relationship banking.

Q300 Chair: I wouldn't call the Co-op a new entrant. They have been around a year or two. Just on that, Lloyds Bank told a seminar organised by Dods recently that they have developed a programme in partnership with Warwick University to get their managers at least up to some speed in terms of knowledge of engineering. Do you think that programmes like that need to be encouraged in the banking sector?
Mr Willetts: Yes, definitely. I wasn't aware of that particular initiative but that sounds excellent.

Q301 Gareth Johnson: Minister, I want to take you back to the EU State Aid rules. Sir David Cooksey, when he gave evidence to us, said that in this country we often wait for State Aid approval before promoting UK technology abroad, whereas in other countries they got on with the job and then worried about it if Brussels contacted them and said they were doing something wrong. Do you think that is an accurate depiction of the current situation?
Mr Willetts: We are certainly aware of State Aid rules. There are lots of meetings where you think you are making great progress until someone says, "Ah, but remember EU State Aid rules," and we do have to comply with them. You say these other countries just get on with it and wait to be challenged. Of course, they can find that down the track they could face a pretty hefty fine and have to repay large amounts of money. Going ahead and then waiting to see if anyone challenges you is itself quite a risky approach. But we

are aware of the rules. We do work within them and then try and move as fast as we can.

Q302 Gareth Johnson: Have we had any pretty notable successes in promoting British technology firms abroad by taking that approach?

Mr Willetts: Perhaps it is because of David Cooksey's particular expertise in life sciences. I think one of the suggestions was that the Biomedical Catalyst arrangement linking MRC and the TSB had been held up by State Aid rules. I checked this when I read that this was one of his concerns. All I can say is that we believe we moved as fast as we could. We were aware of state aid rules, but the rule of thumb is that upstream Research Council science spend is exempt from State Aid rules, and with a lot of the TSB intermediate funding you can't go above 50% support. That is the sort of State Aid framework, and we try to work within that so we can act as quickly as possible. The framework of State Aid rules is basically a good thing. It is to ensure that the single market is a genuine market for competition. It is not an upward auction of subsidies being offered by different EU countries. That is something that we think is a good part of the framework of the single market, so we do try to comply with the State Aid rules.

Q303 Gareth Johnson: Do you think there is anything that we should be doing better within that framework in this current situation, or do you think we have to break out of the framework to do better?

Mr Willetts: Again, I would be interested in the Committee's advice. One of the areas where we have got smarter is that sectoral support is much easier to do than individual business support. It goes back to the point that Mr Miller, the Chairman, was making at the beginning. If you look at something as a broadly-based initiative—and I would welcome that because I think it is the right approach to industrial strategy, not trying to pick particular businesses—you can get much further if you back a technology or research programme of a range of applications that can be drawn on by a range of companies. That is much less likely to hit State Aid constraints than if you want to write a cheque to an individual firm. We do try to comply with that and it probably pushes us in the right direction.

Q304 Caroline Dinenage: As you know, we have taken evidence from quite a number of people over the last months. The strong message coming through from entrepreneurs is that, while there isn't a recession in technology, it is increasingly difficult to get funding for technology companies. I know that the Business Secretary in his announcements this week said he would look at what the press are calling a business bank—the idea of lending to businesses.

One of the things that we have been told by entrepreneurs is that recent regulations have led to pension funds and insurance companies greatly reducing their investments in the UK equity markets and that then drying up funding exchange for businesses. Will the Government address that problem alongside their efforts to increase bank lending?

Mr Willetts: Yes. This is something that John Kay's report touched on as well. If there are ways in which regulations have impeded that kind of long-term investment, we would be willing to look at it. John Kay's report did not come up with a list of detailed public policy interventions. He was really after the City to have a cultural shift and think more imaginatively about the case of long-term investment, but if there are things we can do there we would happily look at it. As I said earlier, we have tried to put in extra funding of over £200 million to reinforce venture capital investment, which is a really practical way we can help. We have maintained several venture capital programmes that way.

We have also put another £50 million into an angel investor co-fund. If you look at America, one of their great advantages in getting those kinds of investments is the angel investor community. For the first time we have now said we will co-invest alongside angel investors.

Q305 Caroline Dinenage: I want to ask you about R and D tax credits, because that is something we have spent a lot of time talking about. The feeling of the witnesses we have spoken to was very much that they tend to have a disproportionately positive effect on smaller and medium-sized businesses than they do on the large ones, where they get swallowed up in their finances. We have been told that banks have received more from R and D tax credits than even GlaxoSmithKline and Rolls-Royce. Do you believe the banks need an R and D tax incentive, and do you think that in some way maybe there is a possibility that R and D tax credits have been used as an incentive, or even a bribe, to businesses to stay in the UK?

Mr Willetts: I wasn't aware of the banks being such beneficiaries of the R and D tax credit. You are tempting me to engage in a bit of banker bashing. If they have a legitimate claim for R and D tax credit I wouldn't stop them, but we have tried to improve the R and D tax credit regime both by increasing the total amount of the relief and making it available above the line. Now, the value of the R and D tax credit for small companies is very substantial indeed. I should have mentioned it earlier but it is a very important part of the offer. The above-the-line treatment will help them enjoy the benefits of it even if they have not yet moved into profit.

Q306 Caroline Dinenage: Given that the Government have provided banks with money to lend, one of the things I have very much come across when I have visited banks and asked them where the difficulty is in lending to businesses is that they have said that directors of small companies need to be prepared to put their houses on the line and they need to be able to put as much sacrifice into their own companies as they are expecting from the banks. What are your thoughts on that? What are the percentages that should go into supporting businesses, particularly technology companies, who might be investing in R and D for something which may take a long time to come to fruition?

Mr Willetts: We do hear these types of concerns and you do hear horror stories where the bank is making a relatively small investment and then immediately wants to take the first claim on someone's house. The purpose of our initiatives is to get banks to lend more at lower cost without making their requests for security any more onerous. Their requests for security should not become more onerous. If anything, they should maintain whatever they would have done anyway or be less onerous. That is the whole purpose of trying to lower the cost of banks' access to wholesale funding and other initiatives. If people show that the banks' terms have become more demanding, we would certainly take that up with the banks. That is not intended to be the way that our schemes work.

Q307 Caroline Dinenage: Do you think there should be a percentage breakdown between how much banks are prepared to invest and how much small company directors are prepared to put up as guarantees as well?
Mr Willetts: I am a bit wary of the Government setting a rule on that. It is part of this breakdown of the corporate lending relationship. Banks have got very bad at project lending. If there is an asset, including your owner-occupied house, that is all right, but assessing and lending on the basis of a project is a skill that, as I say, the banks on the west coast of America have because they are used to that type of lending. I think our banks have lost that capability unless it is a very large project indeed. Your underlying point is correct that the banks need to get back to exercising judgment of lending on a project. That requires a bit more judgment than sending round a valuer to assess the value of someone's house, but the revival of that form of bank lending is very important.

Q308 Jim Dowd: I want to follow up on that point. You say banks have lost that. Are you sure that British banks ever had it? The reason you say that on the west coast they have this skill is because it is assessing intellectual property rather than physical goods. I don't think British banks have ever been particularly good at that. If you can't count it or scratch glass with it, they are not really interested. It is a lack of imagination and a lack of understanding.
Mr Willetts: Thank you very much for that, because I want to clarify one point. Let me read out a particular point I should have made when answering the previous question. These are the rules particularly for the Enterprise Finance Guarantee Scheme. That is where we are engaged ourselves directly in the lending. "Lenders are allowed to take a personal guarantee from borrowers under EFG, as they would under commercial loan schemes. However, lenders must not take a charge on the principal private property." That is one of our rules for the EFG. It then goes on: "As EFG loans are for businesses lacking sufficient track record or collateral, and the rate of defaults is much higher than normal loans, we have a cap on claims at 20%, which is 10 times larger than on normal loan portfolios." I am grateful for the opportunity to clarify that. We have that specific rule for that loan guarantee scheme.
On your wider point, yes, the experts tell me about the so-called "Macmillan gap". I don't know how many reports there have been in the course of the twentieth century about problems of getting bank lending going. As I said, if anything, the loss of local discretionary bank managers has made things worse, not better.

Q309 Jim Dowd: I have a couple of brief questions on the relationship between universities and business. We have received evidence from the SME Innovation Alliance that they feel this relationship is too heavily skewed in favour of the priorities of universities rather than the interests of innovative business. Given that all human relations and activities can be improved in any circumstance, how do you view the relationships between business and universities?
Mr Willetts: I think it is getting closer. Indeed, the most recent World Economic Forum competitiveness report showed university and business collaboration on R and D as one of our strengths compared with our competitors. So we are making progress. We have a programme—again it goes back to the previous Government—of Knowledge Transfer Partnerships. You mentioned human relationships. You get the time of a post-graduate student helping a company tackle a problem. I am encouraging Technology Transfer Offices to think of their role more broadly than just counting up patents and selling IP. I want them to have a broader sense of their relationship.
One thing that does concern me is that perhaps in the past there was a kind of target culture when notching up patents was the priority, especially as universities and researchers do sometimes exaggerate the starting value of their discovery and underestimate the value added by the commercial development of the discovery. Sometimes you can have a dialogue of the deaf in a negotiation where the university sits and thinks it has high value for the IP they have, whereas the commercial entrepreneur thinks that is exaggerated. There are areas where we can improve here.

Q310 Jim Dowd: The thrust of the evidence we have received is that universities tend to see business activity almost wholly through the spectrum of their own spin-offs rather than augmenting and adding value to current commercial activity. Do you see that?
Mr Willetts: As I say, the idea of Technology Transfer Offices and universities having some IP was a good idea. We probably ended up with that getting exaggerated attention compared with these wider relationships. We are trying to broaden those connections through maintaining knowledge transfer partnerships, through the innovation voucher programme, which encourages SMEs to turn to a local university to help solve a particular problem, and through doctoral training centres where more and more people getting a doctorate have business experience as part of their doctoral programme.

Q311 Jim Dowd: On that point, do you think practical business experience ought to count for something in the way that published documentation does when assessing lectureships or professorships or whatever it might be?

Mr Willetts: I respect the autonomy of universities. One thing I do accept is that, when it comes to people making an academic career, sometimes they say, "If we go into an R and D lab of a company for five years and we research for the company, and in that time we are bound by commercial confidentiality and they don't want us to publish articles in learned journals about what we are doing, that looks like a dark age in our CV." It looks like you have not generated anything for five years. I have had this discussion with some of our leading companies, who have realised that if they want to get academics over to work for them they have to provide vehicles in which the academics can show their research activity during that time. We can probably do better at valuing that as part of an academic career.

Q312 Jim Dowd: What about the other way round and getting business people into academia?
Mr Willetts: Yes, I am up for that. One area where I think we could do a lot more particularly is in business schools with business studies. There is a review of business schools under way now. I am hoping to do a serious speech setting out the issues on this next month. I do think that business schools are an obvious way in, but I have anecdotal evidence as a minimum of people with a business background who want to join a business school then being told, "The policy of this university is that all our staff doing any teaching should have a PhD. You have joined our business school at age 45, having built up a business for 20 years, and now you need to get a PhD for us to accept you as a member of staff of this university."
To me, that does seem to rather miss the point of businesses. There may be obstacles like that. Again, I don't want to send out an instruction; it is not how I like to approach our universities. We do need flexibility so that people with a business background can be respected in academia without necessarily meeting those types of requirements.

Q313 Jim Dowd: Finally, there is a general presumption that knowledge transfer takes place automatically from universities to business. Are you satisfied that that really does happen consistently?
Mr Willetts: I think we can do more. Often a large local university is the biggest single R and D resource in an area. You know that in that university there are staff in the IT department or in a range of departments who should be seen as a resource for the local business community and are up for being the local business community. If there was an SME that needs the use of a piece of equipment that it could never afford to buy and operate 100% itself or needs some expertise to solve a particular problem around a particular new material or something, the university is probably the best place for them to turn to. They don't turn to the university as much as they should, and that is one of the reasons we commissioned Tim Wilson to produce his report. Innovation Vouchers are a great way of breaking down those barriers and things like a single point of contact with the university. There are still too many SMEs within 10 or 20 miles of a university who may not have set foot in that university and thought about how it can help them grow their business. Yes, there are still barriers to break down on both sides.

Q314 Chair: I want to press you further on your comments about business schools. Would you see that as a vehicle by which we would end up with more scientists and engineers in the boardroom because of the capacity of universities to provide some business training to scientists and engineers?
Mr Willetts: Yes, I do. Again, I am not going to prescribe to universities how they construct their courses, but you observe it in America where they have this feature of the major and the minor. Your chances of doing a physics degree but also doing some business studies or some law alongside it are much greater. One reason why we have committed ourselves to supporting an enterprise society in every university is because I think every undergraduate should have the opportunity, if they wish, of some kind of experience and engagement with business in the course of their studies.

Q315 Chair: The Government have drawn extensively in the past on the views of James Dyson. He made a very interesting series of comments last week that I am sure you are familiar with. Do you subscribe to his views about the need to give greater support to engineering students in universities? If so, how are you going to do it?
Mr Willetts: We are of course all great admirers of what he has achieved. Incidentally, his company's commitment to R and D is excellent. When it comes to higher education policy, he seemed to be afraid that our excellent new higher education regime would put people off from studying engineering. Of course students don't pay up front, and the evidence is that the information we have been releasing on employment outcomes from particular courses at particular universities means that applications to do STEM subjects, if anything, are doing disproportionately well. We always need to do better, but there was a fear that people would be put off from STEM subjects as a result of higher fees. The evidence does not suggest that fear has come to pass.

Q316 Chair: So you don't subscribe to his view that we should subsidise engineering places.
Mr Willetts: As nobody has to pay up front to do engineering and you only pay back if you are earning more than £21,000 a year—

Q317 Chair: So you don't subscribe to it.
Mr Willetts: No; I don't agree with him on that point.

Q318 Stephen Mosley: We have had some positive feedback about the Patent Box. Last week we had Tim Crocker from the SME Innovation Alliance, who told us that patents were only valuable to small companies if they went on to sell that company to someone else. His reasoning was that, if a small company holds a patent that gets breached by someone else, it is prohibitively expensive for them to defend that patent. I think he went as far as to say that it was almost not worth that company having the patent. Do you subscribe to that, and what do you think can be done

to give greater protection to small innovators and small companies?

Mr Willetts: That is a concern of small businesses and it is a long-standing concern that I recognise. I don't know whether there is a particular link to the Patent Box. The most conspicuous effect is the GSK decision on investment back in the UK, but, again, the Committee may have suggestions. I am not aware of any specific proposal for further helping companies or protecting their IP. If the Committee has any proposal in that area, I would happily consider it.

Q319 Stephen Mosley: One thing that was suggested last week was that apparently a number of European countries have criminal sanctions for people who knowingly breach patents. The suggestion was that you could introduce punitive damages. Would they have any benefits?

Mr Willetts: There has been some improvement in the Patents County Court. In terms of companies getting protection through law, we have tried to lower the costs for them of protecting their patents through the legal system. We have also tried to help provide alternatives to court action, including hearings before the IPO tribunal or using the IPO's mediation and patent opinion services.

I could not talk about punitive damages. That is where the Justice Department is in the lead about what kind of penalties there should be. If the Committee has proposals on that, we will obviously draw them to the attention of the Justice Department. We have responsibilities for IPO and we have tried to make patent protection, so far as it is our departmental responsibility, a bit easier.

Q320 Chair: Minister, we have covered a lot of ground today. I don't know if you have any closing thoughts that you would like to leave us with. This is a very complex area where there are strongly held divergent views about where the solutions lie. What would your magic trick be?

Mr Willetts: I look forward to the Committee's report. My final observation would be that we have, in Research Councils and the science budget, a very effective upstream research activity. In the TSB we have the body that does the next stage. Some countries have a different model. In America it is the National Science Foundation and the National Institutes of Health, which of themselves go closer to market. I don't think we need to copy the American model. We have our own structure, which we have inherited, and we don't want to change it.

The interesting example is the MRC/TSB link in the Biomedical Catalyst. If there are ways within funding constraints and if there are some other areas where we can similarly link up some Research Council funding and some TSB funding in a particular area, I see the Biomedical Catalyst as a potential precedent. As I said, it can't be applied uniformly in every single sector, but if there are some other particular sectors where that model could be applied I would be very interested to see them.

Chair: Minister, thank you very much for your attendance this morning.

Written evidence

Written evidence submitted by the Department for Business, Innovation and Skills

Introduction

1. The Government recognises that knowledge and innovation are the keys to growth in a developed economy. Government stressed the importance of the UK's knowledge base, and the opportunities it provides for innovation, in the recently published Innovation and Research Strategy for Growth.[1]

2. The commercialisation of research is economically important, as it is one of the activities that drives innovation in the economy. Evidence shows that innovative companies, defined as those that have introduced a new product or process, grow nearly twice as quickly in terms of both employment and turnover as non-innovators.[2]

3. The Government recognises that to succeed in the global innovation economy we must maximise all of the benefits from research. Economic and social impact of publicly funded research is delivered through a range of mechanisms rather than a single channel. These mechanisms include:

- delivering highly skilled people to the labour market;
- developing new businesses;
- improving the performance of existing businesses;
- improving public policy and public services; and
- attracting foreign direct investment in R&D from global businesses.

Examples of these mechanisms can be found at Appendix A.

4. The commercialisation of research is a complex area. Government plays an important role in investing in a range of mechanisms to stimulate both the supply and demand side—through incentivising both the research base and business to work together to drive innovation.

5. There has been much discussion about spin out companies and the intellectual property generated by the commercialisation of research, but these activities represent only a small part of university-business relations. The external income generated by Higher Education Institutions (HEIs) from engagement with business and community is at an unprecedented level, having more than doubled in real terms since 2001 to £3 billion. The majority of this income is generated by collaborative and contract research, consultancy, and the provision of professional training, which are the main routes by which knowledge generated by the research base is commercialised. Income from licensing and sales of shares in spin-outs accounts for only around 2–4% of total income per annum.[3]

6. The Government recognises that the provision of funding for research is UK-wide. We will work closely on these matters with the devolved administrations, who offer similar support for the commercialisation of research in other parts of the UK. The UK Government's key partners in this area—Research Councils UK (RCUK) and the Technology Strategy Board (TSB)—will each be submitting a separate memorandum to the Committee, as will the Higher Education Funding Council for England (HEFCE).

7. Professor Sir Tim Wilson is undertaking a review for Government of university-business collaboration. The Committee may wish to consider his recommendations, which are expected to be published before Easter.

Question 1—*What are the difficulties of funding the commercialisation of research, and how can they be overcome?*

8. The ability to support the translation of scientific research into new products and services depends on the capability of the public and private sector research base and innovation system. This system needs to support a range of processes, that bring together specific knowledge, skills, technical resources and financial capital, to solve specific problems or exploit opportunities at different stages of the innovation cycle. There is a strong case for the public sector investing to incentivise and drive innovation. The evidence suggests that this delivers a significant return to the taxpayer (see response to Question 4) in terms of both supporting economic growth and employment creation, and through other benefits such as increasing demand for higher levels skills of the improved environmental efficiency of products and processes. However, there are a range of market failures in relation to innovation, and public sector investments play an important role in mitigating these.

9. Commercialising research requires investment in scientific research, proof of concept and proof of market activities, investment in R&D or in establishing spin-out companies, support for demonstration activities to prove technologies work, and investment in design and other areas that help develop and refine products and services for the market. Support for all of these activities is necessary for successful technology

[1] *Innovation and Research Strategy for Growth,* Department for Business, Innovation and Skills, 2011. www.bis.gov.uk/policies/innovation/innovating-for-growth

[2] Innovation Index data, the National Endowment for Science, Technology and the Arts (NESTA).

[3] Higher Education Business & Community Interaction Survey www.hefce.ac.uk/econsoc/buscom/hebci/

commercialisation; while necessary, research strength alone is insufficient. If an innovation system is unable to do this, and is not adequately integrated, then it poses a significant barrier to innovation.

10. There are a number of established market failures in relation to innovation, relating to the ability to access funding, identifying potential collaborators and in the provision of information. These have an impact on the level of investment companies are prepared to make in R&D, or other forms of funding such as venture capital, that supports technology commercialisation. The market failures arise from the inherent risks that technologies will not work, or work less well than anticipated, and the financial risks associated with long term and complicated technology development projects. This is a particular problem in the UK, where Business Expenditure on R&D (BERD) is 1.1% of GDP. This is well below the Organisation for Economic Co-operation and Development (OECD) average of 1.63%.[4] Early stage technology enterprises are particularly seen as vulnerable to capital scarcity, and find it difficult to raise equity debt or other forms of finance.[5]

11. There is also the difficulty that innovators have in appropriating the economic return from their research and innovation, due to the spillover benefits that occur through, for example, the movement of workers or the use of technologies in new areas of application. Economic research into this area indicates that whilst the private return on investment in R&D is likely to be 20–30%, the social rate of return is likely to be 50–100%.[6] Whilst this creates a strong incentive for public investment into science and R&D, it acts as a disincentive to private sector investment, particularly at the earlier stages of technology development, sometimes identified as Technology Readiness Levels 1–4.[7]

12. Other obstacles that have been identified in the area of innovation include difficulties in accessing specialist skills and knowledge required in connection with innovation, which individual companies do not possess internally, or access to specialist technical facilities or services, the costs of which are too high for most individual businesses to bear. There is also an established market failure in the area of information provision, and the ability of innovators to identify sources of knowledge across the public and private sectors that can support innovative projects.

13. Both the existence of these market failures, and the positive spillovers generated by innovation activities, provide a strong rationale for Government intervention. The Department of Business, Innovation and Skills (BIS) supports a range of programmes, both directly but also through organisations that it funds and sponsors, that seek to address such market failures. These include:

— *Support for R&D*: Government provides support for companies investing in R&D through the R&D Tax Credit. In total, over £1 billion of support was provided through the Small and Large Companies schemes in 2009–10. In the 2011 Budget, the Chancellor of the Exchequer announced that the level of the Small Firms R&D Tax Credit would be increased to 200% in April 2011 and to 225% in April 2012. Direct grant funding for innovation projects, including collaborative projects undertaken between businesses and universities is provided through the TSB, which invests over £150 million per annum in a portfolio of Collaborative R&D projects, many of which involve universities, and SME-focused programmes such as the Knowledge Transfer Partnerships (KTPs), which place a graduate or postgraduate student in a business to undertake an innovation-related project.

— *Proof of concept/market funding*: The TSB provides support for proof of concept and proof of market activities within businesses and universities through the Smart Awards (previously Grant for R&D). Companies can also seek support for the development of prototypes through this programme. The TSB manages the Small Business Research Initiative (SBRI), which enables technology-based SMEs to compete for contracts to develop innovative solutions to public sector challenges, which has helped to support the commercialisation of new technologies in sectors such as healthcare, defence and electronics.

[4] OECD comparative data on levels of R&D investment, 2008. It is important to note that international comparisons are complicated by different historical, structural and industrial factors across countries. When accounting for the UK's sectoral mix, BERD as a proportion of GDP is more in line with countries such as France and Germany.

[5] "The Financing of Technology-Based Small Firms", Bank of England, 1996; D J and B Tether, "New technology-based firms in the European Union: an Introduction", *Research Policy* 26, 1998; "Risk Capital: A Key to Job Creation in the European Union", European Commission, 1998; "Innovation market failures and state aid: developing criteria", Oxera report for the European Commission, 2005.

[6] Z Griliches, "The Search for R&D Spillovers", *Scandinavian Journal of Economics* 94, 1992; M Nadiri, "Innovations and Technological Spillovers", NBER Working Paper, 1993.

[7] Technology Readiness Levels were developed by US Government agencies for use in defence and aerospace programmes but have subsequently been more widely applied. They are used to determine the distance of a particular technology from the market. They operate across a scale of 1–9, with 1 being technologies which are still the subject of fundamental scientific research, and 9 representing technologies which are capable of being manufactured and then used in functioning products. Technology Readiness Levels 1–4 primarily involve research in laboratories; levels 5–9 involve testing the underpinning technologies in a relevant environment, prototyping and the development of associated manufacturing technologies.

— *Support for business investment*: Government invests in a number of programmes that support venture capital investment, notably the Enterprise Capital Funds programme, which seeks to support early stage investments. The Government provides funding through the UK Innovation Investment Fund which invests in a range of venture capital funds providing investment to businesses in all sectors and from early stage to later stage investments. Tax incentives such as the Enterprise Investment Scheme and Venture Capital Trusts provide incentives for investors to provide equity finance for individual companies or to invest in venture capital funds.

— *Demonstration support*: Support for the demonstration of new technologies at scale, to prove these work in operating environments is a key stage in the innovation process, helping to create a market for new technologies. The TSB has supported a number of demonstrators, often linked to its Innovation Platforms—programmes of activity which seek to bring together all those with an interest in the development of technologies in a particular area, including academia, companies, customers and regulators. To date, demonstrators have been supported in the areas of low carbon vehicles, digital technologies and sustainable construction technologies. £25 million was also allocated in the Autumn Statement to support large scale demonstrators in technologies.

— *Information provision*: Support for the Knowledge Transfer Networks (KTNs), which link those interested in a particular technology area or sector across business and academia, enabling the exchange of information and the development of new contacts. The TSB also manages the _ connect platform, which hosts the KTNs, and provides an online networking resource for business (http://connect.innovateuk.org).

14. Another key challenge is demonstrating the market opportunity for new technology, and the potential customer base both in the UK and internationally. A number of Government interventions are designed to address this gap and help universities and businesses to prove the technology concept and prove market applications. These measures include HEFCE's Higher Education Innovation Funding (HEIF) for universities and support from Smart Awards, which help businesses to bridge the funding gap and provide customers and investors with reassurance of the commercial application of the technology. The SBRI also has an important role in pulling new technology through into the market place and demonstrating to other potential customers the commercial viability of the technology.

15. Encouraging the application and commercialisation of research and knowledge generated in the UK research base is one of a number of key strategic priorities for Science and Research funding and policy. These strategic objectives also include incentivising economic impact from research and supporting the leveraging of research funding from business and charities. HEFCE and the Research Councils have developed a broad range of mechanisms, programmes and incentives to deliver these objectives, some of which are set out in the remainder of this memorandum. Further details of these measures and examples will be provided in separate memoranda from HEFCE and RCUK.

16. *Research and Innovation Campuses* such as those at Daresbury, Harwell, Norwich and Babraham, provide thriving environments for businesses, industry, universities and researchers. They enable innovation, deliver impact from Science and Research investment, and act as magnets for investment. For example, 71% (or 41 companies in total) of the companies in the Innovation Centre at Daresbury experienced a growth in sales over the previous financial year, compared to only 30% of the small business population as a whole.[8]

17. Campuses support the creation and growth of businesses in life sciences and biomedical research, energy, security, climate and the environment. In recognition of this, the Prime Minister announced in August 2011 that the campuses at Harwell and Daresbury would be within new Enterprise Zones. The Zones benefit from over £150 million in tax breaks over four years, new superfast broadband, lower levels of planning control and the potential to use enhanced capital allowances.

18. *Public Sector Research Establishments (PSREs)* are a diverse collection of public bodies carrying out research. This research supports a wide range of Government objectives, including informing Government policy making, statutory and regulatory functions and providing a national strategic resource in key areas of scientific research. Many of these bodies are involved in commercialising research.

The European Union (EU) State Aids Framework

19. In delivering support for innovation and technology development in business, the UK Government is required to work within the European Union (EU) State Aids Framework, which aims to limit market-distorting subsidies given to companies. The State Aids framework also enables the EU to meet its international commitments on subsidies in the World Trade Organisation (WTO). Funding for business R&D projects is considered an allowable State Aid, and support can be provided subject to certain levels (calculated as a % of total project costs). Support is allowed for four categories of innovation activity: fundamental research; industrial research; experimental development; and technical feasibility studies. The definitions of these

[8] "STFC Research Performance and Economic Impact Report", 2011. www.stfc.ac.uk/resources/pdf/stfcimpactreport2011.pdf

activities used by the European Commission are those developed by the OECD, and are contained in the Frascati Manual.[9]

20. The State Aids Framework aims to ensure that public funds are targeted on identified market failures in the area of innovation. Therefore, higher levels of support are allowed for fundamental research (100% funding) than R&D in businesses (50% for large companies, up to 70% for SMEs), and lower levels of funding for experimental development (25% in large companies, up to 45% in SMEs), which includes later stage innovation activities such as demonstration. The UK Government recognises the importance of the State Aids Framework in ensuring fair European and international markets for products and services, and is committing to providing support for innovation in business within this framework of rules. However, the Government believes that in some areas improvements are needed to ensure that these enable effective support to be delivered to business, particularly in the area of support for demonstration activities. The Government will be making proposals for change as part of the ongoing consultation on the State Aids Framework for R&D and Innovation being run by the European Commission.

Question 2—*Are there specific science and engineering sectors where it is particularly difficult to commercialise research? Are there common difficulties and common solutions across sectors?*

21. Most of the market failures that exist in research and innovation are generic, and these affect companies in all technology-based sectors. The difficulties in accessing finance and other resources, and market failures relating to the provision of information, tend to be related to company size rather than sector. Most of the available economic research has identified that SMEs face particular problems.[10] However a report produced by Oxera identified that the sector in which a company is active is a crucial variable in innovation market failures.[11] The report found that companies in technology-based sectors that depended on innovation needed to invest a higher proportion of their resources in innovation. Because of this, any market failure in the area of innovation would be magnified in these sectors.

22. Whilst these market failures affect all technology-based sectors, there is some evidence to suggest that sectors are affected to a different extent. Sectors which are capital intensive and have long horizons for product development, such as the life sciences (particularly those SMEs developing new medicines) and low carbon energy where many R&D activities are further from market, are particularly affected by market failures. These relate to access to finance, particularly early stage finance, and difficulties in appropriating the value of their investments. This reduces their attractiveness to potential investors. A report by HM Treasury, *Bridging the Finance Gap,* suggested that the difficulty in raising equity finance varied by region, sector, round of funding and stage of development.[12] Other evidence suggests that for technically complex investments, such as clean energy or life sciences, the equity gap identified by *Bridging the Finance Gap* of £250,000–£2 million could be higher, at £10–£15 million.

23. It is also possible that other factors play a part in reducing the level of innovation and the commercialisation of research that takes place in particular sectors. In some sectors, the existence of long supply chains, comprising companies of varying innovation capability can have an impact. Sectors characterised by large numbers of SMEs (particularly micro-businesses) such as construction, also struggle to adopt new innovations on a large scale. Skill levels in sectors, and the range of disciplines from which staff are recruited may also play a role. The regulatory framework in sectors such as the utilities may also play a part. Companies in the price-regulated parts of these sectors, including the main water supply and electricity transportation companies, are required to have their pricing policies and levels of investment in different activities for pricing periods approved by the relevant regulator. This can limit the resources available for investment in innovation, and create uncertainty about longer term investment frameworks, although this is frequently balanced by other regulatory incentives for companies to innovate.

Question 3—*What, if any, examples are there of UK-based research having to be transferred outside the UK for commercialisation? Why did this occur?*

24. This question rests on a model of innovation that is only partially relevant. The assumption here is that innovation consists of an act of research-based discovery, followed by a separate process of commercialisation which is separately financed. Commercialisation of this type is only one of the multiple forms of innovation, and this type of finance is therefore part of a much wider financial picture. Most innovation takes place in established firms, and is financed via retained earnings. Relatively little innovation follows a linear pathway from research and R&D to commercialisation. BIS would be keen to study well-documented cases of a clearly British discovery that then became the basis of commercial activity elsewhere because of financing difficulties, but at present has no evidence that this has happened on a significant scale.

[9] An agreed taxonomy for classifying public investment in research and innovation, to enable effective international data gathering and comparison. These definitions form the basis of WTO and EU rules on subsidies.

[10] "The Financing of Technology-Based Small Firms", Bank of England, 1996; D J and B Tether, "New technology-based firms in the European Union: an Introduction", 1998; "Risk Capital: A Key to Job Creation in the European Union", European Commission, 1998.

[11] "Innovation market failures and state aid: developing criteria", Oxera report for the European Commission, 2005.

[12] *Bridging the Finance Gap: next steps in improving access to growth capital for small businesses*, HM Treasury, 2003. www.hm-treasury.gov.uk/d/small_business_452.pdf

25. Even where we have clear innovation-relevant research results, the economic benefits do not necessarily have to accrue from commercialisation of a new product. On the one hand, there can be patenting strategies that seek licence income. On the other hand, researchers can make knowledge freely available to companies and then derive income from consultancy, advice, and contract research (this is currently the strategy of at least one major UK university).

26. The main analytical problem around the commercialisation of research is that innovation frequently involves collaboration, often across borders. Innovation usually consists of the creation of new product concepts that are then developed via design, engineering and testing processes. These often run into problems that require further research in order to be resolved. Often such R&D is done outside the innovating firm—whether in, for example, universities, consulting firms or Public Research Organisations (PROs). These can be located outside the borders of the UK. By the same token, UK universities can do research for foreign firms. UK universities, for example, have undertaken significant work for the German car industry.

The UK imports technology as well as exporting it

27. Both science and innovation involve cross-border collaboration. In 2011, 46% of all scientific papers with a UK author were produced with at least one foreign author involved.[13] Among innovating firms, 27% have formal collaboration agreements with foreign partners.[14] Although the UK performs well in both scientific research and high tech R&D, it is important to remember that our efforts are only a small component of a global effort, and that most technologies in use in the UK are imported to some extent. The boundaries between UK and foreign research and innovation are therefore blurred. BIS is aware of evidence that firms have moved from the UK to the Boston area in search of funding, and would be keen to examine further case studies. However, at present BIS has seen no systematic evidence that might suggest whether this is more of a problem for the UK than other countries. In addition, there is increasing international competition for innovation-related resources, driven by the increasing globalisation of business. Investment capital and skilled workers are increasingly internationally mobile, and there are global markets for technology-based products and services. The exchange of people and ideas between countries (often within companies), and the movement of people between different companies in different locations, means that knowledge, skills and technologies are being transferred more quickly than before. These are examples of the positive spillover benefits from innovation.

Question 4—*What evidence is there that Government and Technology Strategy Board initiatives to date have improved the commercialisation of research?*

28. At the macroeconomic level, there is significant evidence that public sector investment in science, R&D and other innovation activities has a positive economic impact. Research suggests that an increase of 1% in public sector R&D achieves a multi-factor productivity increase of 0.17%, which is greater than the equivalent increase of 0.13% achieved by a 1% increase in business investment in R&D.[15]

29. There is also strong evidence that demonstrates the innovation support programmes run by the TSB, and other innovation supporting bodies such as the Design Council, have had a significant impact in driving innovation, and in providing a significant return on public investment. A summary of the results of recent evaluations of these programmes is set out below.

30. A joint evaluation of the *R&D Tax Credit* by BIS and HM Revenue and Customs found that the Credit was important at different stages of a business's life cycle. The repayable tax credit for SMEs was found to be particularly important for new innovative companies, helping them with cash flow and securing external investment. The evaluation also found that the Tax Credit enabled R&D projects to happen sooner and that more risky research and development projects were able to take place.

31. The *Collaborative R&D (CR&D) programme* provides funding to enable business and research communities to work together on R&D projects from which successful new products, processes and services can emerge. It funds activities in both large and small companies, and is used to support the largest scale R& D projects, such as those in the aerospace sector. It is a particularly effective mechanism for supporting innovation projects in existing of new supply chains, strengthening links between large companies and SMEs. Since it was established in 2007 the TSB has funded over 1,300 projects through this process, amounting to around £550 million of grant funding to date which is matched by business. Over £150 million will be invested in 2011–12. Evaluation of this programme showed that for each £1 of CR&D grant, there will be an increase in gross value added (GVA) of £6.71.[16]

[13] *International Comparative Performance of the UK Research Base*, Elsevier for BIS, 2011. www.bis.gov.uk/assets/biscore/science/docs/i/11-p123-international-comparative-performance-uk-research-base-2011.pdf

[14] UK Innovation Survey, BIS, 2011.

[15] OECD data.

[16] "Evaluation of the Collaborative Research and Development Programmes", PACEC for the TSB, 2011. www.innovateuk.org/_assets/pdf/publications/pacec_evaluation_of_crandd_report.pdf

32. *Smart (previously Grant for R&D)*, is a long running programme to help correct the recognised market failures around private finance for high-risk and potentially high-reward technologically innovative projects carried out by SMEs. An independent evaluation of the programme in 2001 found that 94% of these companies could not have pursued their objectives without Smart.[17] The evaluation also showed that, in spite of the risky nature of some of these ventures, some 70% of the projects supported resulted in new or improved products and processes reaching the market place. A further impact evaluation of the programme in 2009 highlighted that 70% of businesses supported had since increased their R&D expenditure or activity, and that 78% had used their participation in the programme to help open up new markets.[18] The average net additional increase in GVA was £95,000 per recipient firm, and the average net increase in employment was 2.1 FTE per firm. Overall, the evaluation indicated that the programme generated a return of £9 for every £1 of public money invested.

33. *KTPs* stimulate innovation by facilitating the transfer of knowledge and the spread of technical and business skills. Around 1000 live projects per annum are undertaken by high calibre, recently qualified people under the joint supervision of personnel from business and the research base. For every £1 million of Government spend in 2009–10 the average benefits to the company amounted to a £3.53 million annual increase in profit before tax, £1.42 million investment in plant and machinery, with 34 new jobs created and 374 company staff trained as a direct result of the KTP.[19]

34. Encouraging the application and commercialisation of research and knowledge generated in the UK research base is one of a number of key strategic priorities for Science and Research funding and policy. In January 2012 a series of reports were published on the impact of Research Council funding. They included a report from RCUK and individual reports from the seven Research Councils. Each report details how research has created wealth, improved society, provided skilled individuals and promoted health and well being.[20]

35. The impact of Research Council funding is recognised in industry. In 2005 the Medical Research Council (MRC) received over US$200 million, from US pharmaceutical company Abbott in recognition of the techniques invented in the MRC Laboratory of Molecular Biology in Cambridge and the Scripps Research Institute in California, and used to develop the first blockbuster therapeutic monoclonal antibody, HUMIRA®. The MRC has a strong track record in commercialising the outputs from its research; licensing income to the MRC reached £61.69 million in 2010–11. This brings the total cash generated from MRC intellectual property generated since 1998 to more than £550 million. A significant source of this income has been MRC patents on key technologies used to produce therapeutic monoclonal antibodies. In October 2011, the Engineering and Physical Sciences Research Council (EPSRC) received a Partner of Choice award from the world's largest consumer products company, Procter and Gamble.[21]

36. Working with the TSB, RCUK leverages wider research funding. RCUK spent £165 million between April 2008 and March 2011 on complementary and collaborative activities with the TSB. These included:

- the Low Carbon Vehicle programme that has supported 440 company and academia partnerships; and
- a project based on nano-scale technologies to develop the next generation of solar energy panels.[22]

37. The *Innovate for Universities* programme delivered by the Design Council is helping improve the commercialisation of research. An independent evaluation by Ekosgen of the 2009–10 programme, found that the design mentoring received by the participating university technology transfer offices had helped improve commercialisation by: reducing the risks associated with a technology; making new concepts viable and appealing and hence more marketable and attractive to potential investors through visualisation and prototypes; and identifying new markets or products for a technology. For example, Nottingham University subsequently secured funding of £250,000 to conduct more proof of concept work for one of its projects.

Question 5—*What impact will the Government's innovation, research and growth strategies have on bridging the valley of death?*

38. The Government has demonstrated its strong commitment to the UK knowledge base by protecting Science and Research programme funding with a flat-cash, ring-fenced settlement of £4.6 billion per annum over the Spending Review period for 2011–15. Since the £1.9 billion the Government allocated for capital in the 2010 Spending Review, the Government has announced a further £495 million of capital investment in Science and Research.

[17] "Evaluation of Smart", PACEC, 2001.
[18] "Grant for Research & Development and Smart Final Report", DIUS/LDA, 2009. http://webarchive.nationalarchives.gov.uk/+/http://www.bis.gov.uk/files/file52026.pdf
[19] "Knowledge Transfer Partnerships Annual Report 2009/10", TSB, 2010. www.ktponline.org.uk/assets/Resources-page/KTPAnnualReport09–10.pdf
[20] "Research Councils UK, Impact Report 2011", 2012. www.rcuk.ac.uk/Publications/reports/Pages/RCUKImpactReport2011.aspx
[21] "Research Performance and Economic Impact Report 2010/2011", EPSRC, 2012. www.epsrc.ac.uk/newsevents/news/2012/Pages/economicimpactreport.aspx
[22] "Research Councils UK, Impact Report 2011".

39. The Autumn Statement and the subsequent publication of the *Innovation and Research Strategy for Growth* and the *Strategy for UK Life Sciences*[23] confirm the Government's commitment to accelerate the commercialisation of emerging technologies.

40. The *Strategy for UK Life Sciences* announced a £310 million investment to support the discovery, development and commercialisation of research. Of this, £180 million will be used to fund an initiative that will target the "valley of death" where investment is currently seen as too risky for many private investors, who, due to the high early attrition rate of programmes and the long lead times to commercial returns, want proof of efficacy in high cost clinical studies before making substantial investment decisions. Over the next three years this joint MRC/TSB Biomedical Catalyst Fund will nurture innovative technologies from the academic or commercial sector through to commercialisation of products or technology platforms in order to attract private equity The fund will build on existing MRC programmes for academia and provide new funding of £90 million through the TSB for support for SMEs, delivering growth to the Life Sciences sector and providing support to both academically- and commercially-led R&D and development to speed up the delivery of the benefits of science to patients.

Supporting business

41. The TSB is the Government's prime channel of support for business-led technology innovation. The TSB provides a range of products aimed at improving the commercialisation of R&D, with proven impacts. These support a range of activities in the innovation cycle and include the Smart Awards, SBRI, CR&D, KTNs, KTPs and the Catapult centres. The *Innovation and Research Strategy for Growth* commits to continue these programmes and provided additional funding to support small business innovation.

42. Government has committed to extend the TSB's Launchpad programme which aims to help strengthen existing clusters of companies. This programme provides funding to small business to develop new products and services and, at the same time, help these companies leverage in private sector finance. The initial competition focussed on Tech City was successful in attracting over 200 high quality proposals, with over 80% coming from new, small or early stage companies. The TSB supported 18 projects with funding of just over £1.75 million.

43. The TSB is also in the process of establishing an elite network of Catapult centres. The first centres have been announced in the areas of high value manufacturing, cell therapy, offshore renewable energy, satellite applications and the connected digital economy. These centres will play an important role in helping the translation and commercialisation of research for the benefit of business.

44. Clusters—geographic concentrations of interconnected businesses, knowledge base organisations and suppliers—can play an important role in reducing risks associated with developing and commercialising new and emerging technologies, and supporting higher adoption and diffusion. Government has committed to remove barriers to the emergence of new clusters and the growth of existing clusters. RCUK, working with others, will establish a principles-based framework for treatment and submission of multi-institutional funding bids to allow consortia to tackle large-scale and ground-breaking new research beyond the capabilities of single institutions.

45. Local Enterprise Partnerships (LEPs) have the potential to influence partnership working between all players in a local economy, and many already have HEI representation on their boards. As LEPs develop their strategies at the heart of local democracies, it is expected that they will play a more robust role in promoting economic growth including bringing together business and universities to commercialise R&D.

46. To further support collaboration between SMEs and external knowledge providers across the public and private sectors, Government will introduce a new Innovation Voucher programme in 2012–13. The Voucher programme will initially focus on geographical areas and sectors of low economic growth, and will look to support small businesses who have not previously engaged with the UK's knowledge base or lack the in-house expertise or research facilities to develop ideas into new products and services.

47. R&D tax credits support business expenditure on research and development activities. Government has recently announced a number of reforms to the scheme, including:

- increasing the rate of relief available for SMEs to 200% from April 2011, and to 225% from April 2012; and
- the introduction in April 2013 of an "above the line" R&D tax credit which will provide greater visibility and greater certainty for large company investors.

48. Turning an initial patent or concept into a marketable product requires a range of complementary activities, including further R&D activity either on the intellectual property itself or the processes required to manufacture or deliver the product or service. The R&D tax credits scheme provides further support during this phase, where the work is seeking to resolve scientific or technological uncertainty.

[23] *Strategy for UK Life Sciences*, BIS, 2011.
www.bis.gov.uk/assets/biscore/innovation/docs/s/11–1429-strategy-for-uk-life-sciences

Importance of the knowledge base

49. Strong universities and the wider knowledge base drive UK competitiveness in the global economy, through underpinning technology-based sectors and enhancing our health, quality of life and creative output. They train the skilled researchers and technologists who work in knowledge-driven sectors.

50. Government recognises the importance of the research base, which includes HEIs, Research Council Institutes, PSREs, and Research and Innovation Campuses, in assisting companies to commercialise ideas.

51. Research Councils support activities which encourage researchers to work with business. These include support for collaborative research, collaborative training, the exchange of researchers between academia and business, and in some cases proof of concept funding. Research Councils are working with nearly 3000 businesses in sectors ranging from broadcasting to biotechnology and engineering to insurance. Research Councils also work closely with a number of strategic partners to deliver impacts from research.

52. RCUK is committed to developing strategic partnerships to ensure that the potential impact which exists in the research base through previous investments is tailored appropriately to meet user needs, and future evidence can be generated collaboratively. A number of sectors have been selected as the focus for current strategic engagement through a coordinated cross-council approach. These include pharmaceuticals, the creative economy, water and energy.

53. Of vital importance is the support that the UK provides for fundamental, or "blue skies" curiosity-driven research, which attracts leading researchers to work here, and allows the combination of ideas from different research fields. Research Councils will continue to fund both responsive, curiosity-driven research proposals, and research initiatives into specific areas. This funding will continue to be complemented through the UK Higher Education funding bodies, which will provide universities with flexible, quality related research funding.

54. HEFCE research funding also includes an element to support research with business (amounting to £64 million per annum) allocated by reference to the collaborative research income generated from business.

55. HEIF, provided by HEFCE, enables HEIs in England to maintain and develop capacity to work with business and other users, including:

- strengthening technology transfer offices and providing proof of concept funding to help with commercialisation of intellectual property outputs (including through spin-outs, licensing);
- support for business development function to help increase interactions with business (such as collaborative research, consultancy, continuing professional development training); and
- enterprise education for students and support for starting a business.

HEIF is being maintained at £150 million per annum for 2011–15, and is being reformed to increase the rewards for universities that are most effective in business engagement.

56. Similar support is offered by Higher Education Funding Bodies in other parts of the UK.

57. Through the Higher Education Funding Councils and Research Councils, Government has developed further incentives to recognise and reward HEIs and researchers for the broad range of economic, social and cultural impact derived from their research. A major exercise is undertaken every few years to assess the research performance of all UK HEIs. The Research Excellence Framework (REF), which replaces the earlier Research Assessment Exercise (RAE), will complete and report at the end of 2014. REF 2014 will not only assess research excellence but will also include, for the first time, an assessment of the impact that excellent research has made on the economy and society. "Impact" will account for 20% of REF 2014.

58. Research Councils now require researchers submitting grant applications to include a proposed "Pathway to Impact".[24] This encourages researchers to consider from the very beginning the potential "pathways to impact" and those who may be interested in the outcome of their research. It will help speed up these impacts and ensure researchers think about the value of their research to the economy and society.

The international dimension

59. Innovation and research are now increasingly international endeavours as most innovations originate from multiple countries. Businesses looking to commercialise new ideas or technologies can also benefit from international partners' ability to provide access to wider markets. High growth economies' strong, long-term growth makes them of increasing importance to UK businesses looking for new markets.

60. The *Innovation and Research Strategy for Growth* announced a range of measures to support international collaboration for UK businesses including:

- UK Trade & Investment (UKTI), the Science and Innovation Network (SIN) and the network of IP attachés will focus particular support on helping innovative UK businesses take advantage of commercial opportunities and build successful international collaborations in innovation hotspots.

[24] www.rcuk.ac.uk/kei/impacts/Pages/home.aspx

— The Catapult centres will all have a focus on international engagement, varying according to where the best opportunities exist.

— UKTI will create a collaborative online platform, enabling innovative companies and service providers to support one another.

61. BIS will review the system of support available to UK participants in Horizon 2020 proposals. Under the "Leadership in Enabling Industrial Technologies" pillar of the Commission's proposed Horizon 2020 programme, support will be available for the deployment of the outputs of research projects by European industry. Such support will play a key role in aiding the commercialisation of research, thereby strengthening Europe's productivity and innovation capacity and ensuring Europe has an advanced, sustainable and competitive economy, global leadership in hi-tech application sectors and the ability to develop effective solutions for societal challenges. The Government recognises its role in ensuring that UK companies are well-placed to benefit from these opportunities by putting in place a support-system that is fit for purpose.

62. International collaboration is also important to the UK's research base. The quality of the UK research base attracts companies from around the world. Companies such as Ford, Pfizer, Airbus, Nokia and Syngenta have all chosen the UK for large scale R&D investment. The RCUK International Strategy outlines how the Research Councils can grasp new opportunities and build on the UK's already impressive international reach.[25] Building strategic links with the institutions and companies in the emerging economies such as the BRIIC countries will be vital if the UK is to succeed in the global economy, and international collaboration in Science and Research has a key role to play in this.

Question 6—*Should the UK seek to encourage more private equity investment (including venture capital and angel investment) into science and engineering sectors and if so, how can this be achieved?*

63. Government is committed to making the UK the best place in Europe to finance and grow a business. Despite the turbulence in global financial markets the Government believes that unlocking private sector investment remains the key to enabling private sector led growth. Evidence from NESTA shows that about 6% of innovative, high growth companies created 50% of new jobs.[26] Government is committed to enabling innovative, high growth businesses, including the science and engineering sectors to access more diverse sources of finance.

64. Business Angels have an important role in supporting early stage innovative companies, not only with small amounts of equity investment, but also in providing mentoring support and networking opportunities. In recognition of the importance of Business Angels the Government has reformed the Enterprise Investment Scheme (EIS) and Venture Capital Trust (VCT) tax reliefs. These changes include increasing the rate of income tax relief for the EIS to 30% from April 2011 and doubling the investor limits to £1 million per annum from April 2012. The EIS, which is not sector specific, supported £611 million of investment in 2009–10 including £125 million in high tech companies (which include instrument engineering, some chemicals, R&D, and computer consultancy among others).

65. The risks involved in investing in the newest, early stage companies are recognised by Government, which has introduced the Seed Enterprise Investment Scheme (SEIS) providing a 50% rate of income tax relief for individuals who invest in qualifying seed companies. To kick start the scheme the Government is providing a Capital Gains Tax Exemption on any gains realised in 2012–13 that are invested through SEIS in the same year.

66. Government also recognises the importance of improved access to equity investment across the English regions. Working with Capital for Enterprise Limited and Business Angels networks the Government has committed £50 million through the Regional Growth Fund to a Business Angel Co-Investment Fund which will support Business Angel investment across England.

67. We know from the USA that governments can play an important role in unlocking private sector investment for early stage, innovative companies. Apple, AOL, Hewlett Packard and Intel all received early stage equity investment from Federal Government backed venture capital programmes. Our own Government backed venture capital scheme is the Enterprise Capital Fund (ECF) programme which invests up to £2 million in a range of early stage, high growth businesses including a number in science and engineering sectors. The ECF programme specifically encourages the creation of venture funds through providing a mechanism whereby private investors can benefit from a greater share in the profits of those funds. This helps to level the playing field between equity gap investment and the returns that might be had from alternative asset classes.

68. The ECF programme has to date supported 10 professionally managed funds, which together have invested £124.6 million in 114 companies. The funds have a commercial focus, but a clear target to invest within the equity gap. Funds often collaborate with Business Angels and other early stage investors, and around 60% of investments to date are in firms at seed or early stage.

69. In the last spending review, the Government committed a further £200 million to creating new ECFs, which will extend their reach. Proposals for ECFs can come from teams focusing on any industry sector,

[25] "Our Vision for International Collaboration", RCUK. www.rcuk.ac.uk/documents/publications/international.pdf

[26] "The Vital 6%", NESTA, 2009. www.nesta.org.uk/events/assets/features/the_vital_6_per_cent

including from teams working with universities and other research and technology institutions to commercialise and invest in early stage and technology-based ventures.

70. Government is also continuing to support the UK Innovation Investment Fund (UKIIF), one of Europe's largest technology Fund of Funds. Working with Hermes GPE and the EIF, the UKIIF targets investment in advanced manufacturing, clean technology, digital, and the life sciences sectors by investing up to £330 million in a range of specialist technology funds.

71. Venture capital markets are increasingly global with a third of investment into UK venture capital coming from overseas including the USA and Asia. Europe continues to under perform compared to US markets, investing four times less in venture capital. The UK Government has led European proposals to create a Pan EU Fund of Funds of the size and scale of successful US Technology Funds. We welcome proposals in the forthcoming Horizon 2020 Framework Programme to place greater emphasis on the financing of innovative, high growth companies across Europe including the creation of Pan EU Innovation Fund of Funds funded through a reprioritisation of existing EU budgets through the EIF and national operators.

72. Government will also strengthen links between the UK and US venture capital sectors. Following President Obama's State Visit to the UK in May 2011 the UK and US Governments have announced that they will bring together UK and US fund managers to enable strategic partnerships to be developed, and to showcase and secure investment for some of the UK's leading innovative companies.

73. The TSB is looking at how it can create greater links between the support it provides and the private equity community. Companies supported through the SBRI programme for instance tend to attract private equity interest as government funding helps to de-risk the technology and there is also the prospect of a government contract. The Launchpad programme provides 50% of the funding to the company. The TSB then creates the opportunity for these companies to meet the private equity community to gain the other 50% of the funding.

74. UKTI's strategy, *Britain Open for Business*, states that it will work to attract venture capital investment from overseas through developing strategic relationships with key venture capital decision makers across the world, making intensive use of their networks to stimulate interest.[27] This new package will aim to attract significant new investment for high growth and innovative SMEs, and bring new venture capital operations to the UK.

75. Not all technology businesses require large amounts of capital and it is relatively common for start ups in the creative and digital sector to use their own finance or that of friends and family to fund their enterprise. This helps to gauge the business potential and avoids diluting the ownership of the business too early. Through the Business Link website (www.businesslink.gov.uk) and the "No Nonsense Guide to Finance for Innovative and High Growth Companies", the Government wants to ensure that innovative businesses have access to the information they need to make appropriate funding decisions.

76. As well as proving the viability of technology, investors will want to ensure that the potential market opportunities and the customer base, both domestically and internationally, are fully understood. A number of Government programmes help to address "investment readiness" and ensure that business owners fully understand what investors are seeking including the potential rates of return on investment.

Question 7—*What other types of investment or support should the Government develop?*

77. As well as addressing supply side measures to support the commercialisation of technologies, Government believes that there are other measures that can support innovative, high growth companies. These include public procurement, prizes and business programmes.

Procurement

78. The scale of Government's purchasing power means that the public sector can be a lead customer for innovative products and services. Through engaging with the supply chain, the public sector can identify opportunities to incentivise the development of new products and services, and use the scale of the public sector market to accelerate the commercialisation of innovation where this represents value for money, benefitting the wider economy.

79. The House of Lords Science and Technology Select Committee report on "Public procurement as a tool to stimulate innovation"[28] recognised innovation procurement as a vehicle to help "…stimulate British industry to generate new products and ideas that will, in turn, lead to economic growth, often based on the translation of scientific research into commercial products and services". Innovation procurement initiatives reduce risk, guarantee sales, encourage market entry, provide early testing ground and manufacturing experience, create demand and make latent demand manifest, and diffuse technology.

[27] *Britain Open for Business: Growth through International Trade and Investment,* UKTI, 2011. www.ukti.gov.uk/uktihome/aboutukti/aimsobjectives/corporatestrategy.html

[28] "Public procurement as a tool to stimulate innovation", 2011. www.publications.parliament.uk/pa/ld201012/ldselect/ldsctech/148/14802.htm

80. In its response, Government set out how its ambitious and radical programme of procurement reform will help foster innovative solutions, through reducing bureaucracy in the procurement process making public procurement more attractive to smaller and more innovative suppliers, and greater use of outcome-based specifications allowing the market to come forward with solutions. The commitments made by Francis Maude on 21 November 2011 around procurement and growth will require Government to undertake greater pre-market engagement before starting the formal procurement process.[29] This will encourage more innovative ideas from the market which will shape future specifications.

81. The SBRI programme operated by the TSB encourages, and provides a mechanism for, the development of innovative solutions to public service needs. The SBRI provides innovative solutions to public sector challenges, new business opportunities for innovative companies and a route to market for new ideas, thereby accelerating technology commercialisation.

82. The recently published NHS strategy, *Innovation, Health and Wealth*, announced that the Department of Health would double its investment in the SBRI programme to develop innovative solutions to healthcare challenges, encourage greater competition in procurement of services, and drive growth in the UK SME sector.[30]

Innovation inducement prizes

83. Governments and businesses are increasingly recognising the potential of innovation inducement prizes as being complementary to other ways of supporting innovation. Prizes can encourage wider collaboration across public and private sector organisations, communities and consumers in response to a clearly identified challenge or opportunity. A well designed prize will aim to solve a multi-disciplinary problem that is not the subject of existing research grant programmes or challenges, and can bring together different types of knowledge and other resources to solve problems. Prizes can be particularly effective in targeting "neglected" areas where innovation is needed, but might not otherwise take place.

84. The *Innovation and Research Strategy for Growth* announced that Government would work with NESTA to establish a Centre of Expertise to run, design and facilitate inducement prizes. Government and NESTA will co-finance a new fund to run future inducement prizes. Government will also contribute £250,000 per annum towards the fund and will seek to leverage interest and investment from the public and private sectors and philanthropic organisations.

Supporting business

85. In addition to the direct innovation support to business provided by the TSB, the Government enables innovative businesses to access external finance through a basket of other measures. These include access to finance information on the Business Link website and the production of a "No Nonsense Guide to Finance for Innovative and High Growth Companies" and the "Fit for Finance Programme".

86. Government has also launched "Business Coaching for Growth" to help 10,000 SMEs a year overcome the barriers they face in achieving high growth potential. The programme will include help to commercially exploit innovation, build a culture of innovation within the businesses and identify and protect intellectual property. There will be strong links between the Intellectual Property Office, the TSB and the Design Council.

Appendix A

ECONOMIC AND SOCIAL IMPACT OF RESEARCH

The following examples demonstrate how economic and social impact of research is delivered through a range of mechanisms.

Delivering highly skilled people to the labour market

— There were 20,080 new PhDs and 162,365 Masters graduates from UK HEIs in 2010–11.[31]

— A recent survey of doctoral graduates showed that over 90% felt that their PhD enabled them to be innovative in the workplace.[32]

[29] www.cabinetoffice.gov.uk/news/radical-package-unveiled-support-business-and-promote-growth

[30] *Innovation, Health and Wealth: Accelerating Adoption and Diffusion in the NHS,* Department of Health, 2011.

[31] Higher Education Statistics Agency (HESA) Student Record. These figures cover graduates of all domiciles from full-time and part-time courses. PhD graduates from UK HEIs increased by 13.8% between 2008–09 and 2010–11. Masters qualifiers increased by 31.7% over the same period.

[32] "What Do Researchers Do? Doctoral graduate destinations and impact three years on", Vitae, 2010. www.vitae.ac.uk/researchers/1272–290131/What-do-researchers-do-Doctoral-graduate-destinations-and-impact-three-years-on.html

— David Lathbury, former Head of Process Chemistry at AstraZeneca's Charnwood site, has looked at the value the pharmaceutical industry gains from PhD training: "PhD students produced by our higher education sector create far more monetary wealth than that associated with a particular project funded in their university department".[33]

Developing new businesses

— Between 2003 and 2011, 40 university spin outs were floated on the stock exchange with an IPO value of £1.79 billion; and 25 university spin out companies were acquired by other business for a total value in excess of £3 billion.[34]

— The software company Autonomy, based on research from Cambridge University, was a FTSE100 company before being acquired in 2011 by US firm Hewlett Packard for £7 billion.

Improving the performance of existing business

— Rolls Royce has a long-established network of Technology Centres in universities in the UK and elsewhere.

— Lloyd's Register is developing a £100 million Maritime Centre of Excellence on the campus of Southampton University.

Improving public policy and public services

— The Natural Environment Research Council (NERC) gathered vital data from the Icelandic volcano which grounded flights across Northern Europe in 2010, enabling flight restrictions to be lifted in airports across Britain, saving money and bringing thousands of stranded tourists home.

— Researchers at the MRC Lifecourse Epidemiology Unit in Southampton developed a computer-based algorithm, FRAX, to assess the fracture risk of patients, giving a 10-year probability of fracture. FRAX is in use worldwide. The economic implications are significant—musculoskeletal disorders cause discomfort for approximately 10 million people in the UK. This public health issue has associated costs estimated to be in the region of £40 billion.

— Professor Theo Farrell, an Economic and Social Research Council (ESRC)/Arts and Humanities Research Council (AHRC) Fellow, undertook an assessment of the British Army's performance in Operation Moshtarak, a 2010 offensive to clear the Taliban from central Helmand Province in southern Afghanistan. The resulting classified report was briefed to Army chiefs, and has informed doctrine development and pre-deployment training for troops going to Afghanistan.[35]

Attracting Foreign Direct Investment in R&D from global businesses

— 450 R&D projects were attracted to the UK in 2006–7 and 2007–08.[36]

— Tata Motors, which owns Jaguar Land Rover, has invested over £85 million in collaborative research with the Warwick Manufacturing Group.

— Eisai is one of the world's top 20 pharmaceutical companies and defines its corporate mission as enhancing patient value by meeting unmet medical needs. As part of its global development strategy, the Japanese company is to develop a £75 million facility on the Hatfield Business Park. The investment will ultimately employ more than 500 people—including some 300 new roles in R&D and manufacturing.

January 2012

Written evidence submitted by Royal Aeronautical Society

(1) *What are the difficulties of funding the commercialisation of research, and how can they be overcome?*

1. The reduction in the level of government funding in the defence aerospace sector is having a significant impact on the commercialisation of civilian technology. Defence based R&D has traditionally driven forward technologies that are often seen as being too high risk or too early a stage for civilian companies prudently to consider backing. Once defence funding has taken the technology to a level where the risk associated with further development has been reduced or the technology has been demonstrated, civilian companies are then more willing to back further development and subsequent commercialisation.

2. For example, the use of composite materials in structural applications in aircraft was led by early development of composite design and manufacturing technology in military aircraft and missiles. This experience increased civilian industry's confidence in the technology and facilitated its further development for use in civilian aircraft such as the Airbus A380, A350 and the Boeing 787.

[33] "Pioneering Skills to Build Britain's Future", EPSRC www.epsrc.ac.uk/SiteCollectionDocuments/Publications/corporate/SkillsHLP.pdf

[34] Data from PraxisUnico.

[35] "ESRC Research Performance and Economic Impact Report 2010–11", ESRC, 2012. www.esrc.ac.uk/_images/Research-performace-impact-10–11_tcm8–19067.pdf

[36] Data from UKTI.

3. The key issue is not actually one of funding defence R&D *per se* (although the resources allocated to fundamental research have declined over the past decade).The problem is actually more to do with the substantial customer capital investment involved in buying new equipment which, in turn serves to stimulate the market. The 10 year equipment programme is now fully committed to existing programmes. As a result, with few new programmes expected there will be few new market opportunities over the next couple of decades. As a result, industry is unlikely to invest on a speculative basis in R&D. Equally, the UK's stated policy of buying leading-edge technology "off-the-shelf" on the global market also militates against either public or private investment in core technologies. In short, this prospect underlines the need for another iteration of the Defence Industrial and Technological Strategy which industry could use as a guide to future investment decisions.

4. The reduction in funding for defence related technology will reduce British activity in riskier technology which will not only reduce the overall rate of innovation, but will also imply that the UK potentially could miss out on novel cutting edge technology, which may undermine future commercialisation of "disruptive" products.

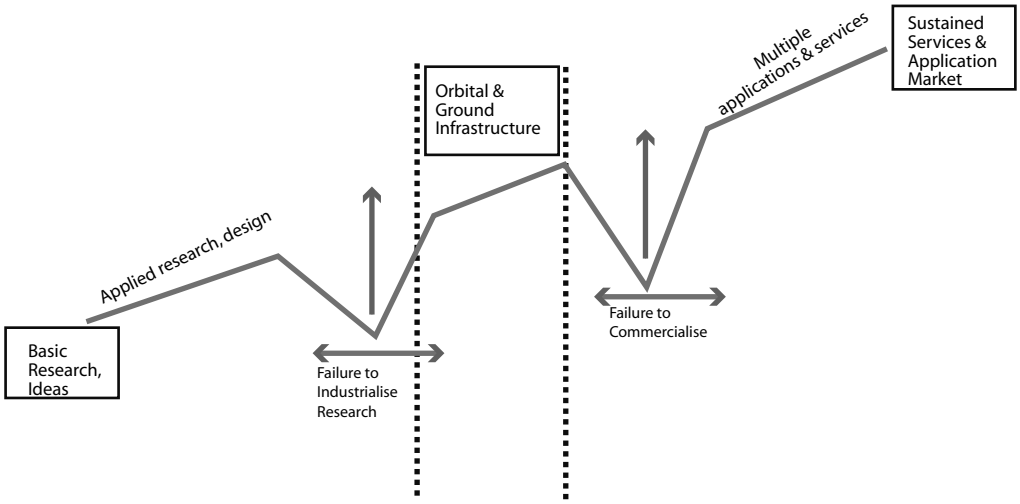
5. The Space sector differs in several respects from aerospace generally and the context for commercialisation of R&D is very different. The space industry and agencies in Europe use a system of Technology Readiness Levels (TRL) to characterise the maturity of a technology and its readiness for commercialisation and/or operational use. Items at TRL 1 to 3 are at the research stage while items at TRL 7 or 8 are ready to be applied. The "valley of death" in this case refers to the long-standing difficulty to move technology from TRL 3 to TRL 7.

6. To help address the space valley of death, the UK participates in many of the technology programmes of the European Space Agency (ESA). A new five year plan for ESA will be agreed by Member governments later this year and will include measures intended to help address the valley of death. A refocused General Support Technology Programme (GSTP) would help technology and products to reach the highest TRL by matching technologies needing in-orbit demonstration with the cheapest and fastest flight opportunity available. Flight demonstration is a powerful means of bridging the gap between low TRL and the maturity required for adoption on missions.

7. More generally, one of the key features of ESA's technology support is that activities at higher TRL levels that have commercial applications are co-funded with the private sector. At the blue skies end of the TRL scale the work is usually fully funded by ESA; but from about TRL level 5 or 6, ESA requires participating companies to provide much of the funding. The level of private sector funding ranges from 50% at about TRL 5 or 6, rising to beyond 70% for demonstration missions at TRL 7 or 8. The requirement for private sector co-funding ensures that activities at TRL 6 and above are efficiently commercialised. One of the weaknesses of the scheme is that there is no intermediate step between 100% ESA funding at about TRL 3 and 50% at about TRL 6, making it difficult to bring promising TRL 3 or 4 technologies to maturity.

8. The UK Space Agency has set in place a number of national initiatives in the past year that complement the ESA programmes. A national space technology programme was announced in 2011, which includes support for In-orbit demonstration. More recently the TSB announced the creation of a Satellite Applications Catapult initiative that will focus on bringing technology to the maturity needed for commercialisation. The Catapult should provide a market pull that complements the technology-push of the national space technology programme and is explicitly targeted at bridging two valleys of death characteristic of the space sector—the first in bringing technology to maturity for space and ground infrastructure, the second in commercially exploiting that infrastructure. The national programmes will also enable the UK to influence the ESA programmes from a position of knowledge and strength, thereby enhancing the value for money the UK obtains from both its ESA subscription and its national programme.

The challenge – twin valleys of death



9. In the case of SMEs, companies face a number of particular problems of commercialising R&D. For an SME whose product sales are dependent on long term evaluation and qualification controlled by regulation, raising finance is difficult. Banks need to see regular income to service debt and R&D tends to be variable, often grant assisted with quarterly payments in arrears. Similarly, Angel Funding tends to be in very small amounts which although helps cash flow, is rarely sufficient to take major innovation into commercialisation; and Venture Capital wants a business plan with a three to five year payback where new aerospace ventures often have a far longer timescale.

10. Government backed bank lending for SMEs is considered by banks on the same merits as they would a conventional loan and the cost of these loans is also high, added to which the Government asks for a 2% risk payment. Banks are reluctant to use this system as the Government is very slow to cover losses.

11. A possible solution to these problems would be to establish a government Venture Capitalist such as the original 3i with a remit to invest in UK companies. This body should commit funds for a longer period than commercial venture capitalists. In bypassing commercial funds SMEs would have an alternative route to fund R&D and its commercialisation. This should create a real incentive for commercial lenders/investors to get involved.

12. In times of austerity, other countries are also having to scrutinise public spending and may cut R&D budgets. As many UK companies, certainly those in the aerospace sector, have a global presence and companies all over the world are looking for technical answers to similar challenges, there is significant opportunity for cross-border collaboration to develop and commercialise technology. The European Framework Programme is an example of how cross-border funding schemes can work.

(2) *Are there specific science and engineering sectors where it is particularly difficult to commercialise research? Are there common difficulties and common solutions across sectors?*

13. All high value manufacturing activities are heavily and appropriately regulated for the safety of workers and end users. Hence there is a need to test and verify materials, manufacturing processes and end products extensively before release to market. Testing is especially critical in proving space technologies and products that have to operate in an extremely stringent environment. Testing takes both time and money and difficult to fund when the potential is recognised but hurdles such as a limited supply chain obstruct near term use.

14. In many cases the challenge of breaking into sector specific "islands of excellence" is a major barrier to commercialisation. As a result, the silo effect can mean that high value innovation in one sector does not transfer readily across to another. The continued difficulties faced by SME engaging with mainly OEM led research centres create further problems. For example, TISICS, a titanium composite technology, has applications in aerospace, space, oil and gas, defence, and marine power. Civil aerospace is well placed to act as a "first user" to develop the technology for future products as other sectors tend to need proven technology before considering it for use in their products.

15. This process could be better supported and technological diffusion encouraged by strategic long term funding for such enabling technology. This would cover development and testing and could be run through the TSB. This would have to be set against a five to 10 year plan where funds are agreed in advance and released against milestones. For example, in the case of Graphene a £50 million investment could bring this product to market. Industry support would be encouraged and banks and venture capitalists might be more willing to lend money if they could see a structured plan backed with government grant funding.

(3) *What, if any, examples are there of UK based research having to be transferred outside the UK for commercialisation? Why did this occur?*

16. A320 wing work has been transferred from UK to China and Korea by Airbus. If the US buys Hawk trainers, the development R&D will shift to USA. Carbon fibre was developed at the former RAE, but there is no longer production in the UK, leading to the importation of several billion pounds of fibre a year.

17. From the 1990s onwards there have also been relatively few major projects to encourage in new technologies. The UK has not developed a new military or civil aircraft since the 1970s and does not participate in large scale space programmes. Major defence programmes are now collaborative, and in the case of the F-35 led by the US and subject to strict technology transfer controls. This could undermine national capabilities in key areas.

18. Given the cost of developing new technology some loss of overall capability is inevitable and is often the price of collaboration and a globalised manufacturing system, it is essential that the UK is able to keep in touch with a cross-section of critical technologies and, in particular, systems integration skills; hence the important of supporting enabling technology and technology demonstration.

19. These and other examples have been largely caused by the absence of a strategic policy to support the underpinning technologies required for production. The Aerospace Innovation and Growth Team Report some eight years ago established a technology plan for the sector that has led to some important public and private investment in key technologies, particular composite material fabrication. This process should be repeated regularly for aerospace and extended to other high technology manufacturing sectors. This strategic view of aerospace technology needs is maintained in the National Aerospace Technology Strategy and updated by the Aerospace, Aviation and Defence KTN of the TSB.

20. In the absence of new defence programmes, the funding of technology demonstration has special significance in keeping design and development teams in being. This also plays a key role generally in reducing the risk of aerospace programmes and thus aiding the commercialisation of new technology and combinations of technology implied by the development of a complex aerospace system. Before the massive increase in development costs, technology development often took the form of prototype development that replicated some of the fundamental characteristics of the targeted technology. However, in many traditional system development methodologies, costly prototypes are not always necessary or appropriate. Technology demonstrations can provide a variety of benefits throughout the systems development life cycle, rather than at a single time for a single purpose.

(4) *What evidence is there that Government and Technology Strategy Board initiatives to date have improved the commercialisation of research?*

21. The collaborative R&D programmes run by the TSB are seen by industry as a key mechanism to increase the Technology Readiness Level (TRL) of those technologies identified as crucial for future products. They also provide a mechanism for supply chain development, with consortia coming together to deliver the programmes. They are viewed by SMEs as an important way to make contact with, and to develop working relationships with OEMs. This is vital to ensure that the innovation created by SMEs is seen and commercialised by OEMs.

22. The TSB programme was developed from cross-sector companies of all sizes and demonstrated that the alliance of OEM and SME companies in a close knit community can cross the valley of death. Members of a consortium collaborate to commercialise their research.

23. In aerospace, the "Integrated Wing" and "Next Generation Composite Wing" are examples of important TSB funded programmes leading to the development of UK technologies that have been fully commercialised. The fact that both Airbus and Bombardier continue to produce wings in the UK, now largely made from composite material, is testament to the long term strategic development of aerospace technology facilitated by the National Aerospace Technology Strategy run by the TSB.

24. The Knowledge Transfer Networks run by the TSB also play an important role in the commercialisation of research.

They:

- Help make companies aware of funding and other assistance that may help them increase the TRL of the technology.
- Use their understanding of the technology requirements of different industries to encourage consortia bidding for R&D funding.
- Provide networking opportunities to help companies with innovative technologies to meet partners or customers who may have a need for the technology and therefore can help commercialise it.

— The Aerospace, Aviation and Defence KTN is also the guardian of the National Aerospace Technology Strategy. This long-term strategy helps to ensure that the technologies required by the UK aerospace industry are identified and developed in a timely manner for commercialisation. This strategy is vital to ensure that the UK stays at the forefront of global technology development retaining both know-how and high-value employment in the UK.

25. Overall, the TSB has been very beneficial to the aerospace sector. For example, TISICS helped British companies to access major potential customers either as partners or because companies had experience of working in TSB projects such as the Integrated Wing Project. This led directly to light weight Landing Gear concepts, which UKTI was able to promote to a Japanese customer. Similarly, following a TSB feasibility study for space, TISICS was able to engage with ESA in Holland and to make contact with Astrium France. Government support for Space is bringing a lot more opportunities for TISICS generally to engage with the European space industry. A TSB feasibility study has also enabled TISICS to work with Alstom in the UK and Switzerland to develop a new higher efficiency turbine blade for power generation.

26. The composites "Grand challenge" competition demonstrated that a fragmented industry can be brought together to work on new manufacturing methods. The Grand Challenge fostered strong relationships across the groups of businesses large and small, who by working together have proven importance of open innovation in a focussed and coordinated approach.

27. TSB funding is extremely useful to SMEs; companies can bid for large or small projects with a reasonable expectation of winning. This contrasts with bidding for EU framework 7 funding, which is often too complex, expensive and slow.

28. In the space sector, the government's decision to fund a national space technology programme and a Satellite Applications CATAPULT Centre, and to participate in the relevant ESA programmes.

(5) *What impact will the Government's innovation, research and growth strategies have on bridging the valley of death?*

29. The Valley of Death problem is difficult to address. TSB funding should only aim to get technologies to Technology Readiness Level (TRL) 6. Companies should then invest to take technology to higher TRL levels and on to full commercialisation. However, under the current austerity conditions companies are finding it difficult to finance such development. The Government thus needs to work with banks and venture capitalists to help provide financial packages that can help both SMEs and large companies to take technology beyond TRL 6 and through to commercialisation.

30. In the aerospace sector, the UK Government has the "Repayable Launch Investment" (RPI) system which typically provides up to a third of the launch costs for a new project, repaid from sales and subject to a long term levy. This has facilitated the commercialisation of extremely large programmes such as Airbus wing and Rolls-Royce engines. RPI has generated a healthy return to the UK taxpayer. RPI has tended to benefit mainly the larger aerospace companies. RPI rules make it difficult for smaller equipment companies to qualify for assistance. The future of RPI in its present form may also be affected by the WTO, which has challenged such systems as a breach of its subsidy code.

31. In the space sector, the Government's long standing participation in the technology and applications programmes of the European Space Agency have been crucial in giving Britain a successful and growing space industry.

February 2012

Written evidence submitted by Dr Richard Worswick

SUMMARY

1. Although attitudes towards the commercialisation of research have changed markedly over the last two decades, and the UK's performance in high-technology manufacturing and knowledge-intensive services has improved, the main obstacles to successful innovation remain cultural, such as the status (and pay) of scientists and engineers (as opposed to that of those in, for example, the financial sector) and recognition of entrepreneurship as well as academic achievement. It is widely recognised that the UK has to do more to encourage young people to study and pursue training in science and engineering if we are to be competitive in world markets.

2. There are many notable successes among UK science-based companies, and measures introduced by the previous Labour and present Coalition Government—tax credits, changes to public procurement, support to universities and companies (eg through the Technology Strategy Board), financial investment in venture capital funds, etc.—have undoubtedly improved the environment for the commercialisation of science and technology, particularly in smaller companies. However, much more needs to be done to improve links between public sector bodies (such as the NHS) and science-based companies, and to build on initiatives to encourage the commercial application of scientific discoveries.

3. Supporting high technology companies, though vital to our longer term prosperity, will not provide a quick fix to the UK's economic woes. With some notable exceptions, new technologies take time to develop and exploit. Emphasis on short term gains is not conducive to building new businesses.

4. Understandably, new governments and new ministers love to announce new initiatives, doing away with some schemes and bodies and creating others. In my view, changing the organisational structure around support for science and technology serves more to confuse than to improve. Better rapidly to build on the structures we have and provide continuity of support.

Biographical Note

1. I have spent most of my career in the management and commercialisation of science and technology and I have worked in both the private and public sectors. When the Laboratory of the Government Chemist Agency, of which I was chief executive, was put up for sale in the mid-1990s, I formed a company (LGC) which was successful in its bid to buy the agency from the DTI. During the decade following privatisation, I developed LGC into an international company providing analytical and diagnostic services and products to a wide range of private and public sector customers and with laboratories and offices throughout Europe, in India and in the US. I was fortunate that the decade from 1996 was an excellent time to build a new business—low inflation, steady interest rates, plentiful investment and loan finance, an expanding UK science budget, strong government support for innovation, etc. Obviously, the external economic environment has changed, but there are still fantastic opportunities to build new businesses. After retiring from LGC I was appointed part-time chairman in 2009 of Cobalt Light Systems Ltd, a company which had been formed to exploit a scientific discovery made at the Rutherford Appleton Laboratory (STFC).

2. This submission is essentially a case study of Cobalt Light Systems which may have relevance to the House of Commons Select Committee on Science and Technology's consideration of how to improve the commercialisation of government-funded research.

The Story of Cobalt Light Systems Ltd

Scientific research and spotting an opportunity

3. In the late 1990s Dr Pavel Matousek was conducting research using the Central Laser Facilities at the Rutherford Appleton Laboratory (RAL) into the interaction of powerful lasers with materials. He discovered a way of obtaining a Raman spectrum from the bulk of some materials. (Raman spectra are produced by the inelastic scattering of light from molecules and can provide a unique "fingerprint" which identifies the material). Previous to his work, Raman spectra could generally only be obtained from the surface layers of materials, but Dr Matousek developed ways of obtaining spectra from beneath the surface of some materials. Although the work began using very powerful laser facilities, it became apparent that the same techniques (in particular "Spatially Offset Raman Spectroscopy"—SORS) could be used with less powerful lasers.

4. Fortunately, the Science and Facilities Research Council (STFC) had set up a unit, now STFC Innovations Ltd, to advise on the exploitation of intellectual property arising from work at the research council. The unit advised on patent applications (8 applications have been filed) and provided some funding to investigate potential applications of the technique.

5. Three applications were identified:

- Biomedical: cancer and bone disease diagnosis.
- Pharmaceutical: process control.
- Security: screening of opaque bottles (eg for drugs or liquid explosives).

6. From around 2004 small amounts of "proof of concept" funding (totalling around £25K) were provided by STFC for different applications of the novel technology and this led to a patent application for SORS. In 2005 NESTA and Rainbow Seed Fund (who were to become investors) agreed to provide some more "proof of concept" funding (around £50K) and in 2006 a further £100k was provided by STFC to hire a development scientist and to fund patent applications.

Forming the company and raising capital

7. The task of developing a business plan and raising initial capital for the putative company (then called LiteThru) fell to the staff of STFC Innovations Ltd led by Dr Tim Bestwick, who had joined in 2003, having previously been involved in high technology and start-up companies. Approximately £700K was raised from the initial shareholders—Oxford Technology Enterprise Capital Fund (independently managed, but two thirds funded by Capital for Enterprise (BIS)), Rainbow Seed Fund (a government-funded enterprise), NESTA and some private individuals. STFC's intellectual property was made over to the company in exchange for a shareholding, and the company moved from temporary accommodation in RAL to a recently completed building for start-up companies adjacent to RAL on the Harwell site. Association with STFC was particularly important at the outset in establishing the company's credibility.

8. Darren Andrews, who had been STFC's IP officer, transferred to the new company and a partner form Oxford Technology Management, David Denny, devoted much of his time to the company. Subsequently an experienced operational director and an applications scientist were recruited. I was appointed chairman in 2009 and a few months later Dr Paul Loeffen was appointed CEO. (Paul had had experience of start-up companies having led Oxford Diffraction Ltd, previously part of Oxford Instruments.)

9. The initial focus was on developing an instrument for pharmaceutical quality control. (The instrument can analyse the content of tablets or capsules inside blister packs at the rate of one per second.) The first sale of an instrument was made in December 2010. The company also sold several customised systems for research and security applications and was successful in an application for a grant of £100K from SEEDA to develop a hand-held probe for the system.

10. Following on from these early sales, we applied to HSBC for a £400K loan under the enterprise loan guarantee scheme to fund working capital. Although 75% of the loan was guaranteed by the government, HSBC insisted that three directors provide warranties for the remaining 25%. It seemed extraordinary that the company was having to pay premium interest rates when the bank had covered its risks completely. Moreover, HSBC required that the loan should be released in two tranches. The first tranche of £200K was released as agreed but the second of £200K, which was to have been released on achieving agreed milestones, was initially refused. Additional hurdles had to be jumped before the bank's agreement was honoured.

Products and markets

11. From the outset several applications were foreseen for the novel Raman spectroscopy techniques. However, early in the company's development the decision was made to focus initially on the market for pharmaceutical quality assurance. Feedback from potential users had been positive and the pharmaceutical industry was obviously a sophisticated customer with experience in the purchase of novel instruments.

12. Of other markets we investigated it became apparent that SORS might be a powerful technique for identifying liquids inside plastic, glass or cardboard containers. Initial discussions with airport operators and the security services elicited positive responses and in 2010 the Home Office (taking the lead on behalf of several government departments in the CONTEST strategy) awarded a contract to Cobalt Light Systems to develop a prototype liquid scanner for use specifically at airports. (A grant under the Knowledge Transfer Partnership scheme in collaboration with Hull University to investigate chemometric aspects of Raman spectra was of limited value, mainly because of the lack of commitment by the university.) However, the overall development programme has been remarkably successful and a scanner (Insight100) based on the prototype developed under the government contract was approved by the European Civil Aviation Conference (ECAC) (the body which oversees international agreements on airport safety and security) in December 2011. ECAC approval opens the door to significant markets for Insight100 if the regulations relating to taking liquids on board aircraft are changed, as expected, in 2013. In September 2011 we were informed that an application for a grant from TSB for £181K (45% of the costs of developing a prototype model of the liquid scanner more suitable for large scale production) had been successful. We have been disappointed by the administrative delays within TSB. Formal documentation (required before work can begin) has taken over four months to emerge from TSB's bureaucracy, which has been deeply frustrating.

13. Using the hand-held probe developed with support from SEEDA, another product has recently been launched. RapID is an instrument which can check the analytical content of bulk chemicals in plastic or paper sacks which are delivered to pharmaceutical works. (Analysing material through outer containers avoids the current procedure of cutting bags open and taking samples for analysis in a laboratory.) We have already sold one RapID system and we believe there is a substantial potential market for this product.

14. The position today is that the Cobalt Light Systems has 16 employees and has products for sale in two markets—pharmaceutical quality assurance and liquid security inspection. A customised system has been supplied for medical research but it will be some time before the results of such research translate into a significant new market opportunity. The company is currently raising further funds from investors in order to support rapid expansion.

Ingredients for success

15. It is too early to trumpet Cobalt Light Systems's success; although the technical risks are much reduced, there are still significant uncertainties relating to market uptake, timing and size of the opportunity. However, the company would not have reached its current position without some key ingredients:

- The inventor scientist was willing to contribute to the new company but to entrust the exploitation of his ideas to others.
- STFC's support has been exemplary. STFC Innovations Ltd, established by the research council, is a small but highly professional and experienced unit. Their understanding (and initial funding) of patents provided vital protection for the company's IP, and the incubator building unit adjacent to the Rutherford Appleton Laboratory has provided excellent facilities for an early-stage company. The proximity to national facilities has given Cobalt Light Systems credibility in building relations with potential customers.

— The investors have been knowledgeable and supportive.

— The early appointment of both the operations director and CEO were crucial. Both joined with experience that was considerably more than would be usual in a start-up company and were willing to work for modest salaries (while receiving share options which could provide rewards in the longer term).

— R&D tax credits provided a vital source of funds for work essential to ensure products were sufficiently developed to attract customer funding.

— A grant from SEEDA contributed to an important technical development. A contract from the Home Office enabled the development of a prototype instrument.

— The relationship with our bank has been good. However, obtaining loan finance was not straightforward. Despite government guarantees under the Enterprise Finance Guarantee (EFG) scheme (the company met the ELG eligibility criteria), additional guarantees were required which reduced the attractiveness of the scheme.

16. There are some parallels with my experience at LGC, where new services were continuously being developed based on emerging technologies. A constant frustration was that the time horizons of investors and financial institutions were shorter than those of entrepreneurs trying to build new businesses. I was often struck by the fact that government departments in Germany and Japan, for example, were prepared to envisage much longer timescales in their relations with industry. The growth of LGC's German operations was supported strongly by regional governments which provided significant capital grants, for example in relation to the company's investment there. Government support to Cobalt Light Systems has been generous (and essential) but ending regional support and centralising funding through the Technology Strategy Board, while probably a sensible move, removed continuity. Small companies find it difficult to steer their way through constantly changing government initiatives.

Conclusions

17. The science on which Cobalt Light Systems's products are based stems from research carried out by STFC. The research council played a pivotal role in helping spin this technology out and forming a company to exploit it. Units such as STFC Innovations Ltd play an essential part in bridging the gap between government research and commercial enterprises.

18. Whether directly or indirectly, Cobalt Light Systems has received significant financial support from the government. Without such support, the company would not have got off the ground. In general, government initiatives have been well targeted and well run, and the independent management of investment funds has led to a more knowledgeable and professional approach than would have been likely had the funds been managed by central government. Our lead investor is an Enterprise Capital Fund, where the tax regime enhances returns on highly risky technology investments. Early-stage funding of technology companies needs investors who are able to understand technology and are cognisant of the risks. R&D tax credits have been a particularly useful source of funds with minimal bureaucracy. Cobalt Light Systems's experience of important TSB support has been soured by administrative inefficiencies.

19. Incentives to individual investors through the Enterprise Investment Scheme are very attractive. Business angels get a very good deal. However, it is regrettable that those employed by a company and who wish to invest in "their" company cannot take advantage of the EIS scheme.

20. While some technology businesses, particularly software businesses, can grow very rapidly, companies set up to exploit advances in chemical or physical sciences often take a long time to get going. Funding development programmes over an extended period presents a challenge. The UK's preoccupation with quick wins is not conducive to building a business over the longer term.

21. Attitudes in the UK towards the commercialisation of research in universities and government laboratories have changed substantially over recent years. Fostering and accelerating this cultural change

requires consistent leadership, sustained funding of the science base, and continuing encouragement of entrepreneurship.

February 2012

Written evidence submitted by David Connell

INNOVATION MYTHS AND LEAD CUSTOMERS: GAME CHANGING POLICIES TO IMPROVE THE COMMERCIALISATION OF RESEARCH

1. Background

1.1 This submission, and the specific, costed policy proposals it contains, are based on:

- My 25 years experience in the technology and venture capital sectors, including as cofounder and for many year Chief Executive of TTP Ventures, a Cambridge based VC fund backed by Siemens, Boeing and financial institutions and specialising in early stage science and technology based companies.
- An extensive series of research programmes on the exploitation of academic research, the characteristics and funding models of Cambridge's most successful S&T companies and overseas innovation policy models. Much of this is in collaboration with colleagues at the Centre for Business Research/UK Innovation Policy Research Centre at the University of Cambridge.
- Lessons learned from leading a six year campaign to get US style procurement based innovation policies adopted in the UK and EU and advising the UK Government on the introduction of the resulting Small Business Research Initiative.

Supporting publications are supplied with this submission and referenced in the text.

2. Innovation Myths

2.1 There have been for many years' three implicit assumptions underpinning the approach to UK innovation policy of successive UK governments:

(i) That academic research is the key source of innovation for new businesses.

(ii) That venture capital is the key source of funding for new businesses.

(iii) That multi-partner collaborative R&D programmes, involving industry and universities represent the best government mechanism for funding innovative R&D in companies.

2.2 As the UK's most successful hi-tech cluster, Cambridge is an excellent "laboratory" in which to examine UK innovation policy. However, detailed research on the start-up strategies of its most successful companies suggests that all of these assumptions are in fact myths.[37]

Myth 1: Role of Academic Research

2.3 Over the last 30 years there have been few really successful new Cambridge companies built on university research in the physical sciences and engineering. All of Cambridge's four largest S&T companies: Arm, Domino Printing Sciences, CSR plc (Cambridge Silicon Radio) and Autonomy (the "big four") are spin outs from existing firms and based on technology developed, and start-up teams built, within their parent companies. And whilst the parent companies were in each case founded by entrepreneurial Cambridge University alumni in their 20s, it was the challenge of solving customer problems in a business environment which in every case provided the stimulus for innovation. Only in the case of Autonomy, was the parent, Neurodynamics, established to capitalise on founder, Mike Lynch's research at Cambridge University.

2.4 The most successful Cambridge University spin outs of the last fifteen years—Abcam and Solexa, are both essentially "Research Tools" companies whose products and services were developed to meet the needs of other scientists. Though both companies are still much smaller than the "big four", this category of company represents the "low hanging fruit" in terms of commercialising the science base and more could be done to capitalise on this opportunity.[38]

2.5 Besides being intuitively attractive, the myth surrounding university spin-outs has been perpetuated as a result of premature celebration by government and media of high profile, VC-backed spin-outs when they are still at a pre-revenue stage, together with a tendency to incorrectly ascribe university research origins to successful Cambridge companies such as Arm and CSR.

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[37] See Connell, D and Probert, J (2010), *Exploding the Myths of UK Innovation Policy: How 'Soft Companies' and R&D Contracts for Customers Drive the Growth of the Hi-Tech Economy*, Research Commissioned on Behalf of the East of England Science and Industry Council by the East of England Development Agency. CBR, University of Cambridge.

[38] This argument is developed further in "*Scientists are Customers too; How the SBRI can Help Research Councils Drive Economic Growth",* David Connell, NESTA, March 2010.

2.6 There is no doubt that policies could be put in place to improve the commercialisation of academic science. However, the reality is that at Cambridge, just as at MIT, it is entrepreneurial university alumni rather than research results which play the key role in building successful new S&T companies.[39] This distinction is important as it has profound implications for policy.

2.7 In fact the most successful source of new product companies in Cambridge is the sub-cluster of technology "consultancies", whose business entails developing technology and products for other companies, mainly overseas based multinationals, on a fee basis. Besides employing some 1,200 people directly, over the last 40 years the four largest firms have created more jobs in "sponsored"[40] product spin outs than the entire university.[41] These are based on intellectual property developed within the parent, usually as a bi-product of funded projects for external clients. Surprisingly, the consultancies also make very little use of research results developed by university academics in their core businesses.

2.8 The role of demanding customer contracts as a stimulus to innovation is also evident in the US. For example, though it was venture capital backed, Intel's first single chip processor, and the basis of its subsequent success, was a side project developed under a paid contract for a Japanese calculator firm. The Federal Government has played a similar role in relation to many other technologies.

2.9 The role of academic research in creating successful new life sciences companies is less clear and there are prima facie reasons to believe that academic science can play a greater role in this sector than in engineering, physics and materials based start-ups. Cambridge Antibody Technology, the UK's most successful biotech start up to date, was based on research by Sir Greg Winter at the MRC Laboratory of Molecular Biology. CAT was acquired by Astra-Zeneca in 2006.

2.10 Nevertheless, no Cambridge biotech company has ever employed more than a few hundred people. Indeed a league table published in 2007 of the 100 largest global biotech companies by revenue includes only three UK firms.[42] The largest, Acambis, ranked 46 with 285 employees and revenues of $57 million, was acquires by Sanofi-Aventis in 2008. Given the emphasis placed on the biotechnology industry as a jobs generator by recent governments, this is deeply disquieting. Though the Government's Strategy for UK Life Sciences, announced in November 2011, contains some important new initiatives, the detail of these is still unclear and the overwhelming focus continues to be on strengthening *research* in universities and the NHS.

Myth 2: Role of Venture Capital

2.11 The second assumption, that venture capital is the key source of finance is also a myth. The dominant source of early stage funding for the most successful firms in Cambridge, measured in terms of sustained profitability and number of employees, is customer funding, especially through R&D contracts.[43] Venture capital tends to come in later or not at all. This *"Soft Start Up"* strategy is common in technology companies everywhere. It contrasts with the better known *"Hard Start-Up"* strategy in which the development of standard products starts immediately, financed by venture capital, and revenues and profitability can be delayed for many years. Other examples of soft start-ups include Research in Motion (RIM, maker of the Blackberry), Microsoft, Logica and Wolfson Microelectronics, Scotland's most successful new technology firm. Vodafone was a spin out from Racal, a classic soft start-up.

2.12 The soft start up model has many benefits, including enabling new entrepreneurs to learn their management skills on the job, before moving to a higher growth model, and gain a better understanding of their technology and potential markets before committing to developing a proprietary product. This reduces business risk.

2.13 Venture capital is predominantly about building new product lines for other companies to acquire. In the UK the acquirer will usually be a corporation based overseas, leading to dispersal of the entrepreneurial team and truncation of further employment growth in the UK. Soft start-up strategies make it easier for the entrepreneurial team to remain in control of a company's destiny and pursue a strategy with much greater economic impact over the long term.

2.14 This does not mean that the UK does not need a strong venture capital sector; for businesses needing to grow fast against competitors it is essential. However, venture capital cannot alone do the job of investing in high risk, long lead time technologies that policy makers currently expect of it. The problem is underlined by the rates of financial return, currently averaging around zero% per annum over the life of UK VC funds. Average returns in science and technology orientated UK VC funds have for 20 years been too far below that

[39] Two thirds of entrepreneurial MIT alumni attribute the ideas for their new enterprises to industry work experience and only 10% to research. *Entrepreneurial Impact: The Role of MIT,* Edward B Roberts and Charles Eesley, MIT Sloan School of Management; publ. Kauffman Foundation.

[40] The term "sponsored" implies that the parent retained a shareholding in the spin out and actively supported its formation. Many other jobs have been created in start-ups created by ex employees without the parent firm's involvement.

[41] The largest firms are TTP Group plc (The Technology Partnership), Cambridge Consultants, PA Technology and Sagentia plc; see *Myths…, op cit*.

[42] *Top 100 Biotechnology Companies*, MedAdNews, June 2007.

[43] *Myths…, op cit*.

of other asset classes to make them attractive to pension funds and other investors in private equity funds.[44] There is no reason to believe that co-investment in VC funds by government, the current policy, will change this position significantly. To build a viable UK venture capital industry, complementary policies are needed that will help create more VC-ready firms and make them more likely to succeed. These are discussed below.

Myth 3: Role of Collaborative R&D

2.15 The third implicit assumption, that funding multi-partner R&D collaborations involving industry and universities is the best way for government to fund innovative R&D projects in companies is also flawed, particularly as regards SMEs. This is the overwhelmingly dominant approach to R&D funding used by both the Technology Strategy Board and European Commission.

2.16 Start-ups and SMEs do not find the collaborative grant model attractive[45]. It does not support the single-minded championship needed to build new businesses and projects tend to be too far from market for small firms to participate. As they usually require matched funding, collaborative projects are inappropriate for the majority of start ups and SMEs which do not have venture capital or significant cash reserves. Firms need to be able to choose their partners, sub contractors and consultants freely, and to change them if things do not work out. A "collaboration" that ticks the boxes in the application form just to get the money can end up being a distraction.

2.17 Fully funded R&D contracts with lead customers, the commercial mechanism which drives the soft start-up model, are much more appropriate. The SBRI scheme, based on the successful US Small Business Innovation Research (SBIR) programme, mirrors the private sector process that has helped make the Cambridge Cluster successful, as it funds the development of technologies and products the public sector itself needs, either as customer or specifier.[46] It also enables companies to keep the IP generated so they can go on to build product businesses. Collaboration with a university is in both cases at the option of the SME, not an artificial requirement which must be met just to get funding.

3. Challenges of Commercialising Academic R&D

3.1 In recent years, a good deal of emphasis has been placed on trying to modify the university model to make it easier to spin out companies. Alongside the strengthening of university technology transfer offices, academics have been strongly encouraged to work more closely with companies in the research they undertake. However, EPSRC funded research carried out by the author, Dr Andrea Mina and Professor Alan Hughes[47] has shown that there are major challenges in trying to accelerate commercialisation in a conventional university research settings:

(i) Most externally funded research projects in universities are undertaken by teams staffed by PhD students and post-docs who tend to move on quickly. As a result it is very hard to retain competence in depth or build the core technology team required to create a spin out business. This is exacerbated by the dominance of short term grants and employment contracts.

(ii) The time that must be devoted to writing publications, teaching, supervisions and giving papers at academic conferences means that R&D during a pre-venture stage can only be advanced in fits and starts.

(iii) IP is often not managed throughout a project. Past leakages of various kinds and competitor positions may only become apparent when commercialisation is being considered. The problem is particularly acute for the long lead time technologies which typify much academic research as there may be an accumulation of IP over successive projects involving many different individuals and corporate partners.

(iv) The pressure on academics to collaborate with industry, coupled with changes in personnel, means that exploitation rights are not always properly thought through or managed over the long term. Poorly negotiated agreements with industrial sponsors can restrict the potential for later spin-offs or licensing deals.

(v) It is very difficult to accelerate the pace of R&D prior to the stage when a technology becomes ripe for exploitation. As a result any competitive advantage can be eroded at this critical stage.

(vi) Universities are not normally equipped with the expertise or resources to take technologies to the demonstrator stage required to attract investment or customer interest.

3.2 It is difficult to see how these issues could be addressed within a conventional UK university research setting.

[44] See British Venture Capital Association and European Venture Capital Association investor return statistics. There is a range of returns around the average, but asset allocations by pension funds and other institutional investors are made largely on the basis of average returns.

[45] *Myths, op cit.*

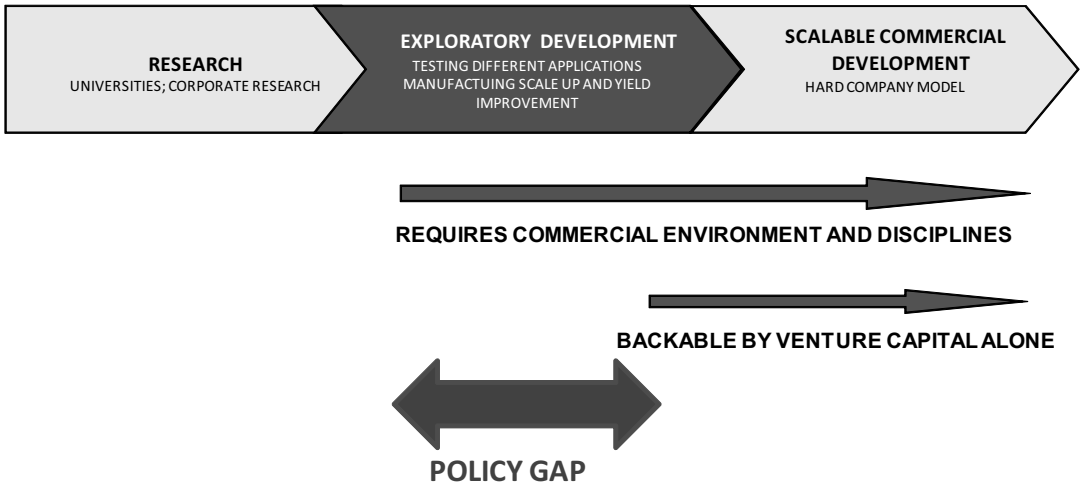
[46] *Secrets*, *op cit.*

[47] The Role of TICs in Rejuvenating British Industry; Submission to House of Commons Committee on Science and Technology Enquiry on Technology Innovation Centres Submission to House of Lords Enquiry on Technology Innovation Centres, December 2010 David Connell, Professor Alan Hughes and Dr Andrea Mina**,** Centre for Business Research, Judge Business School, University of Cambridge.

3.3 The challenge for innovation policy is compounded in the UK because in many areas of technology the natural industry collaborators are foreign companies with little inclination to commercialise in the UK. Start-ups must therefore play a disproportionate role if there is to be significant economic benefit to the UK.

4. The Commercialisation Process and Industry Differences

4.1 The process by which academic research is converted into businesses and jobs is unpredictable and non-linear, but it can usefully be divided into the three phases shown below.



4.2 The initial, *Research Phase* is typically carried out in universities, and sometimes in government funded laboratories and the laboratories of some large corporations. It typically concludes with the discovery of a new material, phenomenon, device, process, algorithm or methodology and a laboratory proof of principle demonstration.

4.3 The final *Commercial Development Phase* encompasses the work of completing the development of commercial products and bringing them to market. This is the domain of companies—particularly start-ups, together with new ventures within existing companies.

4.4 New companies are usually in competition with others addressing the same customer need, and the size and homogeneity of the US market means that companies based there can grow revenues much more quickly than UK firms. This enables them to spend more on R&D and marketing as markets mature, and to make acquisitions earlier to consolidate their position. The time taken to make the first sale is a critical factor in how successful a firm is ultimately, as this makes it easier to make every subsequent sale, as well as to attract investment. Policies to encourage lead customers therefore have an important role to play in reducing the width of the "valley of death".

4.5 In between the *Research* and *Commercial Development* phases is the process of *Exploratory Development,* during which potential applications of the research are conceived, demonstrated, turned into prototype products and trialled with lead customers.

4.6 In the case of software and some information technology hardware this process can be quite short as there is minimal technical risk. Facebook, Google and Cisco, formed by undergraduates, doctoral students and university computer services managers respectively, illustrate this. In each case successful, large scale product demonstrators, involving real, university users, were produced in just a few months. The venture capital backing that enabled the businesses to be scaled rapidly followed later.

4.7 However, in the case of the physical and biological sciences, the exploratory development phase can take years or decades. The most important opportunities are generally based on new technology "platforms", with multiple commercial applications. To define and evaluate them involves working with a range of potential users, in an exploratory manner, progressively focusing on those that look most promising. Blind alleys are common. Lead customers, prepared to pay for initial feasibility studies and the development and trialling of new technologies and products again play a crucial role.

4.8 Work to scale up production, improve quality and incorporate the complementary technologies needed to create a commercially viable product or process often takes place in parallel. Dependence on advances in other technologies means that progress takes place in fits and starts. This can take many years and be spread across continents. Only in very few cases, mainly pharmaceuticals, is the "inventor" able to secure sufficiently strong patent protection to ensure significant royalties at the end of this process. In most cases an accumulation of IP and know-how takes place over many years as the process progresses, with many parties involved. In the case of liquid crystal displays, in which UK academics played an important early role, the lead in developing

the technology passed to RCA Corporation in the US and later to Sharp in Japan, before LCDs appeared in consumer products.[48]

4.9 Large corporations are increasingly hungry for new business opportunities and operate open innovation strategies with a global reach. Intermediate research laboratories like the Fraunhofer Institutes in Germany, ITRI in Taiwan and SRI in the US are constantly searching for academic research findings to help build their own internal, more mission orientated, long term R&D programmes.[49] This process makes it inevitable that research undertaken in UK universities will mainly be exploited by overseas organisations. And the longer the lead time involved the greater the chances that this will be the case.

4.10 To increase the probability of the UK drawing an adequate return from its investment in academic research, where it has an outstanding record, it must be more effective at points in the innovation process which are closer to market.

5. The Policy Challenge and Lessons from Other Countries

5.1 The critical Exploratory Development Phase must be undertaken, not in a university, but in a mission orientated R&D environment, working to commercial standards and with strong management of IP and commercialisation rights. The challenge for policy makers is that the risks and timescales associated with this phase are too great for venture capital backing.

5.2 Two successful policy responses to this dilemma are practised in other countries.

Procurement Based Innovation Policies

5.3 The first is for public sector agencies to fund the development of demonstrators as lead customers, based on their own requirements for innovative technologies as users or specifiers. This enables start-ups and other innovative companies to operate more easily during the exploratory development phase.

5.4 US support for R&D in companies is largely based on this model, using pre-commercial procurement contracts to provide significant funding. Contracts cover 100% of project costs and enable the contractor to retain any intellectual property. This enables start-ups and other SMEs to operate more easily during the exploratory development phase. Key programmes are the Small Business Innovation Research Programme ($2.5 billion per annum) and DARPA ($3 billion). The total is considerably more than this, with probably $5–8m going to SMEs directly each year.[50]

5.5 SBIR projects are phased to manage risk and concentrate funding on the best projects. DARPA projects are also strongly milestone driven. This, and the fact that projects are funded by informed customers, helps reduce the risks associated with trying to "back winners".

5.6 The UK Small Business Research Initiative mirrors closely the US SBIR programme and has proved highly successful since it was launched in 2009. However, it is still only worth around £20m per annum and it has proved difficult for the Technology Strategy Board to persuade spending departments to increase funding levels.

Intermediate Research Laboratories

5.7 The second approach is to construct R&D institutions specifically designed to conduct the kind of mission orientated work needed during the exploratory development phase. These are typically not-for-profit organisations funded through a mixture of public and private sector R&D contracts, sometimes with some core government funding. Examples include the 60 German Fraunhofer Institutes, ITRI in Taiwan and a diverse range of US organisations, including Battelle and SRI International, originally the Stanford Research Institute.[51] SRI's most recent spin-out is Siri, which sells the voice control software used in the Apple iPhone4S. Like SRI's other more successful spin outs, Nuance and Intuitive Surgical, its technology was developed on the back of a large DARPA project.

5.8 To be successful Intermediate Research Laboratories need contracts from informed lead customers, just as early stage private sector R&D companies do.

5.9 The Cambridge technology consultancies operate in a very similar way to the Fraunhofer Institutes on which the Technology Strategy Board's new "Catapult Centres" are based, but with two differences. First, the Cambridge consultancies have had little or no government funding or development contracts and have therefore operated closer to market; and second, they have been much more successful in generating jobs in product spin-out companies. Government innovation policy has much to learn from these businesses.

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[48] Sharpe, S, A Cosh and D Connell, (2009), *Funding Breakthrough Technology: Final Report to the CIKC*; CBR, University of Cambridge, Cambridge.

[49] Mina, A, Connell, D and Hughes, A (2009), *Models of Technology Development in Intermediate Research Organisations*, CBR Working Paper No. 396, Centre for Business Research, University of Cambridge: Cambridge.

[50] Further federal R&D funding flows to small US companies as subcontractors to larger firms. *"Secrets" of the World's Largest Seed Capital Fund: How the United States Government Uses its Small Business Innovation Research (SBIR) Programme and Procurement Budgets to Support Small Technology Firms;* David Connell, Centre for Business Research, University of Cambridge, July 2006.

[51] *Models of Technology Development in Intermediate Research Organisations*, *op cit*.

6. Policy Proposals

Lead Customer Programmes

6.1 The most important thing Government can do to improve the effectiveness with which the science base is exploited is to increase the number and value of public and private sector lead customer contracts available to innovative companies. This includes early stage technical feasibility and design studies, as well as demonstrator and prototype development, and β site testing by users. This could be achieved by:

(i) Increasing the UK SBRI programme in steps from around £20 million per annum currently to £250 million per annum. This is a sum broadly equivalent to the US SBIR programme given the relative sizes of the two economies. All major government departments and agencies should be asked to participate, including the Research Councils through a Research Tools programme.[52] The Technology Strategy Board should be funded to provide half of the funding for each competition, with Departments funding the remainder and owning the topics.

(ii) Adding an equivalent sized budget for larger scale demonstration projects (above the £1 million SBIR Phase 2 ceiling).

(iii) Establishing a similar programme to encourage more private sector organisations to act as lead customers for new technologies developed by SMEs. This could be achieved within EU State Aid Regulations by adapting the TSB's multi-partner collaborative R&D grant mechanism to fund bilateral partnerships between SME suppliers and large company customers. SME support levels (ie the percentage of total project costs funded) should be at EC norms rather than the less generous levels normal for TSB programmes. Further details of this proposal are available on request. After piloting this programme, the aim should be to increase funding projects to £100 million a year.

(iv) Encouraging the European Council and European Commission to include a significant "pre-commercial procurement"[53] element within Horizon 2020, the successor to the FP7 R&D programme which is currently being developed by the Commission. To match the scale of the US SBIR, the author has called for the EC to commit €1 billion per annum to match fund national SBIR programmes on a 50:50 basis.[54]

6.2 Lead customer programmes would help move policy from a technology push to a more demand pull model. It would provide funding for the exploratory development stage and, by accelerating first customer purchases, reduce the width of the "valley of death". By helping firms adopt a "softer" start up model it would enable firms to remain independent for longer, thereby increasing their economic impact in the UK. It would also improve the flow of "VC ready" firms for those that need venture capital investment, thereby increasing average financial returns and attracting more investors into UK VC funds.

Catapult Centres

6.3 The creation of *Catapult Centres* is an important and necessary initiative for technologies with very long lead times. This programme should draw lessons from the Cambridge technology consultancies, whose experience in other areas of technology offers a valuable role model. The first Centre—in High Value Manufacturing—is really a partnership spread over seven existing locations, most of which are university based. To realise the potential of the Catapult programme, it is important that Centres are based on a single site and managed outside the university system. Capital and annual operating budgets are still unclear and need to be studied carefully to ensure the success of the programme is not compromised by underfunding.

6.4 Public sector R&D organisations easily become sleepy, so the aim should be for each to be privatised after 10–15 years, so that new Centres focused on emerging areas of technology can be created.

Universities

6.5 Excellent research universities are a vital part of any innovation cluster, but the most important way of exploiting that research is through their alumni, not the research results *per se*. The excessive pressure on university researchers to collaborate with industry and spin out new ventures has created unrealistic expectations and may even, in some cases, have been counter-productive. The focus must now switch to complementary policies to create demand pull through lead customers, private sector companies and intermediate R&D institutes. For those academics that do have technologies they believe could form the basis of an immediate spin out, a competitive grant scheme should be put in place to enable them to employ technologists from industry for one to two years to develop the proposition during a pre-venture stage.[55]

[52] Proposals for a Research Tools SBRI are discussed in: *Scientists are Customers Too*, *op cit*.

[53] Pre Commercial Procurement is the European Commission term for this kind of government activity.

[54] *Speech to member state economy ministers at the European Competiveness Council Meeting*, Budapest, 13 April 2011.

[55] Eight-19, a photovoltaic spin out from the Cambridge Cavendish Laboratory, was made possible by a scheme of this kind, funded by the Carbon Trust. It emanates from one of a number of technical projects being tracked over a six year period by CBR under the EPSRC funded Cambridge IKC.

How these Policies could be funded

6.6 Given the pressure on Government finances, the funding for these programmes could come partly from improving the cost effectiveness of the UK R&D tax credit programme.

6.7 Since its introduction in 2000 this has increased government funding for R&D in firms generally by around 600%, dwarfing other policies.[56] Three quarters of this money goes to large companies. This increase in R&D funding has been strongly welcomed by the business community, but there are many question marks over whether it represents the best way of using the money. R&D tax credits work by returning a percentage of a firm's total expenditure on R&D many months later, thereby increasing its profitability. There is no reason to believe that most firms will do anything other than spread the extra cash received across their full range of expense items, from marketing to dividends. R&D tax credits are therefore best seen as providing a *subsidy to firms that do R&D* rather than an incentive for them to do more.

6.8 Although there is no requirement for firms to increase their R&D, it seems likely that the scheme has encouraged R&D to be reported which firms did not previously treat as such, aided by eligibility extensions by HMRC. For example, the 2009 R&D Scoreboard published by BIS indicated that three of the top 25 companies by R&D expenditure were UK banks (Royal Bank of Scotland, HSBC and Barclays, up 25%, 30% and 13% on the year respectively) with a total recorded R&D expenditure of £1.4 billion. HSBC and RBS were ranked 6th and 7th respectively, just above Rolls Royce and BAe Systems. A forth company, Tesco, reported R&D expenditure of £192 million, an increase of 50% on the previous year. In 2005 none of these four companies reported sufficient R&D (ie more than £1 million) to be included in the top 750 UK R& D spenders.

6.9 For most established firms the majority of their R&D expenditure goes on incremental product and process developments with relatively little risk. As such it represents part of the cost of staying in business. Policies that focused government support for R&D on higher risk projects, particularly in firms spending a high proportion of turnover on R&D, would appear to offer greater additionality and better value for money.

Conflicts Declaration

I am a Director of TTP Capital Partners Ltd and a minor shareholder in a number of medium and small science and technology companies including TTP Group plc, TAP Biosystems, Knowledge Solutions (UK) Ltd, ZBD Displays Ltd, TeraView Ltd and Argenta Therapeutics.

February 2012

Written evidence submitted by The University of Manchester

Background on the University

The University of Manchester, a member of the Russell Group, is the largest single site university in the UK. It has 22 academic schools and hundreds of specialist research groups undertaking pioneering multi-disciplinary teaching and research of worldwide significance.

According to the results of the 2008 Research Assessment Exercise, the University is one of the country's major research universities, rated third in the UK in terms of "research power". The University had an annual income of £808 million in 2010–11.

The University has an excellent track record of successful and beneficial relationships with business and industry. Partnerships with and work on behalf of business and industry are central to the University's mission.

The encouragement of enterprise is a critical part of the University's culture. Commercialisation of our intellectual property is consequently a fundamental part of our activity. This activity is managed by The University of Manchester I^3 Ltd (UMI^3)—the University's wholly owned Innovation Group.

The University has a substantial track record of exploiting novel and innovative research findings through commercialisation of intellectual property. It currently has a portfolio of some 50 spin-out companies, and in the last four years has successfully licensed over 100 inventions to commercial parties. A number of UMIP spin out companies have achieved success securing an exit and capital return to UoM. Examples include: Nanoco, a company listed on AIM with a current market value of c £125 million; NeuTech Pharma a spin out sold to Novartis for over £300 million in 2006; and the molecular fungal diagnostic company Myconosticia sold to Cambridge-based Lab21 in 2011. A number of our ventures have also attracted significant venture capital funding, going on to launch products and generate revenues. Examples include the software optimisation company Transitive and healthcare technology spin-out Phagenesis.

We have set out below our responses to the specific questions which you have raised.

[56] This refers to funding from generally available programmes and policies and excludes expenditure through departmental procurements or launch aid for aerospace projects, for example.

1. *What are the difficulties of funding the commercialisation of research, and how can they be overcome?*

The main difficulties are that:

— Licensing proposals are typically not of interest to business angels and venture capitalists and so "risk and development capital" is not available for these projects. They can be overcome by special funding schemes in association with corporates but often even they are not interested in seeing these projects at an early stage.

— Spin-out propositions suffer from a lack of significant capital at the early stages where, generally speaking (and as with licence projects), only technology transfer offices understand the nature and scale of the potential and would be prepared to invest.

Data shows that UK venture investment, especially into early stage projects, does not have a good track record of (or is not perceived to be able to) generating better returns than other investment opportunities with shorter time horizons and arguably lower risk. It is therefore likely that it will remain difficult to secure this funding from the market in competition with other investment opportunities. The exception is the US style entrepreneur with deep domain knowledge which again is a scarce resource in the UK. An increase in the scale of venture activity would beneficially allow the kind of specialisation which would increase in turn the depth of domain knowledge.

In the absence of a fully functional market solution, much technology transfer funding therefore comes from quasi government funding. The question then is why the government should fund projects the private sector shies away from and the answer lies in capitalising on significant amounts already spent on the science base where relatively small amounts in relation to research spend could catalyse the massive research expenditure.

The original University Challenge Fund (UCF) was a very good vehicle for early stage spin-out funding, especially pathfinder and proof-of-principle funding, as noted by the Praxis-UNICO submission to this Inquiry. Another substantial funding initiative of this nature, having two significant components to it: pathfinder and then follow-on funding capability would be welcome and do a lot to bridge the gap. However, to deal with the issue properly, the size of each successfully awarded UCF would need to be in excess of the previous Scheme (this University's UCF was originally £6 million to lever some £400 million of research expenditure, ie 1.5%).

— Use of HEIF monies for licensing and spin-out proof-of-principle has been useful, as have been grants from the Gatsby Foundation and the Research Council's various follow-on schemes. HEIF is critical to this field's success.

— The arrival of the Science or Translational Funding Awards, such as the Wellcome Seeding Drug Discovery Programme, have been very important and filled a gap, especially because they are significant awards (c £500K-£millions). Whilst these have mostly been in the bioscience field, they are beginning to be available in other fields such as engineering and physical sciences and we believe that these large scale translation schemes should be supported and increased.

— The North West Venture Capital and Loan Scheme is a part of the landscape of funding though, due to the nature of some of its EU funding, there are output expectations (time, nature) placed upon the managers of these funds which often do not sit well with the longer-term nature and types/scale outcomes of research commercialisation spin-outs, which may act as artificial barriers/brakes on the decision making about such propositions.

2. *Are there specific science and engineering sectors where it is particularly difficult to commercialise research? Are there common difficulties and common solutions across sectors?*

There are particular challenges associated with many environmental technologies, in that the scale-up engineering costs, from laboratory to pilot scale and then to initial prototypes are significant (eg. wave power, wind power) and where business angels, seed investors find that the dilution effect on their investment, and the time to market, along with the associated market, legislative and engineering risks deter them from entry.

In addition, drug discovery and some other medical/life science IP remains a big challenge to commercialise because of the scale of funding required and the time from inception to market.

3. *What, if any, examples are there of UK-based research having to be transferred outside the UK for commercialisation? Why did this occur?*

There are a number of well-known examples. These are listed in the Praxis-UNICO submission.

In particular, as a general observation, overseas investors and firms appear to have more substantial funds and appetites for acquisition. This means that the UK university system, its early stage investors and the taxpayers do much of the "heavy lifting" but that, in many cases, overseas organisations derive many of the benefits. Greater leverage for the UK could be achieved by providing more capital to follow-on early investments so that the chances of them surviving in the UK or being partnered with a UK firm are increased.

A particular concern is that IP holding companies in certain jurisdictions (for example Switzerland and Luxembourg) can benefit from lower tax rates, causing in some cases an exodus from the UK.

A general point is that the UK industry base is not well equipped to support physical sciences research, especially in fields such as electronics, and hence it is not surprising that foreign companies are able to capitalise on UK university research.

4. *What evidence is there that Government and Technology Strategy Board initiatives to date have improved the commercialisation of research?*

Initiatives such as "Catapult" are in the early stages but the goal of stimulating innovation by bringing together universities and industry in this way are an important part of the IP commercialisation landscape and will do much to bridge the gap for certain types of technology developments and obviously helps by introducing the "demand pull" dimension. The new "Feasibility Studies for Technology-Inspired Innovation" Scheme is also very welcome and would be relevant to spin-outs from universities also.

More established schemes, such as Knowledge Transfer Partnerships and "SMART" are ones which the University has found especially helpful and relevant to research commercialisation.

5. *What impact will the Government's innovation, research and growth strategies have on bridging the valley of death?*

We have some discomfort with the phrase "valley of death" which implies that it is only necessary to get through this particular stage. In fact successful innovation is an interactive process in which commercialisation plans have to be effective in all stages and sometimes simultaneously. It is particularly important for many developments to secure the interest and commitment of potential customers even at an early stage. This not only gives investments more credibility, it also provides the innovator with invaluable feedback on the path to commercial products. An integrated strategy for commercialisation needs to include support for demand side measures.

However, if we turn to financial pressure points, though details of the Fund have yet to be released, the recent launch of a BioScience Fund will be an important stimulus to an expensive field of IP commercialisation.

The Policy statements from Ministers indicating that they are taking a variety of approaches to increase investments for applied research—to complement the venture capital approach to invention-led commercialisation—is the "right" way to see technology transfer since it is much broader than licensing and spinning out companies. The impact is difficult to comment upon at this stage: this will be easier to assess once the statements and ideas have been translated to specific actions/schemes.

6. *Should the UK seek to encourage more private equity investment (including venture capital and angel investment) into science and engineering sectors and if so, how can this be achieved?*

There is a distinction between "private equity" and "venture funding" and "angel investments". It is confusing and not helpful, to the university technology transfer scene, to see it as one. The track record of private equity in venture funding is variable, with 3i, as an ex public fund, closing its venture fund recently.

Universities should be encouraged to engage directly with angels and venture capital and supported in their attempts to do so. The University has been able to address this to a fair degree by "sponsoring" a dedicated (£32 million) seed fund (The UMIP Premier Fund) which is funded by institutional investors and managed by a venture capital firm, MTI Partners, which brings relevant direct links to the capital markets onto the local campus and thus allows MTI to invest the time and resource in order to gain a deep understanding of the deal-flow and the nature of the work (as opposed to a "remote" assessment on a project-by-project basis). We believe that the University's Premier Fund" has proved to be a good model, but there are others too, such as Imperial Innovations (stock market listing) and the IP Group (relationships with a number of universities). A new and larger University Challenge Fund Scheme would enable universities to create a good foundation upon which to build and/or develop new approaches as well as enable connection to these existing investment vehicles.

7. *What other types of investment or support should the Government develop?*

There should be special, dedicated schemes and funds to assist the development of universities' licensing business, since most market money (and many of the previous Government Schemes) is really only likely to be relevant for "breakthrough" technologies via spin-out companies.

Key components to success are the entrepreneurs and venture capitalists and corporate venturers who can act as mentors, sales people, and managers/directors for the spin-outs (and licence projects). The University has embraced the contribution of such individuals, through its Innovation Centre/Incubator complex. Much more should be done to include this dimension into the "more formal" professional management approach to technology transfer, eg. support for mentoring programmes, master classes, networking events, seminars, investment pitches/dragons' dens.

We draw attention also to the demand side policies mentioned above, including use of public procurement and encouraging private buyers to adopt certain types of innovation.

February 2012

Written evidence submitted by UK Deans of Science

BACKGROUND

1. UK Deans of Science (UKDS) is a national body that seeks to represent the individuals, usually formally designated as Deans, who are responsible for science in HEIs across the UK and who generally hold the budgets for science including any research budgets. Its primary aim is to ensure the health of the science base through the promotion of science and scientists and of scientific research and science teaching in the UK.[57]

2. This response has been prepared by circulating the terms of reference of the inquiry to all our members, producing a draft response before discussing and finalising it at a meeting of the Executive Committee. The comments are mainly restricted to the challenges of commercialising research that originates in universities, while recognising that the vast majority of commercialisation occurs in industry.

What are the difficulties of funding the commercialisation of research, and how can they be overcome?

3. Commercialisation is driven by entrepreneurs, not by Government nor, except in a relatively few cases, by universities. Commercialisation of university research is highly dependent on there being sufficient, sustainable funding for high quality basic and applied research to be carried out. Within the great deal of world class research that is carried out only a small proportion of a university's research portfolio is likely to provide commercial opportunity. Amongst this, the great majority of projects will be at Technology Readiness Level (TRL) 1–3, barely at proof of concept level, when they emerge from university studies. Funding directed at developing prototypes through to pilot systems (TRL 4–7/8) is needed to promote good ideas into commercial ventures. This would best be supplied in the form of staged funding and/or other incentives to encourage either UK companies to work with TRL3 material and develop this in concert with the inventors and others to commercial prototypes, or to encourage inventors and others to develop the opportunity themselves, to form new companies and take on potentially high risk, market opportunities if no existing company is interested.

4. There is often a propensity to try to retain the commercialisation of research within a university or to offer relatively unattractive licensing terms for work which is only at TRL-1 or TRL-2. UK universities have created a significant number of new companies but these tend to be fairly small and underderveloped and need investment and the involvement of professional management to take them forward and to generate significant revenues. This process takes time as well as money and talent, making such ventures high risk. The general economic situation, the lack of investment funding and the increased aversion to risk by investors, all increase the width and depth of the valley of death, so many otherwise viable propositions will either be stalled or lost completely unless action is taken.

5. In addition to the financial risks and the challenges of finding commercial partners there is a question as to how far a university should extend its traditional role of teaching and research to encompass commercial activities that others are better placed to do. Thus many reports have suggested that universities and public research bodies should regard the IP they create as supporting wider societal and economic benefit rather than expecting commercialisation to deliver a significant income stream.[58]

6. In summary, actions that could be taken to support commercialisation of university research include:

- a proof-of-concept fund to bridge the gap between concept and commercialisation. Such funding would also help de-risk projects. Consideration should be given by Government to co-invest in such schemes alongside established investors. There should be clear recognition that this is high risk funding. Application procedures should be simple and not require full business plans or submission of detailed monthly accounts, etc. for such early stage development, though a steering panel should be appointed to supervise the project;
- continuation of more progressive IP policies with "easy access" to HEI IPR as a key mechanism to encourage early stage uptake and commercialisation of university IP;
- review and rationalisation of support networks. In 2009, one of our members, using information published by Scottish Enterprise, found that there were more legal advisers advising biotech startups than there were actual startups;
- universities creating further mechanisms to facilitate research commercialization;
- Governments and the devolved administrations in Northern Ireland and Wales increasing their support for commercialisation of research, for example by funding of joint university/industry research programmes, with the companies funding a fixed percentage of the full research and development costs in return for the right to exploit the results of the programme;

[57] www.deansofscience.ac.uk

[58] See, for example, *Intellectual Property and Research Benefits*, Wellings 2008, *The Race to the Top*, Sainsbury, 2007.

— new local, national and international initiatives to enable universities to identify and engage with end-users and commercial mentors and non-executive directors who can advise and work with senior academics to bring IP to commercialisation. Such individuals have been located by some universities creating groups of suitable contacts, for example through University business angel clubs and Managing Director network clubs as well as using specialist head hunters;

— consideration as to whether aspects of the Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO) might be introduced into the UK; and

— further initiatives to encourage secondments to university departments.

7. Above all it Government must recognise the impossibility of predicting future needs of the applications of science and fund basic science accordingly. In life sciences there are times when the concept of a commercial proposal is very clear but the technique to deliver it is not available or not fully developed; conversely, there are cases of a major breakthrough in development of a technique, not specifically designed to answer just one problem, but having very wide applicability (eg DNA sequencing, polymerase chain reaction). Difficulties may also occur when an invention is effectively complete. For example, in the development of an oral vaccine where there can be a lack of platforms in the UK to complete trials to bring the ideas to the market.

8. Whatever initiatives may be taken, it is essential that they enable the taking of major risks to commercialise inventions while protecting the financial health of a university.

Are there specific science and engineering sectors where it is particularly difficult to commercialise research? Are there common difficulties and common solutions across sectors?

9. Inclusion of this question suggests that the Committee recognises that different areas have varying potential for commercialisation. While "traditional" science and technology areas have been the source of some considerable success in terms of commercialisation (for example, ICT, life sciences, chemistry, physics, engineering, etc) the most successful commercial outcomes measured in terms of revenue returns to the university can originate from less likely areas and from work at the intersection of several disciplines.

10. There are few areas where it could be said to be "easy" to find backing to commercialise research outcomes. These tend to be in disciplines such as web-based or software development where a product is almost ready for delivery and the market opportunity is fairly obvious. Areas in which there is a major challenge to find sufficient funds for commercialisation include sophisticated engineered products and systems, novel materials, new therapies and medical technologies, biotech, pharma and, perhaps particularly, in new clean technologies where the financial return is often unproven and any developments have substantial lead-times to market making them unattractive investments to any but the largest companies. However, in counter-argument to this, some very large companies are the most resistant to very novel ideas, wishing instead to buy up successful companies or near to market inventions.

11. Although being critical to the support of the world class research base in other disciplines, mathematics has the potential for perhaps the wide and deepest "valley of death". Most cryptography and cyber security relies on mathematics developed many decades (and sometimes centuries ago). While it impossible for government to plan so far ahead, the discipline must be kept vibrant and viable through appropriate funding and supported where appropriate to commercialise its outputs, with Information Security being an example of the usefulness of mathematics that needs to be nurtured.

12. At least some of the solutions to the difficulties mentioned here have been described in the response to the first question above. However, setting up regular broad-based UK "technology exhibitions" as a focus for R&D organisations and companies could bear fruit across different sectors, where an aggregation of technology and information can be brought together to generate new product opportunities.

What, if any, examples are there of UK-based research having to be transferred outside the UK for commercialisation? Why did this occur?

13. Generally transfers can occur either directly from the research laboratory, or when a small company is bought out or invested in by overseas parties. This is normal and natural. However, if UK companies and investors could be encouraged to take a longer-term attitude to opportunities (as they do in Germany and Scandinavian countries) we might succeed further with more home-grown commercialisation.

14. In other cases the specific nature of the work may give rise to overseas investment as illustrated by the following examples. There are other (often confidential) examples where the research that has been contracted by an overseas company has been commercialised outside the UK by that company.

— Many thousands of sites worldwide exhibit contamination of soil, groundwater and surface water by hazardous industrial chemicals. These chemicals, such as fuels and solvents, pose a serious and long-term threat to soils and water quality. With funding from Scottish Enterprise's Proof of Concept programme, researchers at the University of Edinburgh developed novel remediation technology for the removal of hazardous subsurface contamination. When no UK licensing partner could be established, the technology was eventually licensed to a Canadian company and is under-going successful trials in the USA.

— One of the greatest commercial successes in Lancaster University was the development of a novel technique for the irrigation of high value fruiting crops. The technique reduces the amount of irrigation water applied, maintains crop yields and increases fruit quality leading to a significant increase in wine quality. As a result, the impact of the technique, now widely adopted, is measured in £Ms. While there has been subsequent investment within the UK to develop the technique domestically, a clear market demand overseas (in Australia) drove rapid commercialisation. Critical to this commercialisation was the existence of the Commonwealth Scientific Industry Research Organisation (CSIRO), established to ensure rapid commercialisation and impact of national science programmes into all areas of the Australian economy, more often than not, in close partnership with major national industry sectors (such as the wine industry). We may draw a passing parallel with this organisation and the network of Catapult Centres being established by the TSB in the UK, although the Australian investment in CSIRO is significantly higher.

What evidence is there that Government and Technology Strategy Board initiatives to date have improved the commercialisation of research?

15. Our members have commented favourably on a number of national initiatives including HEIF, KTPs, Innovation Vouchers and SMART awards, the Scottish Enterprise Proof of Concept programme and the TSB funding calls that have all contributed to, and improved, commercialisation and knowledge exchange.

16. External evaluations of the KTP programme indicate that funding that increases dedicated human capacity to commercialise research and has significant (additional) impacts in terms of new product and service development and employment, much more so than the simple supply of financial grants to carry out commercialisation. Interventions which continue to focus on the training and development of dedicated R& D staff in SMEs should continue to be supported as a priority. However, there are some disadvantages to universities in KTPs as the university supplies much of the expertise, it may be mentioned in a patent, but not share in the profit accruing from successful projects.

17. The excellent industry-led funding calls from the Technology Strategy Board are generally at the very applied end of the research spectrum rather than directed to commercialisation. It is possible that a similar approach aimed at facilitating commercialisation of research following from TSB collaborative R&D projects would be helpful.

18. We believe that useful lessons may be to be learnt from the Scottish Enterprise Proof of Concept programme, which has led to several successful new company formations in key technology areas. Such funding can encourage significant private investment in a project. Unfortunately in spite of beginning as a programme with a light touch, increasing regulation means that the programme is now less well regarded.

19. Although there are several positive statements to be made about TSB and other initiatives, national statistics continue to indicate that the UK lags seriously behind its international competitors in the proportion of GDP that is devoted to research and development. What is even more disturbing is the rate at which emerging economies are increasing their investment in science (the BRIICS). The TSB might better perform more matchmaking between R&D providers and UK businesses. The Catapult Centres may encourage this, but the opportunity should be available for any TRL3–7 development project to bid for TSB funding.

What impact will the Government's innovation, research and growth strategies have on bridging the valley of death?

20. These strategies are unlikely to have a significant effect without the Government agreeing some quantitative measure of success. We noted with deep concern that it decided to drop even the limited target of the previous Government of the (very low) figure of 2.5% of GDP being spent on research and development. It has also decided to stop funding the excellent R&D Investment Scoreboard so will have almost no robust way of judging the success or failure of any of its policies. Unfortunately it would seem that the more government money is made available, the more potential equity investors withdraw and demand that even more risk be eliminated before they invest their money. It could be better to stimulate investments through further demand side action through fiscal changes rather than seeking to address the delivery side.

21. However, some actions can have a beneficial effect for example:

— initiatives such as SBRI, improved R&D Tax Credits and increased tax incentives for private investment in very small companies can provide pragmatic help in bridging the valley of death. These encourage sustainable "organic growth" of young companies, in which, in the current environment it would be very unrealistic to expect significant bank or venture capital funding;

— policy incentives driving closer collaboration and sharing of services in universities offers significant opportunity for HEIs more effectively to collaborate, combine and commercialise the outcomes from research;

— leverage of TSB funding with European Regional Development funding which should aim to ensure these regionally funds are more closely aligned to technology commercialisation, rather than low-level business support; and

— the UK- China (and other) science programmes should attract more UK and international venture capital and increase collaboration between companies and UK (and Chinese universities) as well as gaining easier access to certain export markets.

22. There is much support for SMEs, though it needs to be channelled to those companies that have real potential for growth. The high tech, high growth companies may have the potential to punch above their weight and lead to notable wealth and job creation, but they probably only exist in a very few sectors such as IT and medical technology. Many other SMEs are low tech and are unlikely to achieve significant growth in the near future or contribute to the UK's strategy to become a high technology, high value-added economy. In contrast, support mechanisms for universities to work with large companies, who may be better placed in some cases to commercialise research, do not seem to be available.

23. It is too early in the lifetime of Catapults to evaluate their usefulness in research commercialisation but hopefully this will happen in the limited number of sectors where they have/are being established.

Should the UK seek to encourage more private equity investment (including venture capital and angel investment) into science and engineering sectors and if so, how can this be achieved?

24. Categorically, yes.

25. One of the major issues is the scattered nature of intellectual property across the university sector. Any policy that encourages connectivity across universities to pool their IPR offer whether nationally or locally would make it easier for venture capitalists and business angels to understand the range of opportunity available.

What other types of investment or support should the Government develop?

26. Further support could include:

— more incentivising of universities to develop their contacts with alumni, perhaps through a fund similar to the matched funding that was set up by to encourage philanthropic donations;

— focussing on increasing the intake of high quality graduates into the SME sector; and

— more short-term posts based in industry, specifically to support university-industry collaborations on a regional basis.

27. Above all, where SMEs exist that have the potential to deliver high technology, high value added scientific manufacturing and R&D it is essential that they are enabled to operate in science parks, preferably near universities, or where this is not possible, exist within networked clusters that may also include connections with large companies.

February 2012

Written evidence submitted by SME Innovation Alliance

1. The Select Committee's questions lie at the core of concerns of the membership of the SMEIA (see below for a brief history of the SMEIA and affiliations and interests of the author).

2. We can report the consistently expressed opinion of the membership, however it is a frustration of all concerned that factual data is in very short supply, we believe this absence almost certainly lies at the root of the UK's inability to improve its performance significantly in this sphere. There is a further frustration that the SMEIA and precursor bodies have been engaged with government at a high level over the last 20 years, and there are things which we "know" because they were disclosed to us in discussions bound by the Chatham House rule, which we therefore cannot attribute.

3. The "Valley of Death" is now a recognisable term, but it is really only the most extreme manifestation of a far more widespread and deep rooted problem. Mixing metaphors, the UK science and engineering industry is now suffering the "perfect storm" in which very many factors interact, nearly all of them negatively and in a very complex fashion. The SMEIA committee have spent enormous effort trying to separate cause and effect, and to work back to any more fundamental root cause, and we do now feel that we have a considerably better understanding, even though that understanding is far from complete. This analysis does however suggest that many of the matters which exercise debate with and within government, particularly with DBIS and the TSB, are still dealing with the surface symptoms, and are very far from tacking the deeper roots. Much of this document is therefore concerned with setting this context.

4. The SMEIA membership are small companies (mainly very small) in the high technology area, and the representatives on our committee and at our meetings are the senior officers of these companies, most of whom will travel widely, will normally do business internationally, and often interact with universities both here and

abroad. We are therefore very aware of the ways that our competitor nations deal with similar problems: there is very considerable frustration at the comparisons that we make. We see that the UK could do so much better.

5. We conclude that the most fundamental root problem is simply that we are not culturally a technological nation. The media make some excellent science programmes, but consistently they "dumb down" the science. Senior BBC presenters feel no embarrassment in admitting ignorance (and incompetence) in science and practical matters. Bizarrely the BBC has rebranded the word "Technology" to mean only what we would call ICT.

6. We have a "generalist" civil service, and so our members and other industrialists have highly asymmetric conversations with senior officials. They believe that they do not need to understand the detail of what we are saying, and that they can make important decisions on "technical advice". We disagree and believe that the lack of scientific and industrial expertise within the machinery of government, which should stay within departments and build departmental knowledge, is a severe impediment to UK policy formation, and again is in contrast to practice in our more industrially successful competitor nations.

7. This national attitude is certainly recognised in schools, which struggle to get sufficient pupils to take science subjects, and teachers to teach them.

8. This also extends to lack of understanding within government of industrial structures and organisations. Both industry and the unions have been screaming out for better technician training, whereas until very recently governments expanded the universities. In our more successful competitor nations the very high skilled technician is a very well rewarded, high status individual. It is not better or worse than an academically based career, but it is certainly different, and it would appear that this difference of function that is really not understood. Whilst UK employers in the engineering sector struggle to get academic engineers and scientists of adequate quality, they struggle far more to get technicians, on whom the output of saleable, revenue generating products largely depends.

9. HMG over many decades completely lost the plot on manufacturing. Despite a very public reversal of policy by the coalition government, there appears still to be little understanding of manufacture, with reversion to the old understanding lurking in the background. In the 1980s and 1990s it was true that the low wage economies had a massive advantage, simply because everything was so labour intensive. But with automation the playing field is almost level. Current policy is to concentrate on automated manufacture of high added value goods, whereas high technology automation of low added value, high volume (and high shipping cost?) commodity goods is equally possible, and may be far more effective in balance of payments improvement. Manufacture appears now to be a separate agenda item from the "knowledge economy", whereas it should be seen as the prime means of exploitation of that knowledge (they are two sides of the same coin).

10. After the national attitudinal problem, the next most basic is probably the structure of our economic system. We own our houses and rent our factories is a pretty reasonable summary of the UK, and is in stark contrast to Germany. This is now getting right to the heart of the problem that the committee is investigating. The UK has high house because there has been no other sensible place to put the fruits of our earnings. If we want to finance businesses to generate wealth, then the banks have to have deposits, and savers have to get a healthy return on their cash, but savings interest is treated as "unearned income" and taxed. So there is little point HMT bemoaning the UK's low savings ratio: they are in command and their policies have caused it to be so.

11. This cuts the other way: because we rent our factories, most businesses have relatively low capital assets on their balance sheet to use as collateral for borrowing. Structurally, small UK businesses are in a far worse position to take risks. Because we rent both our premises, and often our means of production (machinery), companies do not generally build asset value over time. Again a lot of this is the result of long term government (lack of) policy. A study of any industrial estate will show a high rental vacancy rate and very little freehold property. HMRC policy gives far higher allowances against corporation tax for rental and lease, and by comparison almost penalises ownership.

12. The banks are now in sharp focus, and anecdotally there are currently many horror stories of loan facilities being withdrawn. However the banks are being asked by HMG to do something that they should not. "Normal" banking is not about the bank taking a risk with depositors' money, but of providing cash against underlying assets, so that a company can realise some of its asset value as working or risk capital. As above, our small companies do not have those collateral assets.

13. Something we have urged HMG to research is the actual current means of funding small companies. Typically a business owner will have a massive overdraft, and in the last 20 years will also be a heavy user of credit cards. The reason is very simple: the credit card companies do not seek personal guarantees, nor the very onerous standard bank debenture agreement which will have a clause such as "the bank may at any time at its sole discretion and without any other cause seek a winding up order for the company".: we believe that this is a major barrier to borrowing in the UK, and ought to be illegal. We would expect that HMG would discover that a large chunk of the current personal debt is in fact disguised small business borrowing.

14. A final structural element of the UK small business environment has been the progressively increasing influence, and actual effect, of all the vested interest groups. Each of the statements below looks, and is, a

statement of the obvious, but is also an explanation as to why the UK environment for businesses is so complex. We have submitted opinions in Reference (2) cited below to DBIS, in summary;

(a) We have very complex tax law, largely drawn up by consultation between HMRC and the accountancy profession.

(b) UK commercial legal practice is disputational, every commercial agreement is written afresh, whereas some of our competitors enjoy standardised contracts.

(c) The patent system does not work for SMEs, see Reference 1.

(d) Our technical regulatory bodies now work almost entirely in the private sector, but administer the access to legally required compliance (= legalised printing of money).

(e) Our financial institutions are all focused on capital gain, short term aims, and export profit from clients to themselves.

(f) The public sector "business" support organisations achieve very little good for business.

(g) The universities now do appear to have the ear of government in an entirely disproportionate way, and almost all recent policy appears to have been determined by what the universities advise about "their" spin-out technology businesses, and does not align very closely at all with the advice that would have been given by the massively larger body of truly commercial technology businesses. SMEIA is aware that university based networks have been collecting data for submission to this call for evidence: this appears benign, but the questionnaire approach reflects the preconceived views and will thus inevitably skew the evidence.

15. A final and perhaps most important structural element of the UK business scene is that we have very few, long established medium sized industrial companies, we are missing the equivalent of the German "Mittlestand". We also have relatively few big independent companies, whereas we are well populated with huge multinationals. This gives us a very discontinuous supply chain, the UK's very large number of small companies struggle to sell their products to bigger companies, and the same applies to their technology, there is generally very little "pull" (demand) up the supply chain in the non-bio sectors.

16. It is in this general business context that the particular questions of the "Valley of Death" must be considered.

17. The general scenario is of a company with some germ of a new idea. Mainly the SMEIA member companies have the R&D capability in-house and so some early proving can be done out of "own funds". It is then normally possible to apply for grant funding (from the SMART and other TSB funds). There are two problems with this process:

(a) There can be considerable delays (this has got better).

(b) Most funding schemes are "matched funding" (say 60%) and the problem is in finding the other 40%.

18. Generally these problems can be overcome, perhaps by a "Friends and Family" funding round to meet the matched funding requirement. A considerably better alternative is "procurement" funding, at 100+% of cost, as is very successfully operated by MOD/CDE.

19. This process generally leads to something that is effective "proof of concept" and which is patentable. Whilst the patent system is considered dysfunctional, if future funding needs to be raised, patents must be applied for, and a cost base starts to be established.

20. The lack of supply chain "pull" and continuity means that exploitation by partnering with a bigger organisation is less common than perhaps it should be.

21. This is the edge of the "Valley of Death". It is recognised that total funds available "in the market" do not meet demand, but this is not quantified: HMG have no estimate of the need. It is however easily calculable by analysis of the figures from the www.pwcmoneytree.com website which lists US funding deals. By suitable scaling we could have a reasonable estimate of our shortfall: it is a massive number.

22. Access (ie contact with) to funding sources is now far better through investment networks, but the mismatch between need and available funds mean that investors can cherry pick. Generally the "network" angel investors will have the same attitudes as the VC community, which is in short term capital gain, whereas HNW individual investors operating privately, and PE houses, might have slightly longer term.

23. Very good projects can get funding, but often on conditions that the company feels are too onerous. The investor's requirement for capital gains will mean a high "burn rate" of funds, normally seeking more funds in one or more subsequent rounds, with an "exit" for the funds by selling the company on, these days predominantly by a trade sale. The effectiveness of this method of company development is questionable, and very variable between scientific sectors.

24. It appears to work well in the medical, pharma and biotech sectors, where a lot of the initial R&D work is done in universities, and where the nature of the technology is readily transferrable, with the big pharma and medical companies encouraging this business method.

25. Anecdotally it seems that HMG has adopted this as the "standard model" upon which technology policy is based, whereas it is in fact only applicable in bio based sciences.

26. VCs are prepared to take a loss and abandon a project, and this means that the technology will be lost, and this constitutes continual attrition of the industrial technology base that the UK could have had.

27. The VC funding model is also a systematic means to export UK technology. The vast majority of funds come from overseas. If a company has three funding rounds, and if 80% of funds are non-UK, then mathematically the chances of control remaining in the UK after three rounds is 0.8%!

28. Attendance at any investment network meeting will show that bio-science start-up companies aim to give investors an "exit" by a sale to the large multi-nationals for sums in the region £20–£50 million. This is sufficient for a return to the investors and kudos to the R&D teams, but it is selling UK technology short, precisely why the big companies in these sectors are so willing to buy.

29. The alternative for a company with an idea is not to take this funding, and in general such companies will continue, but will not grow, and will not manage to make much money from their technology (DTI did say it had figures from the 1990s to support this).

Recommendations

30. The first is that there are no quick fixes. There are a list of things which our members will consistently say should be done, and a few things which should not be done, but the overriding and consistent message is that this is a structural rather than a particular problem, and it will only be fixed if the underlying problems described above are dealt with properly and systematically.

Research Needed

31. In pursuing this policy the first thing that is necessary is for DBIS and HMT establish and publish some background facts, including:

(a) What annual sum of risk investment money is needed for the UK match our competitor nations in the commercialisation of technology?

(b) What is the shortfall of working capital in the industrial sector, and how are business actually funded now?

(c) What is the rate of export of UK technology through the VC funding?

(d) Investigation of the effects and distortions of all the vested interest groups in the UK

(e) What proportion of genuine innovation happens in each of the SME, large corporate and university sectors?

(f) A thorough revisiting of the patent system as it effects the SME sector, something the recent Hargreaves review promised but did not do (SMEIA has these promises by email)

32. The Dos

(a) Set up a national industrial bank or banks, or mutual banks, to bring competition into general commercial finance, to the general bank lending sector.

(b) Set up new institutions (see CrowdCube.com) that can be effective to bring the general public's and mutual funds to play in the risk finance sector.

(c) Pull the TSB back from playing at "Dragon's Den", themed competitions, timed "calls" and get them to stick to funding projects quickly and simply on pure merit.

33. The Don'ts

(a) Expand the "business support" networks: they are a distraction and simply cost money.

(b) Allow publicly funded institutions any role in "picking winners" or strategic planning of funding themes.

(c) Use any panels of the "Great and Good" to judge or select winners: such panels will always pick the well presented, apparently "safe", project and miss the exciting and good.

Author and Affiliations

The author of this report is Tim Crocker, on behalf of the SME Innovation Alliance (www.smeia.org). SMEIA was formed about two years ago to represent the views of small high technology companies, working across all sectors. It had its origins in part in the two remaining SMART clubs set up in the early 1990s by DTI for the winners of the SMART awards. Member companies will typically be multiple award winners (SMART, GRD, TSB, CDE, FP7) and the principals will most commonly have a strong scientific or R&D background prior to setting up their own companies. Tim Crocker (www.scimar.co.uk) is a physicist and electronics engineer, with 38 years in the electronics industry, five of them as a government scientist, with academic work in deep sea sonar. He has a large patent portfolio, is CEO of his own company, has been founder of seven other high tech companies, and is currently a director of four of them. His is the lead

researcher on motors and electronic drive components within the SAFEDRIVE FP7 project which is developing hybrid vehicle technology. He has other recent technical and commercial interests in wind turbines and LED lighting.

REFERENCE MATERIAL (obtainable from the SMEIA website)

1. The Economic Failure of the Patent System, by John Mitchell.

2. Joint submission of SMEIA and the East of England SMART Club to the Willetts R.I. review, by Martin Lawrence and Tim Crocker.

February 2012

Written evidence submitted by The Aerospace, Aviation & Defence Knowledge Transfer Network (AAD KTN)

BACKGROUND TO AAD KTN

AAD KTN is a single overarching network for the Aerospace, Aviation and Defence sectors spanning Government, Industry and Academia with the principal aim of promoting and enabling innovation in the UK.[59] The AAD KTN is funded by the Technology Strategy Board (TSB) and has around 3000 members. Aerospace, Aviation and Defence as combined sectors employ close to 500,000 people through some 9,000 organisations in the UK. Aerospace continues to be a UK success story being first in Europe and second only to the USA in terms of turnover;[60] Aviation contributes some £8.8 billion to the UK economy;[61] Defence industries' success lie in their ability to export leading edge technology valued on average at £5 billion per year.[62] The growth of global air traffic over the past 50 years has been substantial and forecasts indicate that it will continue at some 5% per annum.

The majority of the KTN activity takes place through 13 National Technical Committees (NTCs) and by having the custodianship of the National Aerospace Technology Strategy (NATS).[63] The NTCs are forums facilitated by the AAD KTN which are focused around key technology themes with experts from industry, academia and government with a remit to advise on future R&T priorities that should be invested in. The National Aerospace Technology Strategy represents the UK national aerospace technology plan developed and delivered by a multi-stakeholder forum comprising of industry and university representatives, alongside government departments and agencies.

Since 1 March 2011, the KTN's remit extended into aviation related activities and now has six priority themes:

- National Aerospace Technology Strategy.
- Autonomous Systems.
- Aviation and the Natural Environment.
- Maintenance Repair and Overhaul (MRO).
- Passengers and Security.
- Introduction of Biofuels to the airport infrastructure.

The KTN is also host to two pan-KTN programmes working across Space and Defence communities. In Space the KTN is the custodian of the National Space Technology Strategy (NSTS) and in Defence the KTN is catalysing Science and Technology connectivity between the MoD and non-defence communities. These programmes attract a further membership of around 3,000.

The AAD KTN's response the questions posed by the Science and Technology Committee is as follows:

1. *What are the difficulties of funding the commercialisation of research, and how can they be overcome?*

1.1 From the various interactions with our membership the KTN believe the funding landscape within the UK has become complicated to navigate with a vast portfolio of initiatives. Ranging from the SME focused assistance through to the recently re-badged SMART scheme now delivered by the TSB to the Regional Growth Fund, aimed at generating employment, operated by the Department for Business, Innovation and Skills. The KTN can spend much time assisting organisations, large and small, in understanding this landscape explaining how all the support mechanisms fit together. There is a need for the landscape to be presented to the SME, the entrepreneur in such a way that it is able to articulate its need and identify the mechanism to assist them more easily.

[59] www.aeroktn.co.uk
[60] UK Aerospace Industry Survey 2010.
[61] *What is the contribution of Aviation to the UK Economy*, Oxera Report, 2009.
[62] UK Aerospace Industry Survey 2010.
[63] https://connect.innovateuk.org/web/national-aerospace-technology-strategy-nats/overview

1.2 The success of the UK aerospace industry depends on the ability to deploy world-class technology, which requires long-term investment in research and technology. Aerospace is also a safety critical and highly regulated industry. It typically follows a technology development cycle constrained by regulation and certification. New technology can take up to 15 years to progress from basic science to product application. This can therefore result in long payback period for investments made in technology development which can be a challenge for the supply chain, even the larger companies.

1.3 If there is a need for both government and industry to demonstrate impact as a result of joint working through SMART, SBRI, KTP or other such mechanisms then it would be advantageous for the metrics across the innovation landscape, Research Councils to the Technology Strategy Board to the Regional Growth Fund to be better aligned. For instance, Research Councils metrics could cover demonstration of KTP or Feasibility Study follow through; KTP could demonstrate Collaborative R&D follow through as a measure of success. If metrics are to be used to demonstrate impact, then it is the KTN's belief that the metrics could and should be used to drive the right innovative behaviour across all sectors.

2. *Are there specific science and engineering sectors where it is particularly difficult to commercialise research? Are there common difficulties and common solutions across sectors?*

2.1 Aerospace/aviation, nuclear, space and marine are highly regulated thereby represent sectors where it is harder to commercialise research due to the additional hurdles that exist. The latest aircraft are increasingly complex "systems of systems" and their often large size poses technological challenges in their own right. Development work is spread not only across the initial R&D process, but also into the vehicle's operational phase, since aircraft and their systems are modified and updated during their operational life, which may be several decades long. The aerospace industry is very conservative in terms of exploitation of innovation because of the certification requirements. New entrants to the aerospace market can find it difficult as they have to demonstrate the appropriate "worthiness" and must be prepared have a long term plan. Some of these issues reside in the also fragmented and complex regulation landscape of aerospace, there are currently multiple bodies and organisations that are involved in regulation, but there is no overarching approach.

2.2 The space community upstream is also heavily regulated with even longer timescales of delivering technology through to completion and yet it is recognised that the value of the downstream space sector is significant. For the UK to truly take its 10% of the forecasted £400 billion Global Space market over the next 18 years as stated in the Space Innovation and Growth Strategy then there is a need to balance short term investments with long term investments to secure the UK's access to satellite based data.

3. *What, if any, examples are there of UK-based research having to be transferred outside the UK for commercialisation? Why did this occur?*

3.1 Other "traditional" aerospace nations and increasingly the emerging aerospace economies support research and development activities of their aerospace sector. In an increasingly global industry with countries keen to develop their aerospace industries, companies have a broad choice of country in which they locate their facilities. This remains a potential threat to the UK that aerospace manufacturing will move overseas. All the major aerospace companies have started this process and initially the activities moved offshore tended to be the ones that will benefit from cheap labour rates. The danger is that as the overseas economies become more technically sophisticated, a mass move of R&D activities will look increasingly attractive. The decision to move offshore is not a straightforward one and for aerospace this can be influenced by other factors such as the need to access a particular market (such as the US or Asia) or a skills base.

3.2 The UK was not in a position to secure the carbon composite wing skins for the latest Airbus aircraft A350XWB due in part to the long term investments of other "Airbus" nations (Spain and Germany) in composite capability. The UK has responded to the challenges and opportunities of composites with several significant investments including the National Composites Centre based in Bristol, now part of the High Value Manufacturing Catapult. The Catapult centre has the potential to become an extremely valuable initiative for advanced manufacturing sectors such as aerospace as they represent a longer term plan of Government and industry collaboration.

3.3 Rolls Royce continues to make investments in the UK, but has made significant investments, including R&D facilities, in Singapore, Germany and the US. In Singapore, a large number of companies have clustered around the Seletar Aerospace Park where for instance Rolls-Royce have based a Trent aero engine assembly and test facility, a wide chord fan blade manufacturing facility as well as a regional training centre and Advanced Technology Centre, an integral part of the Rolls-Royce global network for technology research.

4. *What evidence is there that Government and Technology Strategy Board initiatives to date have improved the commercialisation of research?*

4.1 The Catapults centres have the potential to be a valuable initiative. The High Value Manufacturing (HVM) Catapult represents an opportunity where UK government investment can assist industry by providing access world leading manufacturing capability, both in terms of equipment and academic knowledge. In effect, the HVM Catapult assists those companies wishing to de-risk manufacturing technologies and processes to such a state where they feel confident in the business case to make the necessary investments in capital equipment.

4.2 The TSB's Collaborative R&D funds collaborative projects which not only support industry to industry activity but also academic to business research activity. In certain cases where the academic content of a project is of a high standard, the Research Councils are in many cases able to support the academic content. The collaborative working relationship between the TSB and the Research Councils will be essential in assisting the process of transferring scientific research into industry.

4.3 EPSRC, a major focal point for the aerospace sector, are increasingly looking to ensure the investments in scientific research are aligned to the interests of industry and will look for academia to confirm the impact of any proposal. However, it must be recognised by all parties that industry focused research has to be balanced with the need to allow academia the opportunity to look at blue sky research. A positive move to support commercialisation of scientific expertise EPSRC has supported portfolio of Centres for Innovative Manufacture to allow industry access academic research capability at the low technology readiness levels.

4.4 The role of NATS and NSTS is to articulate an agreed set of priorities for the UK aerospace and space sectors to preserve and expand its position in the global aerospace industry.

5. *What impact will the Government's innovation, research and growth strategies have on bridging the valley of death?*

5.1 The UK government has committed to maintain the science and research budget at £4.6 billion per annum and so able to continue to support a wide range of sectors covering the seven research council remits. However, at approximately £300 million per annum, the TSB are not in a position to assist UK industry transfer research from such a wide spectrum into more commercialised products. The competition for TSB investments is fierce, and whilst competition is advantageous, leads to strong and focused businesses, the very high levels of over-subscription are indicative that should the TSB budgets be increased then more R&D would be de-risked here in the UK thus creating greater opportunities for commercialisation of innovation.

6. *Should the UK seek to encourage more private equity investment (including venture capital and angel investment) into science and engineering sectors and if so, how can this be achieved?*

6.1 The KTN believes that the UK needs to encourage more private equity investment but recognises there is a potential mismatch in expectation as aerospace suffers from long term payback whilst the private equity community look for short term return on their investment. However, once secured on an aerospace platform, there is the likelihood of the commercialised product generating a long term income flow. An opportunity could exist to bring the private and industry close together. If information was published on the successful recipients of UK government grants, this could highlight to the private equity community potential opportunities in the future. There might also be an opportunity due to the over-subscription of grant applicants for those not successful in obtaining grant but deemed to be worthy of support by the assessment process to be flagged up the private equity community.

7. *What other types of investment or support should the Government develop?*

7.1 In addition to national governments' support for research, the EU supports research at the European level. Companies pursue their national competitiveness through national programmes but get extra value in wider collaborations at the European level. A strong national capability, supported through a national programme puts the companies in a good position to win a significant part in European projects. This "leverage" function should not be underestimated in value to the UK.

7.2 There are some resources to assist UK supply chains in accessing/navigating the EU landscape. However a greater level of resource to assist this process would ensure that UK businesses could increase access and share of the EU funds. The Innovation and Research Strategy has identified further staff resources for the TSB to help leverage EU funding however a TSB presence permanently in the EU with a resourced, knowledgeable team whose sole purpose was to represent, inform and connect would improve the UK's draw down of EU funding.

February 2012

Written evidence submitted by the Wellcome Trust

KEY POINTS

— The valley of death is not merely a funding gap. While funding is important, it is equally important to provide access to the right skills, support and infrastructure to facilitate research commercialisation.

— Commercialisation is particularly challenging in the life sciences sector, due to the long time frames, significant capital requirements, and the higher regulatory barriers associated with products intended for use in humans. However, these difficulties have also allowed innovative models to emerge, such as "open innovation" models of drug discovery that enable collaboration between industry and academia.

— At a national level there is value in a diversity of approaches to commercialisation, incorporating a mix of "science-push" and "business-pull" models.

Introduction

1. We welcome the opportunity to contribute to this inquiry. Effective and timely translation of research will enable the UK to capitalise on its track record of excellent basic science to deliver health and wealth benefits.

2. Through our technology transfer division, the Wellcome Trust makes a range of investments designed to bridge the gap between fundamental research and commercial application. The process of developing a research discovery into a commercial product can be enormously complex and expensive, and has traditionally been seen as the role of the private sector. However, public and charitable funders can seed the process by providing a small amount of funding at an early stage to work up the proposition and share the early stage risk.

3. We provide five major types of funding:

— *Translation Awards*: a response-mode mechanism for applied R&D projects that address an unmet need in healthcare and have a realistic expectation that the innovation will be developed further by the market. The awards are open to UK-based academic researchers and companies and can address almost any area of healthcare.

— *Strategic Translation Awards*: allow the Trust to invite applications for applied R&D projects that align with our strategic priorities. Compared with the Translation Awards, the Trust is more proactively engaged in project management, working alongside the institution or company involved. The awards are open to UK and international applicants.

— *Seeding Drug Discovery*: a dedicated programme to facilitate early-stage small-molecule drug discovery. The awards help applicants with a potential drug target or new chemistry embark on a programme of compound discovery and/or lead optimisation. The goal is for funded projects to progress to a stage where there is sufficient evidence to make the project results, intellectual property and outcomes attractive to follow-on developers/investors who may be from the commercial or not-for- profit sectors.

— *Health Innovation Challenge Fund (HICF)*: a parallel funding partnership between the Wellcome Trust and the Department of Health to stimulate the creation of innovative healthcare products, technologies and interventions, and facilitate their development for the benefit of patients in the NHS and beyond.

— *R&D for Affordable Healthcare in India*: supports translational research projects that will deliver safe and effective healthcare products for India—and potentially other markets—at affordable costs.

4. We have also developed a number of one-off translation initiatives and partnerships, including:

— *Hilleman Laboratories*—a joint venture with Merck, based in India, to focus on developing affordable vaccines for diseases that commonly affect low-income countries.

— *Stevenage Biosciences Catalyst*—a £38 million partnership between the Wellcome Trust, UK government, GlaxoSmithKline (GSK), the East of England Development Agency and the Technology Strategy Board, to develop a bioscience park adjacent to GSK's R&D facilities in Stevenage, Hertfordshire. It will provide small biotech and life sciences companies with access to the expertise, networks and scientific facilities traditionally associated with multinational pharmaceutical companies.

— *Centres of Excellence in Medical Engineering*—in partnership with the Engineering and Physical Sciences Research Council, we have funded four UK centres that provide an environment for mathematics, physical science, engineering and medical research to come together, to encourage exploratory research and its translation into specific product developments of benefit to healthcare.

5. To date our technology transfer division has committed over £304 million to translational projects across 80 institutions and in excess of 50 companies. On aggregate, over £532 million has been generated in third-party finance for these projects, which are seeking to develop a range of innovations including new drugs and vaccines; enabling technologies; medical devices and diagnostic tools.

6. Funders of research commercialisation activities must carefully monitor and evaluate the success of their programmes, and be prepared to adjust their strategic approach accordingly. The Trust has evolved its technology transfer strategy over time, developing targeted schemes such as Seeding Drug Discovery and the HICF to address specific identified gaps, while maintaining the more responsive Translation Awards scheme. This gives us the flexibility to support a range of commercialisation models and opportunities. We have also found it very valuable to partner with other organisations, particularly commercial partners who can provide specific expertise in technology development to complement our experience in funding basic science. While commercial partners may bring funding to the table, they also make valuable "in kind" contributions that enable access to specialised expertise, equipment and other resources.

CONSULTATION QUESTIONS

Q1. *What are the difficulties of funding the commercialisation of research, and how can they be overcome?*

7. Commercialisation of a research discovery will involve a range of activities, which can be grouped under two general categories:

- Technical proof-of-concept studies (including clinical studies) that demonstrate that a promising technology or compound arising from basic research can be effective in a real world setting.
- Work to develop the technology into a commercially attractive proposition—developing a business case, identifying potential customers and markets for the product, conducting market research, manufacturing and testing prototypes etc.

8. Commercialisation will be most effective if these two types of activities are allowed to co-evolve. Historically, one of the difficulties of funding the commercialisation of research has been the tendency of public and charitable funders to focus primarily on the former activity, with the expectation that the private sector will step in to fund the latter. In many cases this is not realistic, as potential private sector partners are unlikely to want to invest in a technology until they can determine whether it represents an attractive business opportunity.

9. While more needs to be done to develop, and assist researchers to access, appropriate funding streams for early stage commercialisation, it is important to recognise that bridging this gap is not merely a matter of funding. It is equally a matter of the research team having access to the right skills, support and infrastructure to enable them to develop a promising research project into a fully-fledged commercial opportunity. Research funders are increasingly recognising this, and attempting to integrate the necessary support as part of technology transfer funding. For example, within the Trust's technology transfer schemes we provide academic applicants with a range of mechanisms such as project steering groups, advisory committees, and supporting consultancy costs for troubleshooting or project management.

10. Despite this, the scarcity of individuals with the skills to bridge the research-business divide remains a major barrier. Such skills are usually gained from working in large R&D-intensive firms. Given the UK's relatively low levels of business R&D investment, and the trend for large firms to move their R&D offshore, it is likely that access to skills, rather than funding, will remain the most significant barrier to improving the UK's track record in commercialising the world-class science conducted here.

11. It is extremely difficult even for established businesses to value research concepts and their potential return on investment at an early-stage. This is particularly so in the life sciences. A new technology may provide, for example, diagnostic information in real time, but how much a customer will be prepared to pay for the extra speed of information will not be known until late in the product development process. In drug discovery, return on investment estimates typically are not used until phase 2 human trials, which is usually after £10–15m of investment has already been risked.

Q2. *Are there specific science and engineering sectors where it is particularly difficult to commercialise research? Are there common difficulties and common solutions across sectors?*

12. The difficulties of commercialising research in the life sciences are well recognised. Where products are intended for use in humans, there is a need for comprehensive testing in a clinical environment—a lengthy and expensive process which often requires input from multiple regulatory authorities. The fast pace of technology development in some areas (for example mobile health technologies) means that a technology can be out-of-date by the time this process is completed. Products used in humans also tend to have complex and specialised manufacturing requirements. Transforming a promising research discovery into a viable product may take 10–15 years, with significant and sustained capital investment required over that period. Such opportunities are seldom attractive to venture capital and angel investors, who typically look for a return in five to seven years.

13. From an investment perspective there is also the issue of risk. It is often observed that UK and European venture capitalists are more risk averse than their US counterparts. Life sciences investments are seen as high risk by investors due to the technical uncertainties and the significant regulatory hurdles that must be overcome. A good example of this is the recent European Court of Justice decision that products derived from human embryonic stem cells cannot be patented—while in theory there are other mechanisms to protect the associated intellectual property, in practice investors are unlikely to invest in the development of such technologies within Europe unless there is much greater certainty that a successful product will result. As a result, it is likely that the public sector will need to take on a greater share of the early stage risk for the development of these types of technologies.

14. There are a range of interventions that have the potential to assist research commercialisation in the life sciences. Some of these are specific to the life sciences, and some are more broadly applicable across sectors.

15. With regard to life sciences-specific solutions, possible areas of action include:

- *Improving funding for clinical research*, particularly research that addresses unmet clinical needs or enables clinical experts to engage with research at an earlier stage of the development process.

— *Streamlining regulatory processes*, securing the necessary regulatory approvals can add significant time and cost to the commercialisation process. While it is important to retain robust regulatory safeguards for products that are intended for use in humans, the recent Academy of Medical Sciences (AMS) review suggested that the process for getting clinical studies underway in the UK is particularly slow and complex. The UK's share of global patient recruitment into clinical trials fell from 6% to 2–3% between 2000 and 2006, while the share of the core EU Member States fell less dramatically from 21% to 14% during this period.[64] While we have seen significant progress from the Government in implementing the recommendations of the AMS review, there are a number of areas where more could be done—for example, in streamlining the process for researchers to seek NHS R&D permissions.

— *Creating the right infrastructure* by deploying electronic patient records to support research within an appropriate governance framework, reducing costs by sharing services (eg laboratory services, testing facilities) and data. For example, in the drug discovery area the UK has considerable expertise in identifying potential drug targets, but needs to improve access to screening facilities, such as chemical libraries, which are normally based in industry.

16. More general solutions include:

— *Improving tax incentives for R&D*. In general the UK has a favourable tax environment for business R&D, particularly given the recent introduction of the patent box. However, the tax system does not always encourage the collaboration and interaction between research and business which is critical to effective commercialisation. This is particularly the case with co-located facilities. A zero rating for new charitable buildings can only be retained if the building is used 95% for non-business charitable purposes. In the case of the new Francis Crick Institute, this will restrict the ability to conduct on-site technology transfer and commercialisation activities.

— *Improving links between research organisations and business* through exchange of staff; sharing of resources and expertise.

— *Developing more flexible intellectual property structures* to enable academia and industry to work together on the early stages of commercial development.

17. The drug discovery sector provides a good case study of both the challenges of research commercialisation and the way models of commercialisation are evolving to address it. The current commercial model for bringing new drugs to the market is becoming unsustainable, with increasing costs (the cost of taking a new drug to the market is now estimated to be over £1 billion), fewer drug targets, and lower returns from new drugs which do make it onto the market. These challenges have increasingly led the pharmaceutical industry to explore "open innovation" models which allow new drug targets to be identified and validated in partnership between academia and industry. While the number of academic drug discovery units based within universities is growing, a workshop hosted by the Wellcome Trust in June 2010 identified a number of barriers to the expansion of this approach, including: a shortage of the appropriate technical skills (for example in target identification and validation) and entrepreneurial skills amongst academic researchers; the need to develop appropriate systems to store and share data; and the need to facilitate research in IP-free environments.

Q3. *What, if any, examples are there of UK-based research having to be transferred outside the UK for commercialisation? Why did this occur?*

18. Funders of technology transfer activities can adopt a range of strategic approaches. Where basic science funders invest in technology transfer activities, they tend to adopt a "science push" approach that begins with an opportunity arising from basic science and seeks to develop the project to a stage where appropriate business partners can be attracted (or a new spin-out business created). This contrasts with "business pull" approaches where a funder works with businesses to identify research opportunities and problems and harness scientific knowledge and expertise to solve them. Both approaches have merit, and at a national level there is a value in a diversity of approaches. However, it is important to recognise that a science push approach will not necessarily prioritise research opportunities on the basis that they can be commercialised within the UK. A technology transfer funder with an explicit mandate to deliver economic benefit to the UK will need to identify potential UK-based partners at an earlier stage in the commercialisation process, and take this into account in decision-making about which projects to invest in.

19. The majority of the successful research commercialisation processes the Wellcome Trust has been involved in have involved the transfer of intellectual property to foreign partners. The main reason for this has been the need for significant follow on funding, and the lack of appropriate funding sources and commercial partners within the UK. As a charitable funder with a global focus, we focus on projects that are likely to deliver a tangible benefit to human or animal health—our technology transfer programmes do not explicitly aim to deliver an economic benefit to the UK. However, we are certainly aware of cases where opportunities for economic co-benefits have been missed.

[64] Kinapse (2008). Commercial clinical research in the UK: report for the Ministerial Industry Strategy Group Clinical Research Working Group. www.ukcrc.org/index.aspx?o=2873

20. Examples of research and technology transfer activities we have funded that have resulted in overseas licenced deals include:

— CardioDigital, a spinout company from Napier University, Edinburgh, was established in 2001 to develop tools for monitoring patients to help doctors make better informed clinical decisions. The Wellcome Trust provided funding in 2002 and 2006 to support CardioDigital to develop its software analysis techniques to be applied in a clinical context and to prepare the resulting technologies for the market. This funding enabled the company to develop software to adapt existing pulse oximeter monitoring devices to assess respiration rates. In 2008, the US healthcare provider Covidien acquired the technology and will shortly announce that the product is now being made available in Europe with a limited market release following regulatory approval. This technology allows doctors to detect early warning signs of patients' breathing problems and provide more effective treatment.

— The Wellcome Trust provided career support to Professor David Wraith at the University of Bristol from 1989. In 2002 he established a biotechnology company, Apitope, to develop targeted therapies to suppress the inflammatory responses causing autoimmune conditions. With funding from a Wellcome Trust Translation Award, Apitope developed a peptide therapeutic (ATX-MS-1467) for the treatment of multiple sclerosis. An initial clinical study was completed in 2008, and the following year Apitope announced a licensing agreement with Swiss-based Merck Serono to develop and commercialise ATX-MS-1467. Merck Serono has now taken responsibility for all development activities from the beginning of phase II clinical trials, and is providing funding for Apitope to continue research into other therapeutic peptides for the treatment of multiple sclerosis. Apitope has also raised €10 million from European funders, including LRM, Vesalius Biocapital, Vinnoff and Hasselt University.

Q4. *What evidence is there that Government and Technology Strategy Board initiatives to date have improved the commercialisation of research?*

21. The business-led focus of the Technology Strategy Board (TSB) brings a different perspective to the research commercialisation process from other funders, such as Research Councils and charities. As discussed above, it is helpful to have a diversity of approaches to research commercialisation. It will be important to ensure that the outcomes of TSB funding are monitored and evaluated over time to ensure that the most appropriate mechanisms are being used.

Q5. *What impact will the Government's innovation, research and growth strategies have on bridging the valley of death?*

22. The Government is increasingly acknowledging the need to take a strategic approach to life sciences innovation which seeks to coordinate action across the research, education and health sectors and address finance and regulatory barriers to innovation. This approach was articulated in the Strategy for UK Life Sciences, Sir David Nicholson's review of the adoption and uptake of innovation in the NHS, and the Innovation and Research Strategy for Growth. The Wellcome Trust contributed to the development of these strategies and we appreciated the consultative process adopted by the Government. We are also optimistic that the announcements will have a positive impact on innovation in the life sciences.

23. The new £180 million Biomedical Catalyst Fund is intended to directly address the valley of death, with a focus on enabling collaboration and on providing a "seamless set of support and funding options". The success of this fund in achieving its objectives for growth of the UK life sciences sector will depend on its ability to achieve strong engagement and buy-in from the business sector, as well as from researchers. Companies will need to be engaged in the early decision-making to identify projects and technologies which best align with the strategic priorities of UK-based businesses. If this is not achieved it is likely that the Catalyst Fund will repeat the experience of other technology transfer funds where many projects rely on international partners for commercialisation. Similar arguments can be made in relation to the Catapult Centres (Technology and Innovation Centres), which are a positive evolution but need to be run in close partnership with industry in order to succeed.

24. A number of the actions from the recent Government strategies seek to develop an innovation culture in the NHS, for example through promoting the use of patient data for research, investing in workforce training and building on research centres of excellence to increase collaborations between industry, academia and clinicians. These actions will also assist in bridging the valley of death as they will create incentives for private companies to invest in R&D in the UK and to partner with the NHS to ensure that discoveries arising from publicly-funded research are able to benefit UK patients. The forthcoming NHS Procurement Strategy (expected 1 March) will also assist the NHS to send stronger and clearer demand signals and improve pull through of locally-generated innovations into the NHS.

25. The Government needs to think carefully about the messages it sends about the role of universities in the commercialisation and knowledge transfer process. In his speech on 5 January David Willetts announced the Government's ambition for university knowledge exchange income from external sources to grow by 10% over the next three years. Such a target will encourage universities to see their interactions with businesses within a context of short-term revenue generation, rather than sharing knowledge for longer-term public benefit.

It may dissuade them from seeking out local partnerships that will create jobs and see intellectual property retained within the UK, if greater profit can be made from licencing technology internationally. Universities should be recognised for the broader value they add to the economy, for example through tacit knowledge and the provision of skilled graduates, rather than just the external revenue they generate.

Q6. *Should the UK seek to encourage more private equity investment (including venture capital and angel investment) into science and engineering sectors and if so, how can this be achieved?*

26. It is likely that venture capital and angel investment will remain difficult to attract in the life sciences as angel or venture investors are typically looking for a return in five to seven years. Most life sciences projects are seen as too risky and unlikely to deliver return within this timeframe. If the UK is serious about encouraging venture capital investment in the sciences it will need to develop a range of measures that both reduce the risk (for example through funding more of the business development in the public sector) and increase the potential pay-off (for example through tax incentives) of such investment.

Q7. *What other types of investment or support should the Government develop?*

27. The Government has the opportunity to look at higher education policy signals to enable research assets to be nurtured and developed in the protected environment of a university. The lack of funding mechanisms to do this within higher education, and the expectations that are placed on universities to generate external revenue (paragraph 25 refers) mean that universities are forced to look for external funding too early.

28. Technology transfer funders could consider developing more of a portfolio approach to investment. At the moment they tend to focus on developing single products or technologies, often conceived, developed and evaluated in isolation. As a result, the know-how and learning experience is not shared and often lost. Indeed, as the number of major industrial R&D sites in the UK declines, centres of technological and applied scientific excellence, such as the Clerk Maxwell centre, could help provide the necessary skills and experience to help sustain an innovation culture and be a source of product concepts.

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Written evidence submitted by The Higher Education Funding Council for England

Declaration of Interest

1. The Higher Education Funding Council for England (HEFCE) was established by the Further and Higher Education Act 1992 as a non-departmental public body operating with a high degree of autonomy within a policy and funding context set by the Government. The Council's main function is to administer grant provided by the Secretary of State for Education and Skills. We provide independent advice to the Secretary of State on the funding needs and development of higher education including relations between HE and the economy and society. We currently provide £150 million per annum in HE Innovation Fund which supports a broad range of knowledge exchange activities between universities and colleges and the wider world, which result in economic and social benefit to the UK. Further information about the role, policies and funding allocations of the HEFCE can be found on our web-site.[65]

HEFCE Role and Policy in Knowledge Exchange

2. HEFCE plays a part in the Government's innovation eco-system as an higher education (HE) institutional funder. Since the 1990s, the Council has developed policies to support universities and HE colleges to contribute further to the economy and society. This has been through providing a stream of funding for "knowledge exchange" (KE)—the range of inter-actions between universities and businesses, public services and the wider community that lead to economic and social impact. These inter-actions are described and measured in the HE Business and Community Inter-action (HE-BCI) survey.[66]

3. Our support for KE is provided through HE Innovation Funding (HEIF), which is now an entirely formula allocation to universities, based on performance measures from HE-BCI, standing at £150 million per annum over the period 2011–15. We expect universities to use their HEIF allocations most effectively to achieve impact, developing and enhancing their own strategic approaches to KE.

4. Research commercialisation through technology transfer is a component of KE. However, KE is much wider, reflecting the variety of roles that universities play in the innovation eco-system, including:

(a) research exploitation such as contract and collaborative research;

(b) knowledge based facilities and equipment;

(c) knowledge diffusion and networking;

(d) development of human capital;

(e) entrepreneurship;

[65] www.hefce.ac.uk

[66] www.hefce.ac.uk/econsoc/buscom/hebci/

(f) community engagement; and

(g) and the contribution of HE to the competitiveness of places.

All these contributions support the development of knowledge and entrepreneurial skills for innovation, but also help to increase the innovation capabilities and absorptive capacity of firms, places and this nation.

5. A 2004 paper from US/Europe[67] defined the different models for exploitation:

— The historic Open Science model whereby academics published findings and industry had sole responsibility for commercialisation based on scanning literature.

— The Licence model, adopted in the United States following the Bayh Dole Act of the 1980s, whereby universities took greater responsibility to licence intellectual property (IP) from federally funded research to industry.

— The Innovation model, prevalent in Europe, whereby universities play a much greater and richer variety of roles, as described above as knowledge exchange.

6. Academic experts of innovation have criticised Open Science and Licence models (the "linear" models) on grounds that these will lead to under-utilisation of research ideas because of: failures to transfer and absorb "tacit" knowledge; and their inappropriate focus on supply not demand influences (market pull). This has led to policies that bring universities into close engagement with business, and which spur two-way communication.

7. The 2004 paper also notes that the USA benefits from a great number of technological businesses. If European countries do not adopt innovation models, it is likely that new technologies will gravitate anyway to the USA. Hence a challenge for the UK is develop new technologies, but also to make these "sticky" (to ensure some benefits accrue to this country). Even the USA has become more interested in wider KE and the "stickiness" issue (such as in clustering policy) in recent years.[68]

8. For all the reasons above, HEFCE supports and incentivises universities to have regard to IP, but to take strategic decisions on the best modes of KE to deploy. Universities are diverse; different universities are best placed to make very different contributions to the innovation eco-system.

Trends[69]

9. Overall KE performance in England has improved in the last 20 years; total KE income has increased from just under £2 billion in 2003–04 to £3 billion in the last year of the HE-BCI survey, 2009–10.

10. Income from IP licensing is a very small part of total KE income. IP income from licensing stands presently at around £58 million and has increased by around 85% since 2003–04. There are two main modes of commercialisation of IP, licensing IP to an existing business, or the spinning out of a new company. World good practice generally favours licensing. (Indeed many in universities believe that good practice is to engage closely with business and agree to licence IP to the company at the outset, with the university benefitting in ways that fit its mission, such as through contributions to research funding. In such cases, there is then no IP that needs to be handled by the university either in licensing or spin-outs arrangements.) Universities house many academic entrepreneurs and provide environments to develop the entrepreneurs of the future. However, they are not primarily commercial bodies, but public good organisations that wish to work with and support industry for wider public benefit. It is therefore more time and resource efficient, and consistent with the university role, to license IP to an established wealth creator. However, sometimes a new technology may be so innovative that it does not have an obvious client, and hence a university is then acting appropriately in the public good to spin out the technology itself (and often the spin-out will be acquired by an established wealth creator along the line).

11. We share data with the USA[70]—and publish a US-UK commercialisation comparison within the HE-BCI Survey. Unsurprisingly, given the USA's large scale of technologically based businesses, the USA leads on licensing—with licensing income being 3.7% of total research income, compared with UK at 1.3%. However, UK leads on spinning out new companies, generating one new spin-off per £23 million of research income compared to £56 million per company in the US.

12. In isolation, neither patents nor spin-outs are good measures of performance. Patents are an input to commercialisation; licensing income provides a better view of impact (the value placed by the company related to likely results). Spin-outs should be judged in terms of their longevity, and that they build in terms of wealth and jobs. We collect more detailed information on spin-out performance in HEBCI including longevity, employment, turnover and level of external investment. At the beginning of the century there seemed to be an over-emphasis here in producing new companies with a relatively high number being formed but many remaining effectively dormant. As KE practice became embedded, the number of new companies being formed

[67] "Models of, and Missions for, Transfer Offices from Public Research Organizations", by Gilles Capart and Jon Sandelin at http://otl.stanford.edu/documents/JSMissionsModelsPaper-1.pdf

[68] See for example US National Academies (2010) "Managing University IP in the Public Interest", which reviews Bayh Dole, and recommends amongst other things that USA adopt a broader KE not TT model.

[69] Data is drawn from the UK HE-BCI Survey, developed by HEFCE and now run by HESA. Overall HE KE performance captured in HEBCI reflects a number of drivers, not just HEFCE funding for KE, but overall policies of Government and the range of innovation and research funders. HEFCE works closely with other funders, such as TSB and RCUK, in developing complementary policies on KE, including analysis of HEIF strategies.

[70] Through the US Tech Transfer professional body AUTM.

reduced year on year while the number surviving for three or more years rose consistently, suggesting that HEIs were being more strategic in their commercialisation decisions.

13. We also collect data on methods of commercialisation in HE-BCI, such as the use of specialist third parties. A number of these (usually experts in IP law) have developed in recent years and have links with specific HEIs or departments. The exact relationships vary and the details may be kept confidential for commercial reasons. At the lower end of engagement the third-party may simply have paid a fee to have first refusal over any IP originating in the HEI or department Other examples are where all IP generated is automatically assigned to, protected and exploited by the third party. In these examples it is very difficult to gauge the efficiency and effectiveness of interactions given the limited data available (it's likely of course that one conclusion is that more IP is being exploited than we know about).

14. International experience is that IP management is very costly; most universities that have large-scale commercialisation capability will spend considerable sums on IP management and protection. Spending in UK universities on the protection of IP has increased from £13 million to nearly £30 million since 2003–04 (but it is worth noting that while both MIT and Stanford receive higher levels of income from IP than any UK HEI they spend even more in proportional terms on protection).[71] However, only a few patents usually generate much revenue and some of these will go off-patent shortly after the significant returns begin to flow given the long timescales and low success rates associated with IP commercialisation. This is therefore a risky area and very careful judgement is needed on the scale of IP activity that is worthwhile in any particular university. We believe judgement and experience in universities in this country has improved considerably in recent years. We give some examples of innovations and good practices below. In many cases though, sound judgement may be to do less not more on IP management and protection. We note that even in the USA universities struggle to cover costs; and leading edge performers there who do make a profit still need to use their considerable alumni income to smooth revenues and costs.

University Approaches

15. We ask for strategies from universities periodically, linked to HEIF,[72] which describe overall policies and procedures adopted for KE, including commercialisation. Strategies submitted to us last year for 2011–15 HEIF are presently being compiled into an overview report by PACEC researchers, which will be published in Spring 2012.[73]

16. Our general impression from strategies is that there is a considerable dynamism in KE in the HE sector. Universities are driving hard to work with businesses toward economic growth. As well as incentives from KE funding, universities are driven to work with business to improve employability opportunities for new students, as well as to further their effectiveness in deriving research impact. Universities are also very concerned by cost, given overall uncertainties in the fiscal and public funding environment. Universities are restructuring and keeping a close eye to most effective and efficient KE approaches.

17. In terms of commercialisation narrowly, we see three major trends:

(a) Universities are innovating in new ways to exploit IP. This includes exploring and adopting "open innovation" models of collaboration with business and "easy access" approaches to IP (where costs or legal arrangements for handling IP are kept low and simple, often as part of a wider strategic relationship between the university and businesses). The University of Bristol and Kings College London are examples of institutions exploring easy access approaches.

(b) Access to proof of concept funding and other support for commercialisation varies across the sector. Even when the economy was in recession, some universities were positive about gaining necessary funding. This is not always just about the university's IP expertise, as much as the industrial sector for commercialisation or even institutional brand and connections. Any university Tech Transfer Office (TTO) worth its salt would like more proof of concept funding to improve its results, but it is not necessarily a present constraint. Surrey University said to us in its HEIF 2011–15 strategy: "*the University of Surrey does not believe that lack of Venture Capital or Business Angel support is proving to be a bottleneck for Surrey based start up companies. HEIF 4 funding has helped provide an active entrepreneur and investment community around the University which will be developed further during HEIF [2011–15]… most of the remaining bottlenecks are due to issues beyond HEFCE and BIS control, such as the macroeconomic situation and seismic shifts in global industry*".

(c) Universities are being inventive to cut costs and increase efficiency in commercialisation. As well as commercial suppliers, some universities are very active in extending their capability to provide services to other universities, in the UK and overseas (an example here is Oxford University's commercialisation vehicle, ISIS innovations). Some universities are being highly prudent in reviewing the cost-effectiveness of IP activity and scaling back if appropriate. For example, Aston University said to us in its HEIF 2011–15 strategy: *Following the departure of the Head of IP.., the [University] did not recruit a successor but has trialled outsourcing most*

[71] http://web.mit.edu/tlo/www/about/office_statistics.html and http://otl.stanford.edu/index.html
[72] See HEIF 4 examples of strategies linked to www.hefce.ac.uk/econsoc/buscom/heif/heif.asp.
[73] We and PACEC would be happy to make overview results and strategies available to the Committee.

of its IP management through using ISIS. This trial has both demonstrated the cost-effectiveness and the wider experience base gained through outsourcing these activities, and Aston will be formally tendering for this service early during the new HEIF programme. Like many universities, Aston grew its patent portfolio rapidly over recent years with a resultant increase in patent costs. Following internal analysis, and an external review by ISIS, we shall be reducing the size of the portfolio, setting more rigorous criteria for patenting in future and with a greater focus on those patents which have a clear route to commercialisation. Cranfield has a similarly successful relationship with Imperial Innovations.

International Working

18. Universities, naturally, and increasingly, work in global research networks, and contribute to the solution of global challenges. Their commercialisation work is not therefore solely focussed in the UK, though universities obviously are highly committed to contributing to this country's prosperity.

19. We undoubtedly do see evidence that universities work with overseas companies, and that some UK invented IP is likely then to end up overseas, where this is the only way forward to develop the research.[74] However, much R&D in this country is funded from overseas; and many UK companies strong in R&D now operate globally. The considerations of how research commercialisation can bring benefit to the UK are very complex then, given globalisation of both research/universities and R&D based companies. We suspect international knowledge protectionism will not work, so the challenge for all countries is to increase their ability to capture a range of domestic benefits from commercialisation processes operating globally—the "stickiness" challenge.

Tech Transfer Offices

20. It is worth making a comment here on the nature of TTOs.

21. HEIF (along with many other sources) supports the overall KE infrastructure in a university, which includes: KE strategy and leadership in the institution; academic development in KE practice; and professional KE infrastructure.

22. Around a half of HEIF funding 2011–15 is being used by universities for professional infrastructure, with the residual for strategy and leadership and academic development. Around a half of infrastructure funding supports the research commercialisation agenda (including IP but also collaborative and contract research), with the residual for other KE aspects described in paragraph 3.

23. While many universities may incorporate an exploitation corporate vehicle, the vast majority do not have staff established in a TTO with a sole purpose to exploit IP, but instead have capacity, centrally or across faculties, to support a range of KE/impact activities (and most universities will also have various forms of KE infrastructure-sharing collaborations). In only one university—as far as we are aware—is the exploitation company not wholly owned by the university (Imperial Innovations).

24. There are a diversity of views on the balance between academic and TTO roles and responsibilities (and of inventors and institutions) in commercialisation. However, from our experience of working with other developed economies (including commissioning a number expert studies on US practices), professional Tech Transfer capability is seen as essential to effective process around the globe. The very thorough US review on this topic in Footnote 194 is well worth studying on all these matters.

25. At HEFCE, we respect the autonomy and professionalism of senior university managers to make judgements on when and how they set up Tech Transfer arrangements. Tech Transfer capacity is smaller and less expensive in the UK than the USA, and costs are less. This may reflect that our universities lack ambition—or that with less overall funding (including the substantial alumni and philanthropic contributions in USA), our universities are sensibly prudent.

Funding for the Development and Exploitation of New Technologies

26. The Committee's enquiry is primarily focussed on the funding arrangements for early stage development and adoption and commercialisation of technologies. HEFCE is not itself directly involved in these matters (though universities can use HEIF for proof of concept if that is their priority); no doubt universities and their KE professional associations will comment on their experiences.

27. A word of caution though—we do not think that financing issues particularly relate to university commercialisation. The vast majority of new technologies in the world that become commercially adopted will be devised and developed in the business world, by entrepreneurs, technology consultants, large and small businesses and in supply chains (albeit, we believe, infused and informed by university ideas and human capital

[74] As an example, Imperial College said to us in its HEIF strategy: "*Given the economic environment, it is now more important for the College to develop geographic diversity within its portfolio of industrial partnerships. Between 2008–09 and 2009–10, our research income from non-EU industrial sources increased by over 18% (£9.7 million to £11.5 million) at a time when our funding from industry generally decreased. Building on this success, we will extend our corporate partnership support by investing in a pilot international scheme with a view to furthering our understanding of the international market. Initially targeting the North American region.*"

development). To illustrate this, we estimate that only 19% of patent application filings from UK were from the universities here.[75]

28. What is important in determining what is worth commercialising is the market (together with factors like leadership and management, as well as finance). Universities have changed their character significantly in recent decades, in the UK and globally, to play a greater part working with business and developing the next set of entrepreneurs. Universities are therefore undoubtedly in the market for financing commercialisation, but we believe the issues raised by the Committee are more generic to commercialisation activity conducted everywhere, including, but not limited to, university activity.

February 2012

Joint written evidence submitted by Science Policy Research Unit, University of Sussex and Exeter Business School

1. Dr Paul Nightingale is Deputy Director of SPRU, the Science Policy Research Unit at the University of Sussex, where he leads a research group on innovation policy. Prof. Cowling is Professor of Entrepreneurship at Exeter Business School, where he heads a research group on SME financing. Drs Coad and Siepel are researchers at SPRU working on the financing and management of innovative firms. This submission draws heavily on research funded by the ESRC, NESTA, BIS and TSB as part of the IRC distributed projects scheme, as well as research funded by BIS, the BVCA, NESTA, the EPSRC, ESRC and EU through the FINNOV project.[76] None of the team have any financial interest in any organisation mentioned.

2. We welcome this opportunity to contribute to this call for evidence on this important topic. Before we address the questions we would like provide a small amount of background and context.

3. Care must be taken when considering the "Valley of Death" as it is partly an artefact of thinking about firm growth without taking into account the extremely high failure rates of new firms. Roughly 50% of new firms will exit the market (fail) within their first three years. Sustained growth is atypical as growth patterns follow a random walk. As a result, we should expect to see "dips" in performance and funding after firms initial start up honeymoon. The resulting market exits allow lower productivity firms to be displaced by higher productivity firms in the economy, creating economic growth in a way that is more important than the growth of new entrants. Government policy that extends the life of poor quality firms can therefore have a damaging impact on the economy and should be avoided. Researchers are often very sceptical that there is a major problem with access to finance outside of a few particular areas. In general, most firms, get most of the funding they seek, most of the time. However, it is an open question whether the small percentage of firms that have trouble raising money overlap with the small percentage of firms that drive economic growth and employment. We believe they do.

4. The contribution of average SMEs and entrepreneurs to commercialisation and the economy more generally is often significantly over estimated in public policy discussions. It is true that entrepreneurs are significantly more happy, and new firms make a significant contribution to job creation in their first year of existence. However, it is not clear that they contribute significantly to innovation, the commercialisation of research, or economic growth. Research by Thomas Astebro suggests that of entrepreneurs seeking to commercialise innovations, only 7% successfully reach the market, and their average financial return is -7%. Nor is it clear that having more entrepreneurs would be beneficial to the UK economy. Market entry rates are extremely high in the UK, and EU, at about 20% a year, and this level of market entry may well be excessive. It may be damaging if poor quality firms drive up factor prices, dilute managerial talent, confuse investors and make it more difficult for higher quality firms to grow. The key public policy issue is encouraging higher quality entrepreneurs and SMEs to grow, not increasing the quantity of new entrants having to cross the Valley of Death.

5. There is already significant support for SMEs and their activities to commercialise research in the UK. David Storey estimates that the UK taxpayer spends some £7 billion a year on SME support. This is more than is spent on the Universities or the Police force. We are unconvinced that all of this spending is valuable and think much of it could be spent more effectively. Using a significant amount of it to give SMEs a National Insurance holiday if they employed new staff until the economy recovers, for example, might be a useful stimulus policy.

6. These levels of spending, which are found internationally, suggest SME financing is an area subject to considerable "rent seeking" where special interest groups lobby governments for anti-competitive support, potentially at considerable social cost.

7. Much thinking about the commercialisation of research adopts an inappropriate and misleading "linear model of innovation" in which university research generates innovations, that are then transferred and commercialised. Only 3% of the economy is in high tech manufacturing that draws on research in this way, so even major improvements are unlikely to have a significant impact.

[75] Using HE-BCI data and data on patents from Elsevier International Comparative Performance of the UK Research Base 2011 (report for BIS).

[76] In particular the ESRC-TSB-NESTA-BIS grant RES-598–25–0054 and EPSRC grant EP/ E037208/1.

8. It is more appropriate to think of research as generating talent rather than technology. Universities might be usefully thought of as factories for producing human capital. Research provides training in people who then move from academia into firms where they generate innovations. Sometimes firms generating innovations have technical problems that require them to seek university support, but the main locus of innovation is in firms, not universities. The UK's problem with the commercialisation of research compared to the US should therefore be seen in the context of lower public investment in research (1.3% v 2.6% GDP), which leads to lower technical skill levels in industry, which makes it harder to generate innovations in firms. Firms with poorer quality innovations then find it harder to raise money, but the difficulties of fund raising are a consequence rather than a cause of poor performance. Providing money without addressing quality may therefore have limited impact.[77]

9. The UK is extremely rare in having government departments, such as BIS, prepared to subject its (SME) policy to independent criticism. This is highly commendable.

1. *What are the difficulties of funding the commercialisation of research, and how can they be overcome?*

10. It is well recognised that there are major difficulties in funding the commercialisation of research in the UK and elsewhere and that market failures of many kinds mean investors do not get all the benefits of investment, which can lead to suboptimal levels of investment. This is because of uncertainties, spill overs (where benefits cannot be captured), moral hazards and information asymmetries (where investors do not fully understand their investments and need to depend on trust), and because innovators often lack collateral for loans. We have found evidence this constrains growth.

11. Moreover, it is extremely difficult to make money from early stage investment. Even professional VC funds find it very difficult. Often the problem is *not* lack of money, but *lack of skilled investors* and *lack of high quality firms* worth investing in.

12. Given the difficulties of making commercial returns from innovation, governments have historically played a key role in funding innovation.[78] In the US there is significantly more support for innovation than in the UK, which has a more market based approach.

13. The UK has a number of policy tools to address this problem. R&D tax credits which are very expensive and of unsure value. The "Patent Box" which is extremely expensive, badly designed and unlikely to generate additional spending. Equity support schemes (hybrid funds), which were very poor, but are now often effective and cheap. EIS and VCT support, which are expensive and of unclear value. University Technology Transfer policies, which are expensive and of limited value. SBIR schemes could be extended but we are sceptical of their value. SMART type schemes and other grants have value. A key policy tool is to increase competition in the UK (and EU), especially among large firms to drive innovation in the wider economy and encourage corporate venturing.

2. *Are there specific science and engineering sectors where it is particularly difficult to commercialise research? Are there common difficulties and common solutions across sectors?*

14. Biotechnology seems to have particular problems. Comparative research on the extent of funding problems between sectors is lacking in the UK and more generally. Sectors requiring long term, uncertain investments may have a general problem. Sectors where commercialisation requires the substantial levels of investment generated by Stock Markets may also have a problem in the UK, given the lack of interest of the markets in the UK in technology (in part caused by poor returns compared to sectors such as mining).

3. *What, if any, examples are there of UK-based research having to be transferred outside the UK for commercialisation? Why did this occur?*

15. It is unclear that this is a major problem. We did not find much evidence of firms migrating in our research. See also Michael Hopkins submission.

16. The UK benefits substantially from the international trade in technology, and protectionist measures might be very costly. Policy in this area should consider the benefits of trade as well as any costs.

17. There is limited peer reviewed research evidence that this is a major problem. Threats by firms to leave the UK unless they achieve some policy aim have become more common in recent years. For example, Hedge funds threatening to move to Switzerland or New York or Private Equity Funds threatening to move to Ireland. We are unaware of any PE funds that have gone to Dublin recently, and note that Hedge funds in New York are threatening to move to London. These threats may be raising public attention about something that is not really a problem. Any problem that does exist could be easily dealt with by effective EU action on tax avoidance.

[77] Nightingale *et al* (2009) From Funding Gaps to Thin Markets, BVCA-NESTA.

[78] Mazzucato, M (2010) The Entrepreneurial State, DEMOS. FINNOV 3rd Policy Brief (2012) available at www.finnov-fp7.eu/publications

18. A much more important issue is the transfer of high value added commercialisation activity from larger firms following acquisition, and the problem the UK faces in international UK firms, particularly in the biopharmaceutical industry, moving R&D to the USA. This occurs because US science is better supported.

4. *What evidence is there that Government and Technology Strategy Board initiatives to date have improved the commercialisation of research?*

19. We are unaware of any evaluations of the TSB. The PACEC report cannot be easily accessed. An evaluation would be valuable. An evaluation of the cost effectiveness of the KTPs would be extremely valuable given their costs and basis in a discredited linear model of innovation.

20. Evaluations of science parks suggest they are ineffective.

21. Evaluations of equity support schemes suggest the earliest schemes were extremely ineffective (ie RVCFs), but that UK policy makers learnt very quickly and more recent funds are very well designed and produce positive impacts.

22. The recent House of Lords S&T Committee report on procurement did not find evidence that procurement was being as effective as it might be.

23. In general, evaluations of this kind are difficult and there are few of them. There are many schemes were an evaluation should be undertaken, such as tax credits, KTPs etc.

5. *What impact will the Government's innovation, research and growth strategies have on bridging the valley of death?*

24. It is too early to assess the impact of many recent changes. Some general aims are probably too vague to evaluate. We find evidence that older policies, especially equity support for hybrid VC funds, are having a positive impact.

25. The protection of research funding in the current economic climate is a major and under-appreciated achievement by BIS.

26. Given the economic situation the Government has limited policy options. The resulting Strategy document is thoughtful, well informed and shows a sophisticated understanding of the economic problems it is addressing.

27. Despite our overall positive assessment, we have a number of concerns.

(a) The document still retains an implicit discredited linear model in many places.

(b) There is too much focus on universities and not enough on firms, where the real problem lies.

(c) The value of the SBRI scheme is unclear and the costs do not seem to be fully appreciated. There seems to be considerably more support for this scheme in the UK than the evidence would merit.

28. The policy document seems to be informed by arguments that the UK lacks intermediate institutions to support innovation. We remain unconvinced by this, and suggestions that Fraunhofer type organisations can be transplanted from one nation to another. Nor is it clear that new institutions will always have a positive impact.

29. The final design of the Catapult centres remains unclear, but they seem to be based on a linear model that sees technology transfer as the problem. This reflects a pattern in EU policy whereby, when attempts to improve innovation by increasing technology transfer efforts fail, more money is devoted to technology transfer. Our suggestion is the framing of the policy might be incorrect. The real problem the UK faces is in the lack of innovation (and investment in innovation) in industry. There is also a secondary problem highlighted above related to the lack of spending on research compared to our competitors. There is not a problem of quality in University research in the UK, nor in engagement between industry and universities, which is probably higher than the US, nor in Universities generating firms, which again is probably higher than in the US (although we have major concerns about the quality of the firms that are generated). If UK firms lack the ability to innovate then technology transfer policies are like pushing a piece of string.

30. Outside of a few areas (biotech, etc) universities are poor places to generate technology. Universities lack understanding of markets and customer demands. Academics often lack the skills to run and grow firms. The successful US innovation model involves substantial investment in research in universities, and then very substantial investment in commercialisation in firms. In the EU we spend much less on research in universities, and then attempt to encourage universities to commercialise technology either in firms (that find it hard to raise money because the technology is too early stage), or transfer it to firms that have fewer technical skills and less investment in innovation. Germany has a slightly more effective model that provides large amounts of public support through core funding for technology development institutions embedded within networks of innovative firms. We consider the US model superior.

31. There do seem to be potential problems with a lack of joined up government. For example, taxation policy and innovation policy can sometimes clash. The IR35 legislation, which addresses a real and important tax avoidance problem, can have the unintended consequence of forcing large firms to take on innovative

individuals and SMEs as employees. There can be a mismatch between the focus of some departments on long run economic growth and the focus on others on short term returns.

6. *Should the UK seek to encourage more private equity investment (including venture capital and angel investment) into science and engineering sectors and if so, how can this be achieved?*

32. Policy towards private equity and VC in Europe is often confused because the two very distinct kinds of funding mechanisms are often conflated. Private Equity (PE) investing involves the refinancing and restructuring of existing assets (rather than creating new asset) such as management buy-outs, buy-ins and other later stage development finance. VC is the provision of equity and substantial managerial support to early stage (mainly technology) firms that are developed for subsequent trade sale or IPO. The considerable confusion between VC and PE has allowed PE associations to refer to themselves as VC when lobbying for favourable tax treatment. The effectiveness of this lobbying has made PE investment very profitable, which has attracted VC investors and institutional investors away from early stage investing.

33. Policy making would be improved if VC and PE were considered distinct as is done in the US.

34. It is not clear PE investment is beneficial in the long run to STEM firms. Some PE investments add value by turning around failing firms, while others asset strip. Given PE investments are often targeted at failing firms, evaluating the impact of PE (which may be positive overall), is almost impossible.

35. VC funds struggle to make money from early stage investment. However, a small number of funds do succeed, particularly in the USA where the VC industry and high tech sectors receive considerable government support. These funds have had a huge impact on the US economy. In the UK VC funds are struggling to raise funds. Well designed and well targeted equity support schemes, of the kind developed by BIS, can have a very beneficial impact on the economy at a reasonable price.

36. We believe the value of support for VC funds should be understood in a broad sense, and go beyond the financial returns from the investment (which is likely to be low given the difficulty of making commercial returns from investment in early stage technology firms). It should include the additional taxation that is generated by new firms growing and employing skilled staff.

37. Regional VC funds perform very poorly and should not be supported.

38. Angel investors are playing an important role in funding early stage innovation. Professional angel networks are becoming more sophisticated and are moving into areas of investing that were previously undertaken by VC funds. Making money from early stage investment is not easy, and Gordon Murray has highlighted the moral question of whether the Government should encourage unprofessional investors to invest in areas where professional investors find it very hard to make money. Equity support schemes of the kind used by BIS are effective at supporting business angel networks.

39. In all areas of equity investment policy it is important to recognise that the problems the UK faces are not necessarily on the supply side (ie lack of money). The key problem may well be a lack of good firms worth investing in.

7. *What other types of investment or support should the Government develop?*

40. As well as expanding the range of options, the Government might also consider ending poorly performing policies (after evaluation) and diverting the funds they consume elsewhere. The patent box scheme and various technology transfer schemes would be obvious options to explore.

41. There are a range of options that the government may wish to consider:

(a) Industry supported (co-funded) grants for academic research.

(b) Grants for early stage technology development outside universities.

(c) Support to improve the capabilities of Angel Networks and the VC industry

(d) Larger, industry-sector focused hybrid funds ie a co-funded VC fund devoted to the specific problems facing the biotech or green tech sectors.

(e) Support for pan European, rather than just national, hybrid funds, which would allow more scale and specialisation.

(f) Loan support schemes targeted at firms seeking funds to invest in commercialisation.

(g) Changes to EU State Aid rules that constrain support for innovative firms. EU level VC funds or EU level funds-of-funds that invest in VC funds or Angel networks help to get around this problem. There is widespread recognition that these rules hinder European innovation and attempts to have the rules either clarified or modified is likely to find considerable support in Brussels.

42. In designing these schemes it is often important to consider how funding and human resource problems interact. This makes managerial skills and the skills of investors in supporting firms extremely important. When firms receive finance to support them through the Valley of Death, they often expand their workforces which

makes them more difficult to manage. Similarly firms that expand often require new forms of financing. Funding problems are therefore not only financial problems and should not be considered in isolation.

February 2012

Written evidence submitted by PraxisUnico

BACKGROUND ON PRAXISUNICO

PraxisUnico makes this submission as a key representative body of the UK's research and development and technology transfer profession. PraxisUnico was formed in 2009 from two separate organisations—Praxis (committed to training for technology transfer officers in universities and research centres) and Unico which was a membership organisation including universities and PSREs (Public Sector Research Establishments). PraxisUnico has over 2,600 members from 108 universities and research organisations and 48 commercial concerns, patent agents and intellectual property lawyers are associate members. PraxisUnico holds an annual conference and has delivered professional training to around 2,500 individuals from 40 countries. PraxisUnico makes this submission having consulted its board and members.

Although originally focused solely on "technology transfer" (commercial deals involving intellectual property generated by universities), PraxisUnico members are engaged across the whole range of knowledge exchange activities, promoting the transfer of knowledge in all its forms across the boundaries of universities and into society.

RESPONSE SUMMARY

Our draft response reflects the following themes:

- Difficulties are multi-dimensional but we welcome the Government's commitment to exploring ways in which they can be overcome.
- In PraxisUnico's view, the University Challenge Fund scheme is one of the best examples of a public sector scheme that addressed many of the difficulties in the present environment.
- PraxisUnico would like the commitment shown to the bioscience sectors to be diversified into engineering and the physical sciences if the UK is to re-shape its industrial base.
- Although too early to address the TSB's impact, there is no doubt that its initiatives are providing a much needed stimulus to technology development. Recent changes are likely to have a positive impact as they will foster development across the "valley of death" with closer working relationships to the university sector. PraxisUnico believes that the UK must have an innovation agency but it must take risks to work with new emerging businesses.
- Despite positive signs that the Government's innovation, research and growth strategies will have an impact on the bridging the "valley of death" we are concerned that none of the recent announcements have specifically addressed the issue that a major stimulus is required to systematically re-shape the technology and corporate venturing market in the UK.
- The UK must seek to encourage private equity investment into science and engineering sectors.
- Investment funds that help to develop the outcomes of research are required that stimulate and avoid fragmentation. PraxisUnico believes that the University Challenge Fund scheme can provide an investment stimulus which can be deployed effectively in a multi-dimensional way.

1. *What are the difficulties of funding the commercialisation of research, and how can they be overcome?*

Difficulties

The difficulties are multi-dimensional, and in simple terms there is no way to make it easy. The number of scientific ideas which get successfully into market will always be a small fraction of the total of ideas which are thought to have commercial possibilities. It is not possible at the first steps of commercialising an idea to predict the outcome; insufficient is known. We first need to tolerate failure. Secondly, we need to communicate and celebrate success. What cannot be tolerated is lack of effort and a failure to invest in our country's future.

The second difficulty is already being addressed. The introduction of Impact to the Research Excellence Framework has commenced the process of alignment between university research metrics and university success in both fundamental science and research moving to application in the market. A culture change is underway but it will take time to become fully embedded and this needs to be achieved alongside maintaining the UK's global position in basic science and engineering. PraxisUnico believes the solution offered below presents a further stimulus which would hasten this culture change.

The third difficulty is financial. In 2010 the British Venture Capital Association recorded VC investment as 4% of all VC and Private Equity investment at £313 million out of a total of £8.2 billion benefitting only 397 companies; of this VC investment, £10 million was in seed capital and £46 million in start-up. As a consequence of the high rate of failure and the nature of venture capital in the UK it is a significant challenge to secure investment in new technologies. At the same time the in-house research capacity of many companies

is being reduced as they commit to open innovation. In many countries it is now clear that public funding is required to de-risk technologies (see the Entrepreneurial State—Demos Working Paper for international comparisons).[1] Research by the Russell Group of universities (published in 2010) has demonstrated that this is a long process, quoting an average of nine years from invention to a commercial deal (from the study of >120 case studies). Funds expended on translational research have increased in recent years but given the time from the emergence of a potentially commercial research finding to application can easily be more than seven years and can often be in excess of 15 years, it is simply too early to judge any particular scheme (but see fragmentation below). We cannot however wait to evaluate recent schemes, if part of the jigsaw is missing we must act now.

The fourth difficulty relates to fragmentation. Each Research Council, the European Commission and each of the major charities are committed to seeing the fruits of their funded research into application, and this is to be welcomed. However, this fails to recognise the nature of research. Very rarely is research in any research team funded by a single source. The commercial outcome emerges from groups with diverse funding sources, and increasingly from inter-disciplinary and multi-institutional teams. Each funding source has different rules which, in turn, increase the complexity of moving forward into the commercial domain. This is further exacerbated as it is also very rare that a single research idea will succeed without adding other technologies. Collaboration across the research community not just in research but in commercialisation will become increasingly critical.

The fifth difficulty relates to the absorptive capacity of the UK industrial base. There are two sub-components to this difficulty. First, overall business investment in R and D (of 1.15% of GDP for UK in 2008)[2] is very low by OECD comparison. Secondly, where we do have strengths the trends to globalisation are significant and few business R and D decisions are made in the UK from the perspective of benefit to UK—we would contend that this significant international dimension to UK BERD, whilst a strength in one way is a massive weakness in another. UK researchers looking for commercial partners will therefore increasingly turn to overseas partners with the consequent flow of benefits outside the UK, unless further action is taken.

The sixth difficulty relates to the shape of the UK industrial base which is dominated by large and small companies, but with few medium-sized businesses (CBI Future Champions report, October 2011).[3] This absence of medium-sized companies in part means that the businesses which could gain substantially from new technologies are few in number by comparison to other developed economies.

The seventh difficulty has also been addressed in recent years and this relates to UK Technology Transfer Offices in universities and public sector research establishments. PraxisUnico has now trained over 2,500 professionals in the UK research base over the past 10 years. However, staff churn means that this is a continual process. Income to universities from industrial R and D is now £900 million per annum and income from intellectual property has been rising year on year. However, to evaluate outcome by examining income to higher education is the wrong perspective; the correct approach is to start considering the return to companies from acquiring university technologies. One possible metric is to look at the capital value of companies as they go through IPO or trade sale. Since 2003 the valuation of university spin-out companies which have come to market or trade sale is well in excess of £13 billion (many trade sales are private and undisclosed). These figures are derived from 50 companies (see appendix insert list) and there are a further 1,400 spin-out companies trading which will continue to feed this pipeline. Opinions on the role of spin-out companies in the economy vary but given the absorptive capacity of the UK industrial base (see above) spin-out companies over the next 10 years could make a significant cumulative contribution to the re-shaping of the UK economy when combined with other actions addressing the overall venturing environment.

The final difficulty is "short-termism". What is required is a sustained solution, delivered over sufficient time to assist in the re-shaping of the UK economy. Many public sector interventions are hampered in achieving a major impact as a consequence of being short lived interventions with limited cumulative gain. This "short-termism" was true of the original UCSF as well as for other sub-national interventions through regional or European funding.

Solutions

Some of the solutions are not easy in the present environment but the future growth of the UK economy and its re-shaping will require public investment combined with public sector interventions to stimulate changes in the private sector environment. We must reinforce successes, address fragmentation, stimulate collaboration and invest in our research bases' capacity to support commercialisation.

In PraxisUnico's view one of the best examples of a public sector scheme which addressed all of the points made in the previous paragraph was the University Challenge Fund. This scheme was relatively short lived but its successes are still being celebrated. £65m was invested in a series of experimental funds across the UK run and managed, for the most, by, or on behalf of, consortia of universities. This scheme assisted the development of Imperial Innovations, the development of seed funds in universities, supported the creation of SET squared and enticed the emergence of private sector investment in university companies, as well fostering collaboration between major universities. Over a period of nine years to 2009 these funds leveraged seven times their public sector investment from the private sector to £433 millio. By any measure this scheme was a success. It promoted the development of technology transfer, it built on the strength of the university sector and fostered

collaboration. PraxisUnico has campaigned on numerous occasions for this scheme to be reinvigorated and we believe that the time is right, and much of the original infrastructure is still in place. The scheme should be rekindled, new bids invited and the scheme broadened to support technologies capable of being de-risked for development by existing companies as well as supporting new company development. Unlike the previous versions of the Scheme the successful funds should be "open for business" to all universities, thus ensuring that high quality technology arising in an institution with low volumes of activity would not be deprived of access to investment funds. The scheme should have a 10 year duration in order to provide a major foundation and to build time for traditional VC funds to emerge from the private sector as the deal flow will then be fully established.

The scheme would not be competitive to the MRC DPFS scheme or the new Biocatalyst Fund but would be one of the mechanisms which could provide support for their implementation. The original University Challenge Fund was co-funded by the Wellcome Trust, The Gatsby Foundation and the Government and a multiple sponsor scheme could re-purpose individual funds held by different public agencies for early stage follow-on into a single coherent investment based solution delivered through universities covering the proof of concept, seed and first round funding environment stage.

Whilst the original University Challenge Fund was a useful part of the funding environment a softer money alternative, where innovation can remain an internal project run by the research team for longer, feels more appropriate in some cases. Therefore a basket of funding options to drive projects to commercialisation is required rather than relying on just one route. In early stage development "fragmentation" of support routes can be seen as being more of a positive than a negative.

2. *Are there specific science and engineering sectors where it is particularly difficult to commercialise research? Are there common difficulties and common solutions across sectors?*

There are no easy sectors. The technologies emerging from the research base are the foundation for new industries and will always be challenging. The bioscience sector has the benefit of major corporate R and D in the UK, as does large scale mechanical engineering thus providing considerable commercial insights for the research community. However, even in the bioscience sector the challenges are substantial as the entire business models are changing from traditional drug discovery to personalised medicine, with new models arising from genetics and cellular therapies—the UK must foster the new and not simply sustain the strengths it has which may well be under threat from major disruptions (who could have foreseen the demise of Kodak, for example). A review of BERD statistics by sector demonstrates the challenges faced if the future of the UK rests on building the past. There are huge opportunities in renewable energy and major opportunities in construction and by simply reinforcing the importance of manufacturing to the UK. PraxisUnico would make one plea; the commitment shown to the bioscience sector needs to be diversified into engineering and the physical sciences if the UK is to re-shape its industrial base.

3. *What, if any, examples are there of UK-based research having to be transferred outside the UK for commercialisation? Why did this occur?*

One of the most long standing examples relates to magnetic resonance imaging. The original patent portfolio emerged from three universities in the UK (Oxford, Nottingham and Aberdeen) over more than 20 years generated only royalty income to the UK of circa £300 million in total for an industry generating hardware sales in excess of $2.5 billion per annum for licensees in Japan, US, Korea and Germany. One of the primary inventors sought to gain investment in the UK, unsuccessfully. The importance of these decisions is huge as it is not merely the loss of the major manufacturer but the subsequent supply chain development and investment in further investment in innovation which, in turn, assists the re-shaping of a country's economy. More recently (Jan 2012) the sale of Inhibitex Inc developed in the US (check) to Bristol-Myers Squibb for $2.5 billion relates predominantly to technology developed at Cardiff University. The company migrated to the US early in its development as a significant early stage, higher risk investment could only be secured in the US.

Founded in 1996 by graduate student Mike Lynch and utilising a unique combination of technologies borne out of research at Cambridge University, Autonomy has experienced a meteoric rise. The company was bought by HP in August 2011 for £7.1 billion, producing a several hundred million dollar fortune for Mike Lynch. Autonomy is a global leader in infrastructure software for the enterprise that helps organisations to derive meaning and value from their information, as well as to mitigate the risks associated with those same assets.

Campath® (alemtuzumab) is a monoclonal antibody treatment for B-cell chronic lymphocytic leukaemia. Based on a monoclonal antibody, Campath-1 discovered in the Cambridge University Department of Pathology by Herman Waldmann and colleagues, the treatment was improved by Greg Winter and others at the MRC Laboratory of Molecular Biology in Cambridge, using a process that became known as "humanisation", to create Campath-1H. The initial commercial development was undertaken by the Wellcome Foundation, under licence from the British Technology Group, but after £50m investment, Wellcome dropped the project, it was licensed by BTG to LeukoSite in the USA. LeukoSite merged with Millenium Inc. who then sold the rights to ILEX, later acquired by Genzyme, who now produce and market the drug. Wellcome was a British company (now part of GSK); the others are all American.

Helen Lee developed diagnostics technology primarily for diseases in developing world countries at the University of Cambridge and was seeking financial support to start up a company at the turn of the century. It was not possible for Helen to identify readily accessible funding in the UK and she turned to the USA when setting up her company "Diagnostics for the Real World". She managed to secure funding from NIH through the SBIR scheme and set up her company in California in 2002. Helen is a supporter of SBIR which has three calls a year and has very clear rules and guidelines for engagement. She received nine rounds of SBIR funding. The company currently has 15 employees in California and its first two products are on the market and licensed through Thermo Fisher.

4. *What evidence is there that Government and Technology Strategy Board initiatives to date have improved the commercialisation of research?*

It is probably too early to address the TSB's impact, but there is no doubt that they are providing a much needed stimulus to technology development. Recent changes to TSB funding schemes are likely to have a positive impact as they will foster development across the "valley of death" with closer working relationships to the university sector. In a recent TSB study it found that outcomes from its programmes were enhanced by university involvement. PraxisUnico believes that the UK must have an Innovation agency. There are examples where TSB funding has been used to pump-prime spin-out companies; for example, in the field of tissue engineering at Cardiff University and it would have been difficult (very early stage) to get this off the ground without the TSB funding. The challenges for the TSB are first, to avoid a naive separation between market-pull and technology-push. Increasingly, new markets will emerge through a dynamic environment bringing together technology push, market-pull alongside science-pull and entirely new market creation. Secondly, the TSB must champion the linkages for companies they support into the venture funding communities both corporate and private funds. Thirdly, the TSB must take risks and work with new emerging businesses and not confine action to well established industrial partners.

5. *What impact will the Government's innovation, research and growth strategies have on bridging the valley of death?*

There are positive signs both in recent policy statements and speeches by Ministers and it is too early to say two years into an electoral term. The announcements relating to TSB, Bioscience Investment and NHS Innovation are all welcomed. We are concerned however, that none of these have specifically addressed the topic of this investigation which requires a major stimulus to bring together all of the investments in translational research, with those in the TSB into a new economic policy which has at its heart a systematic re-shaping of the technology and corporate venturing market in the UK.

We also feel the commercial imperatives of a venture capital fund and the need to form a limited company and associated management team do not seem to fit easily with the early stage innovations with long lead time to market. By the time that a business case and project team have been put together, that is getting close to where the investment community can understand a project and invest in it. That's where the challenge funds are really operating, and by then we're climbing out of the valley. If a university spends on patent protection, then it should be able to deploy some associated concept development money.

6. *Should the UK seek to encourage more private equity investment (including venture capital and angel investment) into science and engineering sectors and if so, how can this be achieved?*

Yes, absolutely. Models such as Fusion IP, IP Group and Imperial Innovations have helped bridge the gap between City investors and universities. Relationships such as these also bring a professional, business-like culture into universities, helping to embed entrepreneurial culture. The further stimulus provided by a major university challenge fund scheme as suggested above can build on these early successes, fostering university collaboration, creation of critical mass and support the re-shaping the UK economy.

In addition there exist solutions such as Alumni Angel networks, the sale of "first look" options, specific fundraising/sponsored research or the establishment of a proprietary fund by universities.

7. *What other types of investment or support should the Government develop?*

There are many different calls on funds and the simple answer is that all investment funds that help develop the outcomes of the research are required. These vary from the costs of IP protection (there seems to be a real lack of funding for this activity, budgets are required), undertaking effective market research, bringing in design and engineering expertise earlier into the process, professional advice/advisors and lawyers, investment readiness, expansion of technology transfer training for young researchers, proof of concept funding, entrepreneurs in residence etc. But the answer is to stimulate these areas and avoid fragmentation by initiatives which tackle only one component at a time, which seems to be the present policy dynamic. PraxisUnico believes that the University Challenge Scheme proposed in this submission has the further beauty of providing an investment stimulus which can be deployed effectively in a multi-dimensional way with a clear focus on commercial goals without narrowly defining an inappropriate target for an intervention.

Across all sectors we are concerned about the early stage problems, where nobody really knows if something is worth supporting. Best for the possible means to be fragmented in this case, because then perhaps someone

will pick something up as worth doing. Also it's very difficult to apply systems and measures to events or timeframes at this stage. We recognise that support at this level.

Declaration of Interests

Dr Douglas Robertson is directly involved in the operations of university research commercialisation functions.

January 2012

References

(1) RUSSELL PIONEERING RESEARCH GROUP (March 2010) *The economic impact of research conducted in Russell Group Universities* [online] pgs 35–37. Available at: www.russellgroup.ac.uk/uploads/RG_ImpactOfResearch2.pdf

(2) OECD (2010) *Science Technology and Industry Outlook* [extract], [online] pg 230. Available at: www.oecd.org/dataoecd/40/28/46666019.pdf

(3) CBI (October 2011) *Future champions Unlocking growth in the UK's medium-sized businesses* [online] Available at www.cbi.org.uk/media/1125696/future_champions__finalb_.pdf

APPENDIX 1

UNIVERSITY SPIN-OUTS AND ACQUISITIONS SINCE 2003

(as extracted from PraxisUnico publication *The Review*, June 2011)

2003
Wolfson Micro

2004
ARK Therapeutics
OHM
Vectura
Summit
Synairgen
Ceres Power
IDMos
Microemissive Displays
Andor
Cambridge Display Technology

2005
FusionIP
Proximagen
Provexis
Stem Cell Sciences
Oxonica
ReNeuron
NeuroDiscovery
GETECH
SPI Lasers
Celoxica
Toumaz

2006
Lipoxen
Syntopix
ParOS
Renovo
Oxford Catalysts
Avacta
Imperial Innovations
ValiRx

2007
Epistem
Modern Water
Tracsis
e-Therapeutics
Oxford Advanced Surfaces Group

2008
Scancell

2009
Nanoco Group

2010
Ilika
Tissue Regenix

2011
Microsaic Systems

Acquisitions
Kudos Pharma
NeuTech
Cambridge Antibody Technology
Domantis
Solexa
Arrow Therapeutics
Daniolabs
Plasso Technology
MTEM
Cambridge Display Technology
Meridio
CamFPD
OMD
SIW
Transitive
Thiakis
Phototherapeutics
Biotec Laboratories
APT
Inforsense
BioAnaLab
Orthomemetics
Reactivelab
Apatech
MET
Im-Sense
Exosect (Bee Health Division)
Artemis Intelligent Power
Biovex
Lab901
Chameleon Biosurfaces

Pending Acquisitions
Astex Therapeutics

Written evidence submitted by the Confederation of British Industry (CBI)

Summary

— De-risking the innovation process and giving business the confidence to invest in new ideas and concepts is a key element of translating ground-breaking research into new technologies and markets.

— The "valley of death" in research commercialisation needs to be approached from both sides: helping to give an extra *push* to take ideas from research closer to where commercial decisions can be taken more easily, and helping to create a demand-side *pull* to bring ideas through to market.

— Reform of public procurement to seek out and encourage innovative new ideas could transform the pull side of demand in a wide range of markets. Businesses will invest to pull through ideas where there is a clear commercial proposition. Certainty in regulation will also help generate confidence to invest.

— As a central part of government's efforts on the push-side, the Technology Strategy Board needs to ensure its efforts align closely with the needs of industry. It must develop sufficient focus to create a critical mass of activity and use its position in the innovation ecosystem to help link up research with development with public procurement and other new market opportunities.

Introduction

1. The CBI welcomes the opportunity to submit evidence to the Committee's inquiry. The CBI is the UK's leading business organisation, speaking for some 240,000 businesses that together employ around a third of the private sector workforce.

2. The difficulty of translating research into commercial application is an established issue and one that has no simple solution. There is a "valley of death" where choices have to be made about which research ideas should be taken further and which should be dropped. During early stage research the overall investment made by a company may be significant, but each individual project will probably represent a small fraction of the whole, so while the likelihood of failure may be high, the financial risk if a project fails is minimised. Developing a research idea into a fully-fledged commercial offering invariably requires a different scale of investment—perhaps even orders of magnitude more investment—and while the risk of failure may be rather lower, the financial consequences of failure on each project are now much higher. The result is that businesses will naturally tend towards developing research ideas that they have higher confidence about. But even here, finite financial resources may mean that good ideas are either left behind or may not be developed fast enough or extensively enough to become a commercial success.

3. The valley of death problem is thus about managing risk and confidence and providing businesses with a degree of competitive advantage in order to invest in new ideas.

4. From the business perspective, there are two approaches to minimising risk and building confidence that will help to bridge, or at least flatten out, the valley of death. The first is to look at factors from the commercial side that will make it easier to *pull* ideas through. The second is to consider factors that help to *push* ideas that bit further from the initial research phases to help make commercialisation decisions easier.

5. Government has a role to play on both the push and pull side of the equation, although the focus in the UK has, until recently, been primarily on the very earliest stages of research push. Development of the Technology Strategy Board has seen public intervention in the UK move more effort into the valley of death, although the extent of funding available means this cannot be a panacea. Similarly, government has started to talk about using its public procurement buying power as a demand-side pull driver for innovation, but progress has been limited. These issues are discussed below.

Demand-side Pull

6. Public procurement is one of the most important levers available to government for influencing and directing investment from the demand-side. Even in today's necessarily constrained fiscal environment, the government purchases around £¼ trillion per year of goods and services. This is in comparison to the roughly £11 billion per year invested in all aspects of research and innovation (including university funding, defence R&D and the R&D tax credit).

7. Securing a public procurement contract can provide the stimulus needed for businesses to invest in developing research ideas and technologies further, helping to bring them through the valley of death. It can also help companies secure new lines of funding and can provide the platform for potential sales to other governments, which in turn can stimulate further investment. But to be effective, public procurement needs to be open to innovative ideas.

8. We have welcomed the establishment and relaunch of the Small Business Research Initiative (SBRI) by the Technology Strategy Board, which seeks to support the development of innovative ideas from smaller companies into procurement, but the scale of this scheme is too limited. Even when the different scales of our economies are corrected for, the US invests around six times as much in its equivalent programme as the UK does. Clearly, SBRI's primary focus remains SMEs and early stage businesses although competitions remain open to all companies.

9. The economic situation provides a unique opportunity to make more effective use of the procurement budget in order to achieve greater efficiency and long-term savings. The government must become more intelligent as a customer, with decisions being taken on achieving whole life value, not just on short term cost savings. Without breaking any EU procurement rules, the government can also seek other advantages through procurement such as capability development.

10. The CBI has put forward these steps to government as part of the ongoing reform of public procurement needed in the UK:

— Streamline the process—ensuring contractors are clear on their requirements before inviting bids and reduce administrative burdens on suppliers.

— Incentivise commercial officials to run quick and efficient procurements through increased transparency of timescales and reward those who run successful projects.

— Signal the forward pipeline of projects so that businesses can plan ahead with confidence—in particular in areas of long-term infrastructure investment.

— Focus on wider outcomes rather than the procurement process, giving providers the freedom to design service packages, holding them to account by making payment dependent on outcomes.

— Take whole-life costs into account, ensuring decisions are based on long-term value for money.

— Foster innovation by ensuring procurers demand innovative solutions to drive product and service development from suppliers.

— Place greater emphasis on wider economic value such as job creation and future investment into developing industrial capability and capacity.

11. The government can also create demand-side pull by establishing or freeing up markets—although appropriate limitations will need to be considered too. Currently, we are looking to an efficient 4G auction that will provide the stimulus to bring forward development in the next stages of telecoms infrastructures and digital content. There are also opportunities in housing, low carbon and other markets where targets and incentives can be used to pull through investment or through promoting open innovation in sectors where the UK is able to build competitive advantage.

12. In any area where government regulates activity, it needs to act intelligently when working with business to create an environment that encourages innovation and helps drive new technologies and create new markets. This can only be achieved through consistency and clear two-way communication with industry around what is expected.

13. Providing certainty for companies through voluntary codes, standards and, where necessary, regulation can act as a real driver of investment confidence, helping to bring forward the commercialisation of innovative ideas. Government needs to:

— Inform businesses of future planned changes in the regulatory environment, allowing time to plan and comply with new rules.

— Provide a degree of flexibility in how regulations can be met.

— Provide clarity in requirements and ensure new rules are not open to misinterpretation.

— Ensure poor regulations are dealt with effectively and that additional burdens or conflicts are not placed on business by overlapping or multiple layers of regulation.

Push Factors

14. The Technology Strategy Board (TSB) is clearly at the centre of government's efforts to help push or accelerate the development of new technologies and it has now become an established part of the UK's innovation ecosystem.

15. The TSB operates across mid-tier technology readiness levels, where development costs rise and where risk moves substantially from universities and research labs to business. We welcome the TSB's efforts, but also recognise it is trying to do a lot with only limited resources: it's annual funding is around £317 million per year, compared to c £4 billion per year for the Science Budget. There is an ongoing need to ensure TSB's efforts create a critical mass of activity and that they are not diluted by trying to do everything.

16. In our input to the recent Research and Innovation Strategy discussions, we identified a number of areas where TSB could improve to keep its focus on the technology acceleration through to commercialisation mission:

— Provide greater transparency around the amount of funding available for specific programmes year by year so that businesses can plan ahead.

— Take a more proactive stance on linking R&D investments through to commercialisation—in particular seeking to support the creation of UK value chains and linking investments in research through to public procurement of goods and services (ie not just procurement of R&D through the SBRI scheme).

— Undertake a review of priorities with business to ensure that critical mass of activity is being supported, rather than spreading available funds too thinly. This needs to be end-to-end so that early stage funding for basic research by the Research Councils can follow-on with Technology Strategy Board support for development of the most promising areas that business wants to develop.

— Build stronger links with technology road mapping activities (such as those undertaken by sector bodies and the government's own innovation and growth teams) to ensure priorities identified can be supported effectively at the right time

— Ensure adequate resources are available for demonstration and proof of concept activities and provide supporting links through to other government funds such as the Regional Growth Fund, Business Growth Fund and Green Investment Bank where appropriate.

— Ensure Catapult centres (previously TICs) are run by and for business, that they do not replicate nor displace activity from existing centres of excellence in UK universities and the RTO sector, they map effectively with business priorities and that their business model is appropriate.

— Improve links with small and mid-sized companies to increase the effectiveness of knowledge exchange—work through Knowledge Transfer Networks, RTOs, Catapults as they are developed and through supply chains of businesses already engaged with the Technology Strategy Board.

17. Greater realism is needed towards the timescales of TSB competitions. Often these are too short and do not allow enough time for businesses to develop detailed and informed proposals. This can limit the chances of an application meeting the necessary criteria for success.

18. The government, through the TSB and other routes, also needs to help businesses access European research, development and innovation funding. The new Horizon 2020 programme appears to have addressed many of the concerns of business over bureaucracy and relevance associated with previous rounds of the Framework Programme and we are particularly interested in the focus now being placed on technology demonstration. While proposals for Horizon 2020 are still being worked-through, this appears to shift the focus exactly to the 'valley of death' area of interest to business. The challenge now is to win over hearts and minds in the business community to re-engage with this effort at European level.

February 2012

Written evidence submitted by Comments from the National Physical Laboratory (NPL)

1. Summary of Key Points

— Government laboratories such as NPL can be a bridge between academia and industry and are well placed to support the commercialisation of research. Specifically NPL, managed by Serco under a government-owned, contractor-operated (GoCo) arrangement since 1995, has a track record for undertaking the commercialisation of research through effective academic and business partnerships and application of private sector best practice.

— Government can encourage the commercialisation of research by supporting R&D to de-risk technology and using fiscal measures to increase the return on research exploitation investments.

— The instruments of the Technology Strategy Board make a significant contribution to de-risking technology, both through supporting collaborative R&D and through networking.

— Early adopter customers help to commercialise research, and there are opportunities for government to increase its role as an early adopter through procurement through the SBRI.

— Involving the private sector in the operation of Public Sector Research Establishments can lead to innovative approaches to bridging the "valley of death".

— We are part of the intermediate sector and would welcome an opportunity to give further oral evidence to the Committee of the importance and role of the intermediate sector in the UK innovation ecosystem.

2. About NPL

The National Physical Laboratory (NPL) is a leading UK research establishment with an annual turnover of £70 million and a staff of 600. It is the largest science asset directly owned by BIS and occupies a unique position as the UK's National Measurement Institute (NMI) sitting at the intersection between scientific discovery and real-world application. In 1995 DTI (now BIS) established NPL as a GoCo, Government-owned Contractor-operated, national science and technology laboratory and since that time it has been operated by Serco. The involvement of the private sector in the management of NPL has greatly enhanced its ability to commercialise research—see para 9, Q7.

NPL undertakes work for government and its agencies and for business. Its expertise and original research underpin quality of life, innovation and competitiveness for UK citizens and business:

— NPL provides companies with access to world-leading technical expertise and scientific facilities, assuring the confidence required to realise competitive advantage from the use of new materials, techniques and technologies.

— NPL develops and maintains the nation's top-level measurement standards, supporting an infrastructure of traceable measurement throughout the UK and the world, to ensure accuracy and consistency.

An important aspect of NPL's work is the exchange of knowledge with business, government and academia which it carries out through a Knowledge Services Division of over 30. This team:

— Supports the dissemination of knowledge from NPL's R&D programmes; economists at BIS estimated a return on government investment of 50:1 for NPL R&D programmes.

— Oversees the exploitation of NPL's intellectual property; for example spinning out Argento Diagnostics Ltd as an SME now working with UK Sport to develop a Point of Care testing technology to support UK's high performance sports groups.

— Manages large parts of two Knowledge Transfer Networks for the Technology Strategy Board.

— Supports academia to exploit their research for example through a Research Council funded Knowledge Transfer Account at Surrey University.

3. Q1: *What are the difficulties of funding the commercialisation of research, and how can they be overcome?*

The first step in the commercialisation of research is the identification of any intellectual property generated by it, and then the assessment as to whether this has potential commercial value. Those carrying out research do not always appreciate the commercial value of some of the innovations created by their work. This requires different skills and methods which have been developed at NPL, such as procedures to capture IP and, where appropriate, investment of Proof of Concept funds to test the commercial potential and carry out early-stage development. As important as the potential value of the innovation itself is the leadership to support its exploitation and whether the technology has reached a sufficient maturity for commercialisation.

Developing technology for commercialisation usually requires taking risks and making large investments. The challenge is to match the return on investment with the size of the risks taken. This can usually only be achieved through a staged process where the level of risk is reduced as the requirement for investment rises. Success requires:

— Entrepreneurial drive sustained over a number of years through the stages that lead to successfully spanning the valley of death.

— Knowledge of how to use the staged process necessary to cross the valley of death.

— Recognition of the need for and access to a range of specialist skills complementing those of the innovator.

— Market-pull for the product, ie right product at the right time for the right market sector.

— Ready access to a wide range of finance, such as Proof of Concept funds, grants, loans and equity investment.

Difficulties arise in commercialising research when:

— The market, eg investments provided by Angel Funds and Venture Capital, is unable or unwilling to invest because the risks to generate a return are still too high

— The right knowledge and skills are not assembled for successful commercialisation.

Government can increase the commercialisation of research by catalysing the interactions necessary to overcome these barriers to success, and where the "valley of death" is too wide for the market to bridge, can provide financial support, for example through funding for translational research to prepare new technologies for commercialisation.

4. Q2: *Are there specific science and engineering sectors where it is particularly difficult to commercialise research? Are there common difficulties and common solutions across sectors?*

For many sectors the difficulties of commercialisation of research are common because they are subject to similar risks. However for some sectors there are additional risks to commercialisation:

— Where the sector is highly regulated, eg the pharmaceutical sector. Meeting regulatory requirements is costly and lengthens the time to market.

— Innovative, disruptive technology, such as new sensors, may offer clear technical advantages over existing technology and be used in new applications with potentially enormous commercial advantages. However, if based on an entirely new principles, it will require significant investment to de-risk and demonstrate reliability if the market is going to adopt the technology, especially in critical application areas such as healthcare, aerospace, energy, and safety. To develop a robust technology and prove reliability, technology innovators from SMEs, Universities and RTOs need to access and understand the end users in these critical application areas; to access other technology areas such as materials and electronics; and to access supply chain partners for design, manufacturing, and testing & validation. Our experience of running technology networks is that networking is a very effective way of brokering the right connections and bringing together development teams across the value chain to develop and prove disruptive technologies. Further, our experience of working as part of these value chains using NPL scientific and metrology expertise has proved that measurement, testing and validation are critical in the acceptance of new technologies and methods in the uptake and commercialisation of disruptive technologies.

— Where an innovation aims to replace a well-established mature technology, eg parts of the sensors and instrumentation sector. Innovative products are initially likely to be produced in small numbers at a higher cost so that although delivering greater value through their novelty, they find it difficult to compete in the market because they are seen as of lower value for money when compared with much lower cost mass produced products.

5. Q3: *What, if any, examples are there of UK-based research having to be transferred outside the UK for commercialisation? Why did this occur?*

NPL does not have specific examples of UK-based research transferring outside the UK for commercialisation. However, we are aware of an example of an international company that chose to maintain part of its R&D support facility in the UK. Agilent Technologies is a leading international instrumentation company that has decided to keep some of its laboratories at Winnersh in the UK in part at least because of the close working partnership with NPL and UK accredited laboratories, and the excellence of the services they provide. As evidence for this we attach in an appendix an extract from a letter NPL received from a General Manager of Agilent Technologies (UK) Ltd a couple of years ago.

6. Q4: *What evidence is there that the Government and Technology Strategy Board initiatives to date have improved the commercialisation of research?*

NPL is often asked by UK businesses to partner in collaborative R&D projects funded through the Technology Programme of the Technology Strategy Board; we are currently partners in over 50 such projects. The fact that business seeks NPL out as a partner provides clear evidence that the research carried out by NPL, funded by BIS through the programmes of the National Measurement System, is valued by those tasked with commercialising research. Through our work with these business partners we also are very aware of both how important these collaborative projects can be in de-risking the exploitation of research and of the impact they make on innovating products and processes. However, we are constrained by commercial confidentiality from providing specifics for current or recently completed projects.

We can also provide evidence of the support provided by the Knowledge Transfer Networks for the commercialisation of research. During the 5 years NPL managed the Sensors and Instrumentation KTN it helped companies leverage £97M to de-risk technology to prepare it for commercialisation. The KTN also has much anecdotal evidence of how the networking it has facilitated has helped bridge the valley of death by bringing together potential customers and innovators. For example an entrepreneur set up a new business as the direct result of Rolls Royce asking to be its first customer at a KTN event. Contacts are gold-dust to start-up businesses.

More recently, we welcome the Government's commitment to "Catapults" (formerly Technology Innovation Centres) managed by the TSB. However, it is important that these centres should be business-led and complement existing centres of excellence (often Research and Technology Organisations).

Our experience of developing the Technology Innovation Fund at NPL is that a relatively small value of support, that is well targeted, can provide disproportionate benefit to companies, especially SMEs. We can provide examples. We encourage the Technology Strategy Board to continue to develop a diverse range of funding mechanisms to support innovative companies which reflects the diversity of needs of these companies, from the company size, sector, complexity of development projects and number of collaborators.

7. Q5: *What impact will the Government's innovation, research and growth strategies have on bridging the valley of death?*

We highlight the following as aspects of the Government's recently published "*Innovation and Research Strategy for Growth*" that will help bridge the valley of death:

- Government can help the commercialisation of research by tipping the balance between risk and return on investment. This can be by funding the de-risking of new technology through instruments like Innovation Vouchers, the SMART programme and collaborative R&D supported by the Technology Programme.
- It also helps increase the return on investment through appropriate fiscal measures like R&D tax credits.
- SMEs want customers even more than investment. Government procurement supports commercialisation of research for example through the SBRI scheme.

The Strategy also highlights the role of the intermediate sector, including NPL, as an important part of the UK's innovation infrastructure in the following extracts:

- Our [The UK] excellence in teaching and research is underpinned by institutions with a global reputation, such as the British Standards Institution, the UK Accreditation Service, the National Physical Laboratory and the Intellectual Property Office.
- The government will also continue to invest in translational research at Public Sector Research Establishments, such as the National Physical Laboratory, which support business to develop innovative products and services.
- The UK Innovation ecosystem also embraces Innovation infrastructure organisations, including the National Measurement Office, National Physical Laboratory, British Standards Institution and UK Accreditation Service.

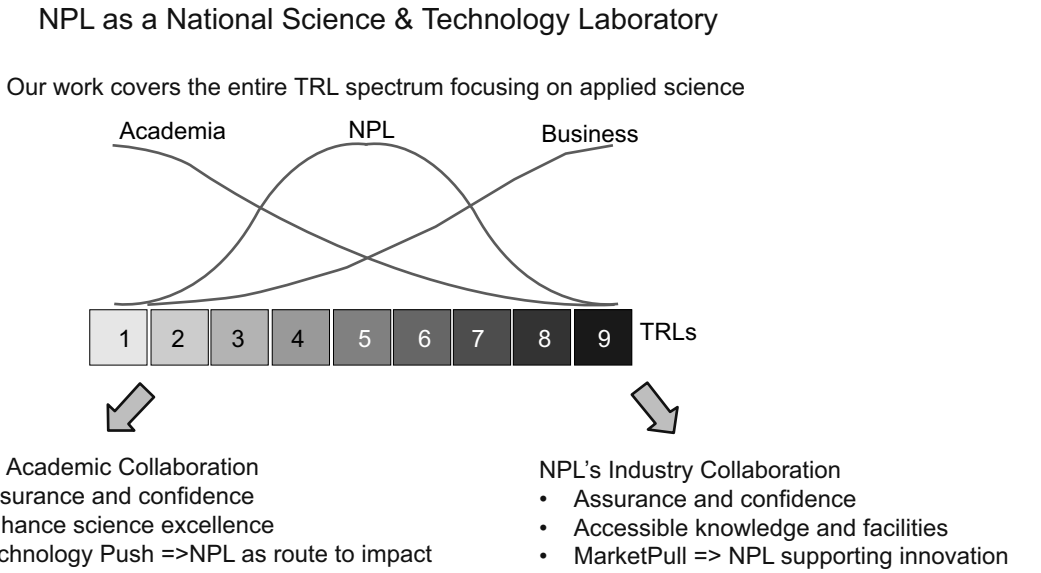
— Research and Technology Organisations (RTOs) are positioned between academia and business users of technology. They are a range of companies and organisations whose activities bridge gaps in the process of converting research outcomes into innovation and new technologies for use. Examples include … the National Physical Laboratory providing knowledge-based services to support the application of science and technology through better measurement. This intermediate sector is an important part of the innovation system, and is estimated to contribute £3 billion annually to UK GDP, and support over 60,000 jobs.

— The National Measurement Office, National Physical Laboratory and British Standards Institution will work with international measurement and standards bodies and committees to promote the UK's strengths in measurement and standards and to the UK businesses associated with them.

In conclusion it states:

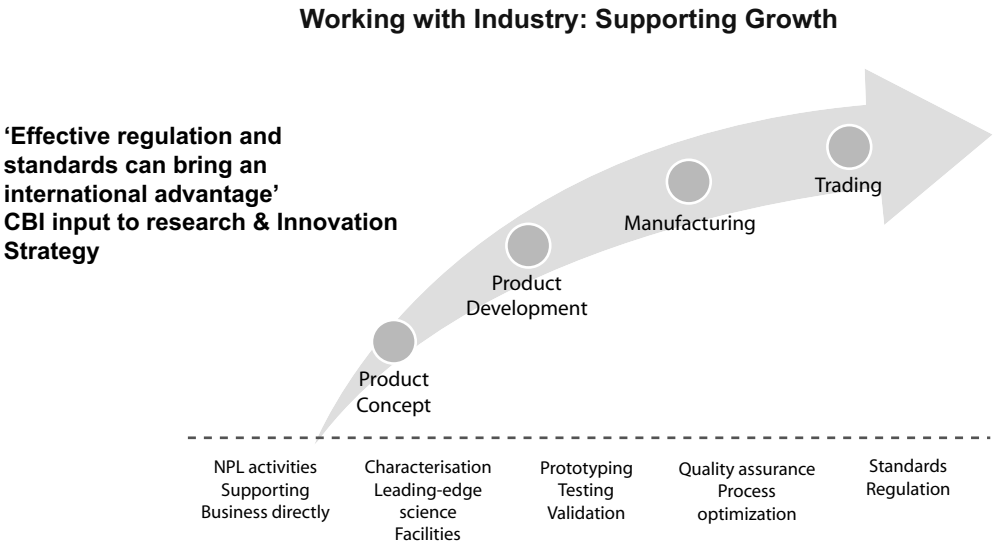
— We believe that the intermediate sector is an under-used asset. It provides technical advice in many sectors, including agri-food and water where we are seeking to encourage higher levels of investment in innovation. We will work with RTOs to develop a strategy for using their experience and expertise as part of the innovation ecosystem.

The Strategy clearly recognises the importance of the intermediate sector to the innovation ecosystem and that it is an under-used asset. We would welcome an invitation to give further oral evidence on the vital role of the intermediate sector to your Committee. The key points are illustrated in the following diagram which shows the position of NPL as a member of the intermediate sector between academia and business. The diagram uses Technology Readiness Levels (TRLs)[79] to map out the journey from scientific discovery to industrial exploitation. The intermediate sector carries out translational research developing technology from TRL 1 to 3 in academia to TRL 7 to 9 in the applied research laboratories of business.



As a government laboratory NPL along with its innovation infrastructure partners of National Measurement Office, British Standards Institution and UK Accreditation Service supports the commercialisation of research all the way from product concept to trading.

[79] TRLs were originally developed by NASA to describe the maturity of a technology from initial principles (TRL1) to actual system demonstrated through successful operation (TRL9).



However, whilst the strategy recognises the importance of Public Sector Research Establishments (PSREs) like NPL for translational research, it does not include any recommendations to enhance their role. Our experience is that involving the private sector in the operation of PSREs significantly increases their ability to provide translational research services to help business, both large and small, to bridge the valley of death. (See responses to Questions 8 and 9).

We have clear evidence of the value of the support NPL can give innovating business. In an independent survey of 1,000 UK businesses, a benefit of £700M in additional profitability was identified for a single year, dependent upon accessing measurement services to support product and process innovation.

8. Q6: *Should the UK seek to encourage more private equity investment (including venture capital and angel investment) into science and engineering sectors and if so, how can this be achieved?*

Our experience is that involving the private sector in the operation of PSREs like NPL leads to innovative solutions for the exploitation of their intellectual property. We give as an example the exploitation of a technology for Point of Care diagnosis by NPL:

- The new science on which the technology depends came out of a government research programme at NPL.
- Serco used an internally funded Strategic Research Programme for a Proof of Concept project for the technology.
- The success of this project led to the establishment of a company Argento Diagnostics to exploit the technology.
- Serco then provided management expertise and a loan of £2 million to Argento Diagnostics to develop a prototype.
- Argento Diagnostics was spun out of NPL as a limited company.
- Good progress is now being made to fully commercialise the technology in its first application for UK high performance sports groups.

9. Q7: *What other types of investment or support should the Government develop?*

It is our experience that involving the private sector in the operation of PSREs significantly enhances the commercialisation of their research. If we take NPL as an example:

- Tripled its revenue from the commercialisation of its research since 2004 (now approaching £25 million per annum).
- Established regional hubs in partnership with academia and industry to serve the needs of local industry (eg laboratory at the University of Huddersfield).

— Provided financial (£2 million) support and management expertise to exploit NPL intellectual property through the spin out of a bio-diagnostic company.

— Supported the exploitation of intellectual property through the establishment of a Proof of Concept fund for NPL IP.

— Invested £40 million in the last 10 years in scientific capital assets at NPL.

— Worked with many research partners, currently over 300 in the UK and abroad, and interacted with nearly 2,000 SMEs.

— Brokered £100 million of funding for the de-risking of technology (£1M pa of which is provided by Serco itself through the NPL Technology Innovation Fund).

— NPL has developed partnerships with major businesses in the UK, eg Rolls Royce and BP, to help them innovate to continue to compete internationally.

However, such commercialisation is not at the expense of the science with NPL's peer reviewed publications and citations more than doubling since 2004.

Public Sector Research Establishments (PSREs) like NPL maintain significant scientific and technological capability to fulfil their core government function, in the case of NPL to provide the UK national measurement system infrastructure. NPL makes spare capacity on this capability available to business and government customers through R&D services at commercial rates. NPL often receives inquiries from SMEs with a need to de-risk a technology through the application of our specialist facilities and knowledge which they cannot to afford to access, putting the commercialisation of their research at risk.

February 2012

APPENDIX

EXTRACT FROM LETTER FROM AGILENT TECHNOLOGIES (UK) LTD TO NPL

As you known, we made some significant changes to our European services business a couple of year ago. The main theme of that change was to centralise many of our service deliverables such as calibration and repair. With increasing complexity of our instruments and consequent increasing cost to maintain them, we had to get a better utilisation of our equipment ands achieve a higher productivity. Due to its proximity to two of our main factories and excellent logistics, we selected the Agilent site in Böblingen, southern Germany, as our main European service operation.

At the same time as we made this decision, we also realised that we had to maintain and improve our high frequency and accredited work. Although, it might have been more obvious to set this up in Böblingen, we took the decision to expand our operation in Winnersh, UK to deliver this European wide service. One of the main reasons that we made this decision was due to the close working relationship that we have developed over many years with NPL and UKAS.

As you known, we have now completed a significant investment in our UK labs—both in terms of the infrastructure and people. We are delivering an excellent service from this operation and it is, today, one of the highest performance labs in Agilent. The services that we deliver from Winnersh are for customers both in Europe and countries beyond. I am certain that without the guideance and consulting that we have had from you and your colleagues in NPL, we would not have achieved that. In particular, the help that you gave us in the last year to establish the IPIMMS and 50GHz Noise Source systems was invaluable. These are unique services that were only made possible through the close cooperation of NPL, UKAS and Agilent engineers.

Written evidence submitted by ADS

About ADS

ADS is the trade organisation advancing the UK Aerospace, Defence, Security and Space industries. Farnborough International Limited (FIL), which runs the Farnborough International Airshow, is a wholly-owned subsidiary. ADS has offices in England, Scotland, Northern Ireland, France, the Middle East and India. ADS comprises over 900 member companies within the industries it represents, of which over 850 are small and medium enterprises (SMEs). Together with its regional partners, ADS represents over 2,600 companies across the UK supply chain.

ADS also supports SC21, Sustainable Aviation, Defence Industries Council, RISC, Defence Matters and hosts the Aerospace & Defence Knowledge Transfer Network.

BACKGROUND

Investment in Science and Research today will ensure that the UK maintains its cutting edge capabilities in the Aerospace, Defence, Security and Space industries in the decades beyond.

— Investment in Science and Research has made the UK the largest Aerospace sector in Europe and the second largest in the world after the USA. (17% market share), and worth over £23 billion. to the UK, of which £16 billion. (70%) is exported world-wide. The sector directly employs nearly 100,000 people in the UK, and supports a workforce of around 360,000. Total R&D in 2010 amounted to £1.7 billion, more than 7% of annual turnover.

— The Defence Industry employs 314,000 people in the UK—directly and through the supply chain. The industry is highly skilled, with 59 percent of workers holding a university degree or equivalent. The industry invests 8% of annual sales revenue in research and development—amongst the highest in industrial sectors.

— Around 450 companies within the membership of ADS are engaged in growing Security, resilience and policing markets, at home and overseas, for which there are many interfaces with UK Government, the police service, the other emergency services and operators of the Critical National Infrastructure (CNI). Security-related SMEs maintain a heavy focus on upper tier technologies and comprise 93% of the ADS membership. A recent survey completed by ADS found that its members generated around £2 billion worth of business in the UK security market during 2010.

— The UK Space industry recorded a total turnover of over £7.5 billion. in 2008–09. This represented a real growth of 8% since 2007–08—the UK sector expects to grow 10% each year. The sector is strong in areas such as satellite communications and satellite navigation, and well placed to capitalise on new emerging services derived from Earth Observation, Cyber Security, Cubesats, and Broadband Services. The global market is anticipated to continue to grow at a robust rate of 5% on average in the next decade.

1. *What are the difficulties of funding the commercialisation of research, and how can they be overcome?*

1.1 The long technology development cycle within the four industries ADS represents means they have a necessity for a balanced portfolio of Research and Development (R&D) at all times. The development of technologies is iterative and achieved by evolution rather than a series of separate discoveries, so research continuity and funding stability are essential.

1.2 Research in defence is falling. The UK Government spend on Research and Development is less than half the level it was fifteen years ago. This, coupled with a loss in funding from agencies, like RDAs has created a sense of uncertainty within industry and does not incentivise the private sector to continue its own investments. Industry welcomes the Government's decision to halt this decline and sustain investment in Science and Technology at a minimum of 1.2% of the defence budget, announced in the "National Security through Technology" White Paper. The Government must now work to reverse this trend to prevent our position in the export markets weakening.

1.3 ADS members are already successfully engaging with some excellent Technology and Innovation Centres, recently launched as Catapult Centres. The concern here is that while future new centres are considered, high-performing existing ones need to be supported. A comprehensive mapping of what the UK has already is necessary and ADS does not believe this has been done.

1.3.1 Industry welcomes the Catapult Centres and ADS believes that industry involvement with them from an early stage, is essential. From inception, Catapults must work with large businesses (who often have the best understanding of market demand) to pull through the best research to meet their needs.

1.3.2 Over 850 of ADS's members are SMEs, some of which are highly innovative, and funding for the commercialisation of their research is vital. A barrier that often disincentivises industrial participation, disproportionately affecting smaller companies is the overly bureaucratic processes, particularly in applying for funding. Catapults should play both a direct and indirect role in supporting the UK in assessing European R&D support.

1.4 The Centre for Defence Enterprise (CDE) has proved effective at bringing in new ideas and providing them with seed corn funding, but there is little evidence so far of exploitation into products. Efforts should be made to achieve downstream exploitation by bringing in companies that may provide exploitation funding at an early stage in the process.

1.4.1 Award of CDE funds to an SME should include a commitment to pitch the idea to Primes and CDE should be measured on its ability to stimulate ideas which then become attractive to industry to fund.

1.4.2 Trade bodies could be encouraged to work with CDE on engaging with companies in receipt of CDE support to see whether they can help companies develop beyond the seedcorn phase and attract development funding. ADS has discussed the idea in principle with banks of bringing

together with industry expertise to help provide potential lenders with better assessment of the risks and thereby facilitate exploitation; ADS would welcome further discussion on this aspect.

2. *Are there specific science and engineering sectors where it is particularly difficult to commercialise research? Are there common difficulties and common solutions across sectors?*

2.1 In the export-led Defence sector, Government has to decide whether the UK is simply going to buy from the global market or whether it can and should stimulate an industrial base to generate the required technological capabilities. The Catapult programme should ensure that key strategic capabilities remain indigenous in the UK and the MOD now needs to clearly define its priorities so that necessary future R&D can be understood. Only this will give Industry the confidence to invest. Joint planning for the technology development between Government and Industry is the best way forward to ensure investment is complementary and not duplicative and delivers the confidence needed to both sides. ADS looks forward to the publication of the MOD's 10 year equipment plan later this year.

2.2 In the Aerospace sector, the long term returns from R&D make it an unattractive capital market investment and so Government intervention is key. The failure of the capital market is exacerbated by international market skewing, where other nations including France, Germany and the USA, are specifically backing their Aerospace Industries with R&D support. Such nations have recognised the growing market and the long term economic benefits of a strong national Aerospace Industry. Future market predictions estimate a £352 billion return between now and 2029 for the UK if it maintains its 17% global aerospace market share.

2.3 Some of the most successful advanced manufacturing technology programmes that have delivered innovation and growth through the supply chain have been regionally supported. With the demise of the RDAs and no assurance that funding for their innovation activities is to be retained, there is risk that these value-add innovative projects will evaporate. ADS has led a federation of Regional Trade Alliances to deliver a range of technology development and exploitation projects at the regional and local supply chain level, through a programme vying for Regional Growth Fund support. The ENTASC will be a nationally supported, regionally delivered programme, which will embed a variety of high value and advance engineering technological capabilities into SMEs, enabling them to achieve growth in sectors such as aerospace, defence, automotive and energy.

3. *What if any, examples are there of UK-based research having to be transferred outside the UK for commercialisation? Why did this occur?*

3.1 There has been an erosion of the Aerodynamics research capability in the UK. Unlike in France and Germany, whose Aerospace research centres conduct industry-relevant research to the benefit of industry but at little or no cost to those companies, the UK is reliant on Universities and Research and Technology Organisations (RTOs), working separately with no overall coordination. These Centres influence EU research priorities within the Framework Programme (FP7) and draw down funding once it becomes available—all to the benefit of their national Aerospace industries. The French and German aforementioned centres have therefore been able to build their respective countries' Aerodynamics capability, making them much more attractive to global business. There is a genuine risk that future wing design and therefore manufacture, will move to these nations for future generation aircraft.

3.2 ADS is working through the Aerospace Growth Partnership (AGP) process to define an Aerodynamics centre for the UK. Having a stronger European voice will enable the UK to act as a beacon for large scale European Technology Demonstrators as well as European Research Infrastructure and enable UK industry to capitalise on the globalised market as is already happening in France and Germany.

4. *What evidence is there that Government and Technology Strategy Board initiatives to date have improved the commercialisation of research?*

4.1. ADS is concerned that the Technology Strategy Board model is becoming increasingly unfit for the Industries we represent, in particular Aerospace. ADS welcomes the Government's recognition of the need to develop the entire Innovation Ecosystem; however this may be undermined by discrepancies in funding levels. Whereas Research Councils receive £3.5 billion per year, the TSB only receives £500 million: £300 million in direct funding and £200 million funding for Catapults. The value placed on knowledge creation therefore is greatly welcomed however this should not be to the detriment of knowledge exploitation, a critical part of the process that the TSB should provide.

4.2. Technology Demonstrators are an effective route to maturing and exploiting R&D, enabling the thousands of discrete parts of the supply to come together in order to integrate and demonstrate these technologies at the systems level. They allow a fair and transparent partnership with mutual benefits for all concerned; SMEs develop their technologies quicker, gain exposure through showcasing their capabilities and assimilate invaluable knowledge of the sector; systems integrators are able to integrate those into products that meet market demand; and critical mass is formed through a truly multidisciplinary approach.

4.2.1 ADS therefore welcomes the £25m investment in Technology Demonstrators announced in the Government's Autumn Statement 2011 however looks to the Government for future clarification on which Industries will be set to gain from this investment.

5. *What impact will the Government's innovation, research and growth strategies have on bridging the valley of death?*

5.1 ADS welcomes Govt commitment to ring fence Science investment but is concerned about the impact on our industries of what constitutes a 5–6% cut in real terms over the CSR period. This is in stark contrast to the US where the Administration is seeking an annual budget for the National Science Foundation in 2012 that is 13% higher in cash terms that the 2010 figure. This is compared to the UK science budget which will be 6.7% lower in cash terms in 2012–13 compared with 2010–11

5.1.1 Science investment needs to be supported as part of the wider innovation climate, whereby base research can be efficiently brought to exploitation. This is best done by aligning research with national strategies such as NATS (National Aerospace Technology Strategy), which has been a successful partnership between Government, Industry and Academia, transitioning research into technology demonstrators and through to products that bring economic growth, exports and sustains jobs in the UK.

5.2 Similarly, ADS welcomes the Catapults launched to date and looks forward to engaging with further centres as they emerge.

5.2.1 Some very hard decisions will need to be taken to ensure that Catapults are supported at a critical mass, so that they are effective. Spreading investment too thinly is not going to create any critical mass of activity, and the activity will fail.

5.2.2 Strong coordination will be needed to ensure that Catapults not only avoid duplicating work that is going on elsewhere, but also influence those research and innovations streams to ensure maximum pull through and therefore business and economic impact. A governance structure which allows this nature of interaction needs to be established. Catapults cannot become independent commercial operations and must link in with other parts of the innovation system.

5.2.3 ADS strongly endorses that the Centres need to evolve to financially sustainable business models. However, the TSB should recognise that some Government money will always be necessary to make Catapults successful. Attempts to make them financially sustainable within too short a time window will encourage them to focus on the types of activities that are going to generate short term income, rather than on delivering long term targets.

5.2.4 Catapults need to operate flexibly and innovatively so that SMEs can engage at any point in the process. Large companies will sign up from the inception of a 10 year programme, SMEs will not. This flexibility of approach will enable supply chain companies in particular to diversify into multiple sectors; the main effect of spill-over is at the lower end of the supply chain, where technology advances and process improvements filter down and are available for use in the range of sectors beyond those in which they were developed.

5.3 The Government has recognised the need to develop the Innovation Ecosystem as a whole rather than a set of separate interventions and, in the Aviation sector, Industry is working with the Government through the Aerospace Growth Partnership to identify not just the sector's technology and innovation needs but broader requirements too.

6. *Should the UK seek to encourage more private equity investment (including venture capital and angel investment) into science and engineering sectors and if so, how can this be achieved?*

6.1 ADS believes that at a time of financial constraint, it is all the more important for investment in research to be focussed on the right areas and effectively pulled through. One of the features of the advanced engineering sectors ADS represents is the very strong interaction between public and private investment. Industrial R&D is made possible and multiplied by public funding research and innovation. Cuts in public funding for research gives the private-sector less confidence also to invest which will ultimately hurt UK economic growth, exports and jobs.

6.2 Catapults will play an important role in fostering international technology partnerships and will be increasingly prevalent in paving the way for exports. In order to attract additional funding and de-risk some of the investments that others make, the Centres need central core funding from Government and have long-term financial stability.

6.3 ADS would suggest that Government consult with the private equity sector to gain a deeper understanding of the incentives that would encourage investment in the science and engineering sector, however at the outset, it is likely that tax breaks for such investments and reduced capital gains tax on returns should be considered as a first step.

6.4 Critically, the Government must work to help businesses, particularly SMEs access European R&D funding. The new Horizon 2020 programme addresses many bureaucracy and relevance issues but businesses have become increasingly disenfranchised throughout FP7 and previous Frameworks until now. Government has a role to play in reversing this trend and providing the necessary support for businesses to exploit European funding as it becomes available.

7. *What other types of investment or support should the Government develop?*

7.1 The sectors that ADS represents are primarily affected by the changes in the Engineering and Physical Sciences Research Council (EPSRC) budget. To ensure the future success of its sectors, ADS believes that spending on Science and Research has to increase in the long-term. Despite financial pressures, the long-term nature of research necessitates a growth plan that spans multiple parliaments. The current freeze is in effect a real-term cut at a time when Science spending plans of similarly developed countries are rising.

7.2 ADS is also concerned that with the existing degree of uncertainty and real-term cuts, it will be difficult to attract students to Science, Technology, Engineering and Mathematics (STEM) subjects. This could play out as a vicious circle which erodes the science base—making the UK a much less attractive place to invest for global businesses.

7.3 ADS recommends that Government consider funding for long-term, large collaborative Centres. This would be an efficient way of using resources. A good example is the Advanced Simulation Research Centre (ASRC) in the South West that brings together industry and academia around strategically important, exploitation driven, multidisciplinary research, that benefits multiple sectors eg rail, marine, aerospace, wind energy in the case of ASRC.

7.4 Through a range of regional and national programmes and investments, such as the Autonomous Systems Technology Related Airborne Evaluation & Assessment (ASTRAEA) in the aerospace sector and Systems Engineering for Autonomous Systems Defence Technology Centre (SEAS DTC) in the defence environment, the UK has a global lead in terms of technical capability in developing and deploying autonomous systems. Pockets and clusters of excellence exist, comprising the knowledge and skills to both develop and exploit these technologies. A business-focussed Catapult in this area will enable a coordinated approach to investment in innovation. Moreover, an Unmanned Air Systems (UAS) Catapult will ensure that promising research is transitioned through the "valley of death" to realise its wealth-creating potential.

February 2012

Written evidence submitted by the Russell Group

SUMMARY

— The Russell Group is pleased to contribute evidence to the S&T Committee's inquiry. Russell Group universities are partners of choice for thousands of leading businesses in the UK and internationally. The UK's world-leading institutions play a crucial role in stimulating economic growth, by engaging closely with business, enhancing skills and competitiveness, and generating major new products and world-beating spin-out companies.

— There are significant problems in the UK's funding pipeline to take a research idea through to a final product or service, including problems in accessing "proof of concept" funds and sufficient venture capital (particularly compared to the US). It remains a significant challenge in the UK to secure investment in new technologies.

— Government initiatives should aim to address the issues in the funding pipeline, in order to increase the commercialisation of research. However, funds should not be diverted from basic research—this would be counter-productive. Additional tax incentives, building on the past strengths of the University Challenge fund, and strengthened support for the role of incubators would all be very beneficial to take research from conception to commercialisation.

— To address the UK's needs for accelerating technology and innovation, there is real value in building on the strengths, competitive advantage and capacity of the UK's existing research base. In straitened times, it is important that Government funding continues to support research-intensive universities in their innovation and knowledge transfer/exchange activities.

1. *What are the difficulties of funding the commercialisation of research, and how can they be overcome?*

1.1 Russell Group universities are partners of choice for thousands of leading businesses in the UK and internationally. According to a recent survey by the UK Innovation Research Centre, academics at Russell Group institutions are particularly likely to have taken out a patent, licensed their research to a company or formed a spin-out than academics at other UK institutions. Data from HEFCE's Higher Education Business and Community Interaction survey showed that in 2009–10:

(a) Representing just 12% of institutions included in Russell Group universities between them received 68% of all university contract research income from commercial businesses and charities.

(b) 81% of universities with contract research with commercial businesses worth over £5 million were Russell Group universities.

(c) Russell Group universities accounted for 61% of all intellectual property income generated by UK universities and for over half of all spin out company turnover.

1.2 The Russell Group has recently established a new initiative to drive forward collaboration with companies and enhance innovation. A new high-level working group on innovation will engage with leading industrialists and business leaders to realise maximum benefit for the UK economy from the world-leading research activities of Russell Group universities.

1.3 Collaboration and exchanging knowledge and skills with business is a core part of the missions of Russell Group universities. Russell Group universities are supporting businesses in developing and commercialising new technologies in a variety of ways, including:

(a) Technology exploitation via technology transfer offices, or often via dedicated technology transfer companies. For example, Imperial Innovations invested over £14 million in 20 companies in 2008–09, and external investment in its portfolio of companies was £41 million in 2008–09, rising to £75 million in 2009–10.

(b) Provision of various kinds of incubation facilities for new companies, along with investment and knowledge transfer/exchange support. An example is the University of Warwick, which has a "virtual tenancies" programme that allows emerging companies to access the support and facilities at Warwick's science park without having to physically relocate.

(c) Incentives to access research expertise. Most Russell Group universities have knowledge transfer/exchange secondment programmes in place. In addition, the Universities of Liverpool, Warwick, Birmingham, Nottingham, Glasgow and Newcastle have awarded local businesses thousands of pounds worth of "innovation vouchers", enabling small companies to access research expertise through consultancy or collaborative projects.

(d) In collaboration with industry and the Technology Strategy Board (TSB) Russell Group universities have sponsored the two main advanced manufacturing research facilities in the UK (the University of Sheffield at the Advanced Manufacturing Park and the Universities of Birmingham and Nottingham at the Manufacturing Technology Centre).

1.4 The Higher Education Innovation Fund (HEIF) in England and Northern Ireland, and the Knowledge Transfer Grant and Horizon Fund in Scotland, are major public funding sources underpinning the highly successful knowledge transfer/exchange activities undertaken by Russell Group universities. These funds are an essential component of the UK's innovation system, enabling institutions to share high quality innovation with businesses, diffusing knowledge into the economy and creating economic benefit for the nation. Many universities in England use HEIF funding to support Proof of Concept funding, and such small scale funding is critical, before seed and further capital becomes available.

1.5 The Government's recent changes to the allocation of HEIF will help to ensure Russell Group universities in England build on successful existing initiatives, and fulfil their potential in knowledge transfer/exchange activities. Although a cap remains on the amount of HEIF funding available to any single institution—restricting the ability of research-intensive universities to receive funding in proportion to the full scale or excellence of their knowledge base—the Government's changes to the allocation of HEIF are positive moves in the right direction. At a time of constrained resource, it is essential to target the investment through HEIF on those universities best able to translate world-class research and knowledge into economic benefit to the UK.

1.6 Universities still face considerable barriers in transforming ideas into social and economic impact due to the risks perceived by the private sector regarding investing in new developments. A report by the Russell Group shows that groundbreaking research conducted in Russell Group universities has resulted in far-reaching impacts, but successful commercialisation requires sustained long-term investment, often over many years or even decades.[80] There are significant problems in the UK's funding pipeline to take a research idea through to a final product or service, including problems in accessing "proof of concept" funds and sufficient venture capital (particularly compared to the US). It remains a significant challenge in the UK to secure investment in new technologies.

1.7 Government initiatives should aim to address the issues in the funding pipeline, in order to increase the commercialisation of research. However, funds should not be diverted from basic research—this would be counter-productive. Instead, key areas the Government should consider include:

(a) Resources should be focused where there is most competitive advantage to be gained from integrating research, teaching and translation. To address the UK's needs for accelerating technology and innovation, there is real value in building on the strengths, competitive advantage and capacity of the UK's existing research base. In straitened times, it is important that Government funding continues to support research-intensive universities in their innovation and knowledge transfer/exchange activities. Investments should complement rather than compete with the current capabilities of the UK's research base, and be considered on a national (rather than regional) scale.

(b) The Government should consider further reforms to the tax regime which would particularly encourage more investment in early stage high-tech companies. Changes in tax should make a clear distinction between technology-based businesses, distinct from other small or early stage ventures.

[80] Russell Group *The economic impact of research conducted in Russell Group universities* (2010) www.russellgroup.ac.uk/russell-group-latest-news/121–2010/4134-economic-impact-of-research-at-russell-group-universities/

(c) The Government should build on the past strengths and lessons learned of the University Challenge Fund. This scheme was instrumental in promoting collaboration across institutions, attracting private sector investment in university companies, and developing seed funds in universities. For example, the scheme assisted the development of Imperial Innovations.

(d) Early stage ventures could be supported further, for example through rebates in corporation tax, allowing them to roll-over losses from one year to the next.

2. *Are there specific science and engineering sectors where it is particularly difficult to commercialise research? Are there common difficulties and common solutions across sectors?*

2.1 The biosciences sector and large-scale advanced engineering in the UK benefit from major corporate R& D activities. However, even within these sectors, business models are rapidly changing with companies such as Pfizer closing sites in the UK. It is difficult to generalise across sectors, and the UK must not only sustain sectors which are currently strong, but also foster sectors where the UK shows promise. The £180 million "Catalyst" fund, targeted at the biomedical sector, is a welcome boost to our universities' efforts to attract outside investment. However, it is important that the UK's cutting-edge research is supported from conceptualisation to commercialisation in a range of other fields of research, with direct potential and opportunity for competitive global businesses.

3. *What, if any, examples are there of UK-based research having to be transferred outside the UK for commercialisation? Why did this occur?*

3.1 The knowledge exchange activity at the UK's leading institutions is often compared to the US's top institutions, such as Stanford and MIT. While some have criticised the under-performance of UK universities on licensing income with respect to the US, research shows that this could be attributed to the time lags in achieving significant financial return from licensing, and the fact that US technology transfer operations have been established for much longer, and have had more time to build a licensing portfolio. In addition, when individual institutions are compared between the UK and US, on their ratio of income generated from intellectual property to research expenditure, the analysis shows that the top UK universities operate on similar levels to US universities such as Stanford, MIT, Harvard, Cornell and the University of Pennsylvania.

3.2 It should also be noted that some Russell Group universities release some of their IP to companies for free to maximise the impact of research. The University of Glasgow, King's College London and the University of Bristol are leading the Easy Access Innovation Partnership, a collaborative project to promote new ways of sharing intellectual property with industry through increasing engagement between universities and industry. The University of Edinburgh has developed a licensing system to allow industry easy access to two packages of university IP. This system complements the ut.com website that allows industry access to all technologies available from Scotland's key research universities.

3.3 Spinout companies in the UK tend to be acquired by companies outside the UK at a relatively early stage. For example, a company originating from technology developed at Cardiff University moved to the US early on in its development, due to lack of funding in the UK. Similarly, a company spun out of the University of Bristol was acquired by a Belgian company due to lack of sources of capital in the UK. In addition, there are examples at the University of Birmingham where commercialisation needed to take place overseas, as UK businesses were not sufficiently interested in the technology.

3.4 The fundamental weakness contributing to the movement of commercialisation of research to outside the UK is the lack of willingness of UK businesses to invest in early stage innovations (absorptive capacity). Overall business investment in R&D in the UK (1.15% of GDP in 2008) is very low by comparison to the rest of OECD countries. The best route across the Valley of Death is for UK businesses to be willing customers of innovation, taking on risks with the potential for significant downstream benefits. However, the change needed can only be achieved through the Government creating an improved environment for innovation by strengthening tax and other incentives for companies investing in innovation, and by becoming an innovation-focussed customer in its own right. Without action, the UK's top researchers will continue to turn to commercial partners overseas, leading to a loss of financial benefits to the UK economy.

4. *What evidence is there that Government and Technology Strategy Board initiatives to date have improved the commercialisation of research?*

4.1 As noted in question one, HEIF and University Challenge Funds have made a real and positive difference to commercialisation, knowledge transfer activities and seed funding within universities. Schemes such as the Technology Strategy Board's Knowledge Transfer Partnership (KTP) programme are also important in developing partnerships to transfer research outcomes into the market. Adopting a planned and systematic approach to communicating the benefits of KTPs to companies and academics is essential to increasing the number of KTPs. For example, the number of KTPs at Cardiff has increased from five to 26 over the past three years.

4.2 We welcome recent changes to TSB funding schemes which will develop closer working relationships with universities. Members of the Russell Group collaborate enthusiastically with the TSB because they recognise the TSB's strength in assisting to translate outstanding fundamental science into marketable products

and process improvements. There are examples where TSB funding has been essential in funding university spin out companies. We would emphasise that TSB funding should complement, rather than compete with, the current capabilities of the UK's research base, and be considered on a national (rather than regional) scale. Also, funding for the TSB and other initiatives to increase the commercialisation of research should not be diverted from basic research—this would be counter-productive.

4.3 The Government will need to consider and monitor how the new Catapult centres fit within the existing research environment. To achieve maximum impact the new centres should be closely linked to the world-class research base within the country's leading universities. Decisions for the location of these centres should be based on proven academic expertise and industrial capability. Existing successful centres are often closely associated with, or even embedded within, universities which have a critical mass of excellent research and teaching, and a proven track record of translation.

4.4 The High Value Manufacturing Catapult Centre (involving Bristol, Sheffield, Birmingham, Manchester, Nottingham, Warwick with Loughborough and Strathclyde) is acting to bring employees of established companies (potential customers), early stage companies and academics together in an environment where co-creation and co-location engenders the acceleration of technology adoption—this can be viewed as a an embodiment of open innovation. This is well exemplified in the National Composites Centre, hosted by the University of Bristol.

5. *What impact will the Government's innovation, research and growth strategies have on bridging the valley of death?*

5.1 We welcome the Government placing research and innovation at the heart of its growth strategy, and the recent innovation and research strategy. However, we consider it is very difficult to predict the outcome on bridging the valley of death. As outlined in questions one to three, we would urge the Government to go further in addressing the problems in the funding pipeline taking research from conception to commercialisation, and to introduce funds similar to the "Catalyst" fund for other sectors.

6. *Should the UK seek to encourage more private equity investment (including venture capital and angel investment) into science and engineering sectors and if so, how can this be achieved?*

6.1 Yes. Relationships between investors and universities are highly productive, resulting in much learning on both sides of different working cultures, and models such as Fusion IP, IP Group and Imperial Innovations have helped bridge the gap between City investors and universities. The role of informed angel investors, where expertise is perhaps more critical that investment capital, is well documented in the US and they are increasingly playing a more prominent role in the UK.

7. *What other types of investment or support should the Government develop?*

7.1 As outlined in question one, we would welcome the Government developing initiatives that address the entirety of the funding pipeline, from conception to commercialisation. Costs include IP protection, undertaking effective market research, and investment readiness. We would encourage the Government to develop initiatives that look at the funding pipeline as a whole, rather than developing initiatives that only address one part of the pipeline at a time without consideration to other parts. Regional Venture Capital funds and Enterprise Capital Funds have been very valuable, in many cases these are co-invest funds with Government funding or interest matched against private capital.

7.2 The role of Incubators as ideal places to support, nurture and accelerate the fragile early stage companies should be supported. This is exemplified by the family of SET squared Business Acceleration Centres (at Southampton, Bristol, Bath, Exeter and Surrey). This model offers a proven route that ensure ideas "fail fast" with a controlled closure, or are accelerated in a highly supportive yet totally commercial environment.

7.3 Government tax measures are valuable in supporting early stage companies across the Valley of Death. The Enterprise Investment Scheme is important, and its extension into SEIS is helpful, as are R&D tax credits, although take up at early stages can be low. The Government may wish to consider how R&D tax credits could be both better promoted and simplified.

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Written evidence submitted by Engineering the Future

This report has been developed in collaboration by the following institutions:

— The Royal Academy of Engineering.
— The Institution of Chemical Engineers.
— The Institution of Engineering and Technology.
— EngineeringUK.

Engineering the Future is a broad alliance of engineering institutions and bodies which represent the UK's 450,000 professional engineers.

We provide independent expert advice and promote understanding of the contribution that engineering makes to the economy, society and to the development and delivery of national policy.

Introduction

A growing recognition exists within government, industry and the media that the UK needs to "rebalance" its economy, moving the emphasis towards capturing value from wealth-creating products and services and away from "financial engineering". Recent government policies and announcements explicitly recognise the need for economic recovery based on high-value, high-technology manufacturing. Ensuring that the UK industrial system is able to capture value from products and services based on high-value and high-technology manufacturing requires constant innovation and commercialisation of new products, services and business processes to maintain a competitive advantage.

Innovation is not a simple linear process—it requires feedback from the market and timely investment at critical points of development. The "valley of death" is used to describe that period in the development of a product or service when a significant increase in investment is required, making the risk of failure much more likely to outweigh any potential future return. It can occur in a wholly commercial organisation as well as in the context of commercialising university research and new, nascent, technologies.

The "valley of death" is not necessarily an intrinsically bad thing. One of the things it does is act as a filter, taking out poorly conceived propositions. Any change in policy to support the commercialisation of products, services and processes must be wary of artificially prolonging the lifetime of those weaker ideas.

The problem with the strict economic approach to the investment process is that strategic priorities can be overlooked. Processes to overcome the "valley of death" must be employed where products and services are strategically fundamental to a business or provide sovereign capability to the UK. Without a long term approach to maintain capability via the implementation of innovation into product development can and has resulted in a leading position in a business sector being lost. The key is to identify those technologies where bridging the "valley of death" is essential and those where a "fast follower approach" is sufficient. The role of the TSB to provide a focus for long term capability investment is vital.

1. *What are the difficulties of funding the commercialisation of research, and how can they be overcome?*

1.1 New and established companies are still having difficulties in accessing working capital from banks on appropriate terms. Overly stringent restrictions have remained in place despite much political comment. Government should be using its position as the main shareholder in largely taxpayer-owned banks to enforce a change in behaviour and increase lending to companies. The Business Growth Fund (BGF) is a new venture where the government has formed a consortium of banks that are providing cash supported by government guarantees. The target is to support rapid growth of selected SMEs in the annual revenue range £10 million to £100 million. However, this is a new scheme and we await take-up and outcomes. The BGF consortium model could possibly be extended to earlier innovation phases and including venture capital and private equity houses alongside banks. The government has put into place measures such as the Enterprise Investment Schemes (EIS) to support the commercialisation of research. EIS helps smaller high-risk companies and established SMEs find funding by stimulating investment via tax-incentives. It is important for government to continue to proactively publicise the scheme to ensure that the SME community is aware of it. Government should also ensure that, in line with its approach to reducing bureaucracy, that schemes for SMEs are not overly bureaucratic or burdensome which could then create a disincentive to engagement.

1.2 Capital is available from UK venture capital funds and private equity, but is usually short-term in nature. Short-term thinking also means investors start looking for the exit route from a spin-out company at the time of creation, and do not think about growing it into a large organisation. This has dissuaded investors from supporting innovative research, which often takes much longer to return a profit. Another reason for this attitude among investors is a lack of understanding of engineering propositions, and the timeframes needed to develop and establish these types of businesses.

1.3 A closer relationship between universities and business should be developed to increase the amount of successfully commercialised research. Open innovation, "combining internal and external ideas as well as internal and external paths to market to advance the development of new technologies",[81] is encouraging

[81] www.openinnovation.eu/open-innovation/

collaboration between universities and industry. Catapult Centres and Local Enterprise Partnerships will play an important role here. They can effectively reduce investment capital requirements for companies entering certain markets by offering open access prototyping, scale-up and demonstration facilities. Catapults will also form a hub for useful multi-company and university consortium activity. Government should continue to show support for carefully chosen growth sectors where a comparative international advantage exists. This has been done in the recently published Strategy for UK Life Sciences. These interventions show long term support for these areas from government and give confidence to investors. Professional engineering organisations will also continue to act as a conduit between business and academia, bringing parties together through events, projects, awards and funding.

1.4 The management of companies spun out from universities is also a challenge when commercialising research. Different universities operate different technology transfer models. Universities new to commercialising research can tend to believe that ownership of the IP is vital. They encourage academics to form as many companies as they can, in which the university holds equity and owns IP. Companies set up in this environment can sometimes be ill-conceived and poorly managed. Universities with more experience may come to recognise that ownership of IP is not as important as value gained through exploitation. Where a company owns the initial IP, and the university is one of the shareholders, the company is free to act as it wishes guided by commercial principle. Allowing organisations independent of universities to bid to run spin-out companies could also reduce the fail-rate.

1.5 Both in the UK and in Europe, there is a political perception that innovation and rebalancing of the economy will be driven by the private sector with a significant contribution from SMEs, which may be somewhat optimistic. Larger established companies are the traction engine that pulls through smaller companies in their supply network. They should be equally encouraged and supported to commercialise research, both in their own right and in concert with SMEs and their own supply network companies.

2. *Are there specific science and engineering sectors where it is particularly difficult to commercialise research? Are there common difficulties and common solutions across sectors?*

2.1 The globalised nature of business now means that the choice of where to develop and manufacture products is strategically and commercially very important. For example, in the past, the UK had a strong electronics manufacturing base, but this has now largely shifted to the Far East, where the costs, skills and fiscal regimes are more attractive. The tax havens and investment grants offered by countries such as Singapore have also exerted a powerful pull on the pharmaceutical industry. In this context, UK companies need to be strategic in their decisions and ensure they remain in control of value of production, even if the products are manufactured elsewhere.

2.2 The quality of the supply network in the UK can hinder the commercialisation of research in some sectors. For example, the chemical process industry and chemical engineering have a highly fragmented supply network, in many cases international in nature, and with a multitude of products, processes, roadmaps and innovation processes. These characteristics make it very difficult to implement innovative supply networks. Another example is batteries, fuel cells and hydrogen storage products, which cannot be manufactured in the UK as there are few, if any companies able to operate to scale up production of materials. Inevitably the exploitation at scale must be done elsewhere.

2.3 In sharp contrast to this are the automotive and aerospace industries where dominant OEMs actively encourage innovative supply networks to form, because they know that a quality supply network is a comparative advantage for the business. The innovations in the automotive industry are offering something of a renaissance opportunity for the UK where the legacy in automotive and involvement in motorsport has established a skills base.

2.4 A lack of understanding by investors of the technologies and regulatory environment can also be a hindrance to the commercialisation of research in some sectors. Large scale process applications tend to need plenty of capital investment and often require stringent regulatory constraints and approvals to be satisfied. In this environment, it is hard to envisage a succession of small start-ups. Rather than trying to secure start-up funding, smaller companies in sectors like this could approach larger companies and offer to licence their IP to them.

3. *What, if any, examples are there of UK-based research having to be transferred outside the UK for commercialisation? Why did this occur?*

3.1 Many instances exist of UK-based research having been transferred outside the UK for commercialisation. Factors may include: favourable tax regimes, better funding opportunities, less government bureaucracy or availability of a skilled workforce. However, a critical issue is where the value of production is captured, which may not devolve to the country or region where products are made. For example, ARM designs and licenses out intellectual property (IP) rather than manufacturing and selling chips. It is an extremely profitable and rapidly growing business with profit before tax for 2011 up 37% on the profit forecast to £230 million.

3.2 An example of a company choosing to manufacture abroad that will be well known to the committee is Plastic Logic.[82] When considering manufacturing bases, three sites were shortlisted, Dresden, Singapore and New York State, and judged on:

— access to local grant support and prospects for low operating costs;

— speed of the process from outline agreement to site hand-over; AND

— access to a skilled workforce.

3.3 Dresden was the winner, because it had an excellent skills base and there was clear support for manufacturing through the German network of Fraunhofer Institutes. Although there is access to both these advantages in the UK, planning and construction timescales in the UK are not competitive, particularly in the more economically successful parts of the country.

3.4 Other companies that have previously tried to base manufacturing in the UK have moved manufacture abroad. Cambridge-based charity Raspberry Pi had to revise their plans to manufacture their low-cost computers in the UK mainly due to prohibitive taxation.[83] The organisation blamed a lack of UK competitiveness as well as HM Revenue and Customs for their decision to manufacture in Taiwan and China.

3.5 Further anecdotal examples of companies commercialising abroad exist. Ilika is a materials discovery business using technology developed at the University of Southampton from EPSRC funding. No adequate UK suppliers could be found to scale up the novel hydrogen storage materials and so it is being done in the US. Another reason for commercialising abroad was that no UK end user for the material existed.

3.6 To ensure the value of production stays within the UK, the government should develop an integrated strategy which differentiates it from other economic centres. A joined up approach includes the following elements: a strong research base, a skilled and flexible workforce, an effectively integrated supply network culture, supportive and stable government policy, a tax regime proven to encourage innovation and its commercialisation and a supported R&D infrastructure from the new Catapult network, other TSB initiatives and greater collaboration between universities and business.

4. *What evidence is there that Government and Technology Strategy Board initiatives to date have improved the commercialisation of research?*

4.1 This is a question that the committee should pursue in more depth with the Secretary of State and the TSB itself.

4.2 The *Engineering the Future* partners are supportive of the TSB. Commercialisation of products and services is a long-term endeavour. As an organisation, TSB has been in existence for four years, the Small Business Research Initiative (SBRI) started in 2001 and the first Catapult centres have only just been created. In relation to schemes such as SBRI, there have been examples in other countries notably the Small Business Innovation Research (SBIR) scheme in the US, where there has been considerable success in supporting SME growth through public procurement.[84] The TSB, SBRI and Catapult centres should be given more time and resource to embed themselves properly into the specific technology areas they have decided to support and develop their delivery practices before a full evaluation of their impact can take place.

5. *What impact will the Government's innovation, research and growth strategies have on bridging the valley of death?*

5.1 Among the developed European nations, the UK is unusual in that it has not historically supported "intermediate institutes" of any significance and certainly not on the scale of the Fraunhofer Institutes (Germany), TNO (Netherlands) or VTT (Finland). Instead, the UK placed greater emphasis on university research with mixed results for the nation's innovation performance. The creation of the TSB Catapult centres, following the announcement of a £200 million innovation programme in 2010, was a welcome development. The TSB could also coordinate a strategic programme to support and strengthen the supply networks.

5.2 At the SME end of the scale, innovation vouchers aim to encourage small firms to experience a low cost, low risk taster of working with a university or an R&D organisation. The scheme now operates nationally and a further tranche is expected in 2012. This scheme should be carefully monitored and, if successful, maintained and expanded.

5.3 Annual reporting of R&D expenditure should be encouraged. It is regrettable that BIS chose to withdraw funding from the well respected and widely used R&D Scoreboard in 2010. As a measurement of innovation, knowing the amounts of funding is of limited use, but without the Scoreboard there is no way of comparing R&D spend across the full range of industry sectors.

[82] www.publications.parliament.uk/pa/cm200809/cmselect/cmdius/50/50i.pdf
[83] www.zdnet.co.uk/news/emerging-tech/2012/01/11/raspberry-pi-enters-production-but-not-in-uk-40094792/
[84] www.nesta.org.uk/publications/reports/assets/features/buying_power

6. *Should the UK seek to encourage more private equity investment (including venture capital and angel investment) into science and engineering sectors and if so, how can this be achieved?*

6.1 The UK should be encouraging more private equity investment. The key to achieving this is to make the UK an attractive area to invest in. Countries such as the USA, Germany, Switzerland, France, Singapore and China have a much clearer and better defined landscape that is understood by business. The UK is not clear on what the strategy is to support the rebalanced economy. A much sharper, distinctive and consistent narrative needs to be developed to highlight our innovative, entrepreneurial and commercial spirit grounded on excellent science and engineering.

6.2 Existing government strategies (such as the new BIS Innovation and Research Strategy) point broadly in the right direction, but often lack sufficient resources behind them to make a real impact. Government can improve this by continuing to support and increasing the funding behind the work of the TSB and the work they do. Schemes such as the Enterprise Investment Scheme should be more widely advertised in order to further stimulate "Active Angels". The government could also consider launching an Innovation fund, as described in our answer to question 1.

6.3 A high level of technology ignorance exists within some sectors of the funding market. The engineering profession has been working to bridge this gap and should be supported in continuing to do this. For example, The Royal Academy of Engineering provides:

- Engineering Enterprise fellowships, enabling researchers to spend 12 months commercialising their research with the help of business mentors and access to business angels.
- ERA Foundation Entrepreneurs' Award, established to identify entrepreneurial researchers, working in UK universities, in the field of electro-technology, who are at an early stage in their career.

6.4 Regulators also have a role to play in some sectors. They should examine the need for capability development and retention beyond the requirements of their license and authorisation conditions. This would encourage further investment from outside sources.

7. *What other types of investment or support should the Government develop?*

7.1 There can be no innovation and growth without the skills base to drive it. With this in mind the government should:

- maintain investment in engineering undergraduate education;
- take steps to encourage companies to invest in training (such as tax breaks on training costs);
- facilitate easier take up of visa rules for STEM academia and those who bring both learning and experience (such as chartered professionals including chartered engineers);
- continue to reduce bureaucracy around apprenticeships; and
- provide loans for postgraduate study.

7.2 Universities and industry should be encouraged to cooperate. Incentives to encourage individual academics and universities to undertake high quality industry outreach, both on a national and international level, as well as academic research could be created through the REF scheme. The Wilson Review of university-business collaboration may provide further guidance on this. Universities should also be encouraged to cooperate rather than compete with each other, both within the UK and internationally. The recent announcement to exempt universities from VAT on shared services is a strong signal of support from government in this area.

7.3 Government can also encourage innovation further in the UK by:

- acting as a smart customer, driving innovation through procurement;
- strengthening UKTI's capability in engineering and science;
- negotiating trade agreements that include collaboration and innovation; and
- creating a regulatory environment that can encourage innovation.

7.4 Companies should be encouraged to base their R&D activities within the UK. Putting into place tax and funding policies that have been successfully shown to support R&D activities within companies would encourage this. The NESTA supported study *Innovation: what works?* may provide some guidance in this area. Additional benefits to companies beyond R&D tax credits should also be examined where re-investment is towards UK infrastructure and academia. Bodies offering funding for R&D should have simple, transparent and fast response administrative processes for grant applications. Grant funding and tax relief facilities should also be continuously available, with no artificial deadlines for applications. Multinational companies headquartered in the UK should also be allowed to offer secure career paths to top talent from overseas.

7.5 Government should also continue to support the work of the engineering professional bodies to promote engineering within the UK. These bodies work to bring people from industry and academia together and also by recognising companies and individuals that have contributed to innovation in the UK by means of award schemes. They also provide funding for researchers keen to commercialise research. Initiatives which raise the

profile of engineering within the UK, such as the Queen Elizabeth Prize for Engineering, Tomorrow's Engineers, The Big Bang Fair and I'm an Engineer, get me out of here! should also continue to be supported.

February 2012

Written evidence from the Technology Strategy Board

Introduction

1. The Technology Strategy Board is a business-led organisation with a leadership role to stimulate technology development and innovation for the benefit of UK business in the areas which offer the greatest potential for boosting UK growth. The organisation operates across Government and advises on polices which relate to technology, innovation and knowledge transfer. The Technology Strategy Board is the UK innovation agency and acts as the prime channel through which the Government incentivises business-led technology innovation.

2. The Technology Strategy Board was established in July 2007 and has invested more than £1 billion to date, the majority of the funding being matched by business. It has directly supported around 4,000 companies and works with nearly every University in the UK as well as many further education organisations.

3. The route from idea to new product or service is neither straightforward nor always linear, requiring lots of different interactions. In our strategy for the period 2011–15, "Concept to Commercialisation",[85] we set out the role of the Technology Strategy Board in providing financial stimulus to support R&D and innovation as well as the importance of connecting the innovation landscape. This involves supporting interaction between the science base and business at earlier stages of research & development as well as between business and private sector investors at the later stages of commercialisation.

4. Our partnership with Research Councils UK (RCUK) enables the Research Councils to take advantage of the business-led expertise of the Technology Strategy Board in catalysing innovation in focussed priority areas; and enables the Technology Strategy Board to capitalise on the Research Councils' role in funding and influencing excellent research and knowledge transfer—so that both are more effective in strengthening the knowledge-based economy and attracting inward investment.

5. The commercialisation of research and the support of innovation across the economy are vital to deliver future products and services and to generate economic growth. The Technology Strategy Board welcomes the Committee's inquiry and we make the following points in response to the specific questions raised by the Committee.

Question 1—*What are the difficulties of funding the commercialisation of research, and how can they be overcome?*

6. Looking firstly at funding the commercialisation of research by public sector organisations, bodies such as the Technology Strategy Board operate against a set of rules which underpin the types of support which can be provided. This includes the need to demonstrate market failure and additionality and to operate within European State aid rules.

7. Market failure, as set out in the Treasury Green Book,[86] refers to "where the market has not and cannot of itself be expected to deliver an efficient outcome". We therefore need to ensure that the projects we are supporting address the additionality criteria and we are not supporting projects which the private sector should support. European State aid rules govern how far we can help a business take a product through to commercialisation. The rules generally allow the funding of R&D and innovation projects up to the development and demonstration of prototypes but not beyond, although there is greater flexibility for early stage SMEs.

8. Looking at the question from the perspective of a business, it is usually the case the closer the research gets towards commercialisation the higher the costs tend to be and accessing the necessary funding and skills becomes more of an issue. The development and demonstration phases tend to be the phases where there is the highest level of risk and also the highest cost.

9. The deployment of wave and tidal devices or the need to undertake clinical trials for the introduction of a new medical product are two examples where moving from research towards commercialisation is a huge step. The level of funding needed can be significant and even if the required performance can be achieved, doing so at the necessary price point can be a major hurdle. In some cases this can be made more difficult if regulatory or environmental compliance is lengthy and costly in the home market or overseas.

10. To overcome these issues, we are looking at ways of better joining up with other parts of the innovation system to help businesses move innovative projects closer to commercialisation more easily. This includes developing better connections with the private equity community who can fund projects through to

[85] www.innovateuk.org/_assets/0511/technology_strategy_board_concept_to_commercialisation.pdf
[86] www.hm-treasury.gov.uk/d/green_book_complete.pdf

commercialisation as well as working with experts in areas such as design, IP protection, legal and corporate finance advice, business coaching and mentoring providers, incubators and accelerators.

11. The European Commission is currently undertaking a consultation on the "Review of the EU state aid rules for research, development and innovation".[87] We will be providing input to that review looking at how the rules can be improved to enable us to provide better support to business, particularly towards commercialisation.

12. One of the key issues of bridging the gap between research and commercialisation is scaling up and demonstrating technology. One of the advantages delivered by our programmes, and where we have achieved some of our biggest successes to date, is the ability to demonstrate at scale. We have supported large scale demonstrators such as the Retrofit fit for the Future programme with 87 dwellings in the UK being used to assess the potential of new approaches to reducing the environmental impact of the current housing stock. The Low Carbon Vehicles Innovation Platform demonstration programme trailed 340 low carbon vehicles on the roads in the UK helping to test and validate the technology and to understand the user issues. The Innovation Platform is expected to continue for up to 10 years, and co-ordinates the UK's low carbon vehicle activity from initial strategic research through collaborative research and development, leading to the production of demonstration vehicles and the strengthening of supply chains. The long term nature of the programme, agreed with all stateholders, is important in developing the long term vision and for engaging with business who want a consistent approach.

13. We are also in the process of implementing the DALLAS programme which is currently being developed to test out assisted living technologies with approximately 50,000 users across the UK. Only by undertaking these trials, too expensive for any one company to do on its own, will business be able understand how technologies and systems work in practice which can then feed into their development pathways.

14. The Technology Strategy Board has an annual budget of approximately £330 million per annum to support R&D and innovation activities across the economy. With the three demonstrator programmes mentioned costing over £20m each there is a limit to how many we can run, which is why the Government in the Autumn statement provided an additional £25 million to deliver another demonstrator. There are opportunities to do more.

15. To further support the UK's capability to commercialise research, we are currently putting in place a network of Catapult centres. As well as the core support the centres provide, we expect them to have a much larger impact on the overall innovation system in the UK and a greater impact on supporting the commercialisation of research. The Technology Strategy Board, RCUK and the Funding Councils are developing a joint strategy to encourage collaboration between the research base and Catapults to maximise the benefit to the UK's innovation landscape.

Question 2—*Are there specific science and engineering sectors where it is particularly difficult to commercialise research? Are there common difficulties and common solutions across sectors?*

16. The Technology Strategy Board works across the economy and has a good view of the problems faced by different sectors. Examples include the high costs for the development, deployment, testing and validation in the energy sector such as for wave and tidal devices or the long timescales it often takes to move research to commercial product in the life sciences and healthcare sectors as well as regulatory environment in which companies must operate.

17. Distruptive technologies can be particularly difficult to commercialise and we have developed an Emerging Technologies and Industries strategy[88] exactly for this scenario. The strategy has four themes: invest in demonstrators, generate critical mass, create a nationally co-ordinated programme and nurture capability.

18. The difficulties however tend to relate less to specific areas of science and engineering and more to a set of generic issues. The journey of moving a concept through to commercialisation is often complex, requiring many different steps and interactions. There are a number of problems and challenges which we consider impede this journey, in particular:

- *Business investment is too low and too late*—The immaturity of technology leads to uncertainty about time to market, development costs and commercial viability. Small businesses in particular lack the capital to invest and are seen as higher risk investments by capital providers. Investment in new and emerging markets is delayed because total market size and rate of development is uncertain. Many businesses will wait until the market development is clearer and are likely to miss valuable opportunities.
- *Innovation disrupts value chains and business models*—New technologies, and technologies newly applied to existing markets, can disrupt existing relationships and value chains. Bringing new technologies to market requires discussions and relationship building with multiple players—public (standards, regulation) and private (suppliers, competition). This requires time, effort, knowledge of players in new technologies and the ability to bring parties together which is generally beyond the capabilities of individual businesses, particularly SMEs.

[87] http://ec.europa.eu/competition/consultations/2012_stateaid_rdi/

[88] www.innovateuk.org/_assets/pdf/corporate-publications/tsb_emergingtechnologiesstrategy.pdf

— *Longer term trends not visible to all players*—Longer term opportunities can emerge from emerging technologies, new uses of existing technologies, cross over applications from one sector to another, new challenges for society, or new government policies. These are not always visible to all players.

— *Innovation infrastructure complex and inefficient*—The public (and private) innovation system is complex, fragmented and often difficult to navigate. Information and knowledge does not flow optimally through the system.

— *Government does not make best use of its levers*—Government action in areas of procurement, regulation, standardisation and fiscal incentives shapes markets, but not always in a way that benefits UK business the most.

19. In supporting the commercialisation of research, there are some issues although not directly linked to the difficulties of funding, which do have an impact on the ability to commercialise the research. There are issues such as making the first connection and bringing business, particularly SMEs, together with academia. There are often differences between business and academia in the language used and also in expectations in terms of timescales and the value of intellectual property. These issues largely come down to a lack of understanding from both sides as to how each other operate.

20. It is important to help the business and academic communities forge closer and better relationships where the translation of research happens more naturally. The initial engagement can be achieved through tools such as innovation vouchers or support such as that provided by the Knowledge Transfer Networks where there is the capability to put a company in touch with the best academic to meet their needs, which might not necessarily be the closest. The relationship can then be taken forward through different routes such as collaborative R&D projects which provide a focus for the relationship. The Technology Strategy Board's connect platform also provides a novel way for business and universities to network, collaborate and share knowledge online.

21. The network of Catapult centres will add a new dimension to the support being provided, giving companies access to the equipment, facilities and expert knowledge in the centres which would otherwise be unaffordable or unattainable for small companies.

Question 3—*What, if any, examples are there of UK-based research having to be transferred outside the UK for commercialisation? Why did this occur?*

22. Academia and business operate on a global basis and value chains are increasingly global in nature and so it is likely the value from UK research will not all be generated in the UK. Universities are increasingly seeking private funding from overseas to support spin-outs and with large companies manufacturing in many locations, the commercilisation of research overseas may be the manifestation of a healthy global manufacturing presence. Other factors include the need to compenstate for only having a small domestic market by developing new products and services where they are most likely to be exploited and a difficult regulatory environment making it easier and more efficient to obtain approvals and access markets overseas.

23. There is evidence of early stage companies that have moved their focus to the US in order to access the necessary funding for comercialisation and scale-up, such as from the US venture capital sector and the US Government through the SBIR programme. For example, a UK academic spin-out became a US registered company so that it was able to access support through the SBIR programme in order to get the funding needed to move the business forward. A condition of SBIR is that the company must be registered and have a US base. Although that particular company has a growing footprint in the UK, such a move away from the UK could well lead to a greater shift to the US overtime.

24. It is necessary to accept that we are in a global market and so can expect some offshore ownership. The issue is how to get non-UK companies to spend and anchor their R&D money in the UK, including through centres of expertise such as the Catapults and by creating a favourable investment environment.

Question 4—*What evidence is there that Government and Technology Strategy Board initiatives to date have improved the commercialisation of research?*

25. There are a number of studies conducted over the last 3 years showing the impact of the initiatives supported by the Technology Strategy Board, in particular Collaborative R&D,[89] Knowledge Transfer Networks,[90] Knowledge Transfer Partnerships [91]and an early assessment of SBRI.[92] The economic evidence of impact of our programmes shows in the region of a 10 to 1 return on investment with an indication that our more recent "demand led" approach is delivering higher returns. The evidence shows that 83% of the projects supported will deliver products or services likely to reach the market and that the majority of businesses would not have invested in the project without government support. Other impacts demonstrated include collaborative R&D projects delivering on average an additional net 33 jobs per project and softer impacts such as enhanced image and reputation and skills for the businesses involved.

[89] www.innovateuk.org/_assets/pdf/publications/pacec_evaluation_of_crandd_report.pdf
[90] www.innovateuk.org/content/press-release/knowledge-transfer-networks-reviewed.ashx
[91] www.innovateuk.org/_assets/pdf/corporate-publications/ktp%20strategic%20review%20feb%202010.pdf
[92] www.nesta.org.uk/publications/reports/assets/features/buying_power

26. The evaluations of individual schemes do not however demonstrate the impact of the Technology Strategy Board overall such as the role we play in the innovation system and the value we add through our convening power, bringing communites of people together from different backgrounds to move an area forward. A review of the Technology Strategy Board will be carrried out during 2012.

Question 5—*What impact will the Government's innovation, research and growth strategies have on bridging the valley of death?*

27. Taking into consideration the time lags in the system, the true impact of the Government's strategies in these areas may not be known for some time. We do however feel that the Government's strategies provide a framework and contain all the elements necessary to help reduce the impact of the "valley of death". The next stage is very much the co-ordination of all the different activities, both public and private, to ensure the sum is more than the individual parts.

28. The Government provides a wide range of support including investment in the knowledge base, advice and guidance, funding to support R&D and innovation projects (grants, contracts, equity investment through funds of funds), through to infrastructure and centres. To help address the valley of death the various forms of support need to be used collectively and in a way that efficiently and effectively moves an idea from concept to commercialisation.

29. There is one vital ingrediant necessary to underpin this approach which is continuity, both of funding and commitment, over the long-term.

Question 6—*Should the UK seek to encourage more private equity investment (including venture capital and angel investment) into science and engineering sectors and if so, how can this be achieved?*

30. The simple answer to the question is yes. It is important to create an environment which encourages such investment to happen. The Enterprise Investment Scheme, Seed Enterprise Investment Scheme and Venture Capital Trust tax reliefs are examples of where the Government has put in place support which helps to encourage such investment and are viewed positively by business and at the same time felt to be under publicised. There is also potential to attract more foreign investment into the UK.

31. As well as creating the environment, a potential way of addressing the "valley of death" is to create better linkages between the support provided by the public and private sectors. The Technology Strategy Board support of R&D and innovation projects provides a way of de-risking the technology, therefore making it more attractive to potential investors. Each project funded will have been selected from a wider number of applications and been subjected to a technical and financial assessment. By the end of the project, in most instances, the technology will be closer to market making it more attractive to potential investors.

32. We are currently looking at ways of providing greater visibility of the businesses and projects we support as well as making the best connections to the private investor community, including working with organisations such as Capital for Enterprise. We are looking at the potential to use an online database of projects seeking support as well as creating opportunities where companies needing finance can meet with or pitch to those looking to invest. This approach was trialled recently as part of the Tech City Launchpad competition. Companies successful in obtaining a grant of 50% from the Technology Strategy Board were given up to 12 months to obtain the other 50%. To help them obtain the funding, companies were brought together with potential private investors and provided with access to other business support, such as organisations providing "investment readiness" training and business coaching and mentoring.

33. There should certainly be an encouragement of more private equity investment into science and engineering. The soultion rests with creating the right environment and the need for greater communication and visibility, creating the linkages between those seeking finance and those looking to invest.

Question 7—*What other types of investment or support should the Government develop?*

34. It is our view that Government does not necessarily need to introduce new types of support, but ensure the greater use, co-ordination and alignment of existing support. Our strategy "Concept to Commercialiation" as well as the Government's "Innovation and Research Strategy" both set out plans for the greater co-ordination of publically funded support, together with building the links to sources of private funding.

35. There is the opportunity to do more to support the commercialisation of research by government acting more as a lead customer, supporting innovative ideas which address policy challenges faced by government departments and the wider public sector. The combination of a potential government contract and the use of a mechanism such as SBRI can help to rapidly move research towards commercialisation. The first customer can be the lifeblood of a new company and so a contract from Government to support R&D such as through SBRI has the potential to have an enormous impact. Our experience of the projects we have supported through SBRI is that they are particularly attractive to the private finance community.

36. A good example is Eykona Technologies, a company spun out of University of Oxford in 2007, which is developing a wound measurement device. The company won funding through SBRI in October 2010 and since then has raised £2.4 million of private funding and grown from 4 to 14 employees.[93]

37. Schemes such as Smart can help companies access funding of between £25k and £250k, often the level of funding needed to get an idea off the ground but difficult to access from private sources such as institutional investors and banks. There is huge demand for funding through Smart and at present only the best of the best projects are funded.

38. The Catapult centres are a new edition to the innovation landscape and will once established will play an effective role in helping with the translation and commercialisation of research. The Innovation and Research Strategy announced that the Technology Strategy Board would be responsible for delivering innovation vouchers and again they have a role to play helping to create the initial engagement between SMEs and academic institutions. There are also other models which are showing promise such as the Easy Access IP model developed by the University of Glasgow.

39. The new Business Coaching for Growth programme will be important in ensuring that high-growth SMEs (including those that seek to take research-led business ideas to commercialisation) have access to support in developing their commercial capabilities and connecting with private sector sources of early-stage funding. We will work actively with the BCG providers to signpost this service to appropriate companies.

40. The Technology Strategy Board and the Research Councils are working closely together developing joint strategies and co-ordinating and aligning activities in a number of areas. An example is the recently announced Biomedical Catalyst Fund, a joint activity between the Technology Strategy Board and the MRC aiming to help the commercialisation of MRC funded research. Another example is the Innovation and Knowledge Centres (IKCs) which are centres of excellence with five years' funding to accelerate and promote business exploitation and to build critical mass in an emerging research and technology field. Their key feature is a shared space and entrepreneurial environment, in which researchers, potential customers and skilled professionals from both academia and business can work side by side to scope applications, business models and routes to market. To date, six IKCs have been supported.[94]

41. The key activity across all of the areas is joining up the support and making it simple and easy to access. There is the potential for more co-ordinated strategic programmes between the Research Councils and the Technology Strategy Board to ensure continuity of support across the innovation system. There is the potential to do more through schemes such as SBRI and Smart and to ensure new activities such as the Catapult Centres and Innovation Vouchers form part of the overall support system.

Conclusion

42. The valley of death is not something unique to the UK and is an issue countries globally are trying to overcome. The need however to move ideas more rapidly to commercial products and services is vital to generate economic growth. More needs to be done in a more joined up manner to make the UK a truly attractive investment proposition in terms of fiscal measures, skills, labour flexibility, supportive regulatory environment and facility to navigate.

43. We need to create a favourable environment in the UK which supports investment and makes the UK an attractive proposition for overseas investors and companies looking to fund and locate their R&D here. The Government could act more as a lead customer and ensure that approvals processes, which can be lengthy and costly, do not unduly impede a companies progress. There needs to be a higher level of co-ordination of the existing support that is available to help businesses and to more effectively create the links between the support provided by the public sector and the private investment community.

44. Long-term continuity of funding and commitment are vital. A lot of the basic ingredients are in place or in progress. Co-ordination of effort is now what is needed.

Case studies of projects supported by the Technology Strategy Board can be found at—http://www.innovateuk.org/publications/case-studies.ashx

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[93] Video cases studies—www.innovateuk.org/content/case-study/sbri/nhs-east-of-england-healthcare-competitions.ashx
[94] www.epsrc.ac.uk/funding/grants/business/schemes/Pages/ikcs.aspx

Written evidence submitted by Research Councils UK

Key Points

Research is a vital component in the UK innovation landscape, as highlighted within the Innovation and Research Strategy for Growth economics paper.[95] Research Councils are instrumental in shaping the research landscape to play a leading role in the innovation ecosystem—through the research we fund; the infrastructure, both nationally and globally, we support; the talents we develop and help prosper; as well as the partnerships with business and government that we forge on behalf of UK research; the Research Councils nurture innovation and the broad contributions of research to the growth and wellbeing of the UK.

Research Councils UK consider that there is no single point of failure—or "Valley of Death"—that affects the whole innovation system, but sector by sector there are a number of different aspects where there can be insufficient progress towards impact. Commercialisation problems are often sector specific and therefore there is no single solution. In order to ensure that the innovation ecosystem is highly effective it is important to address the full range of factors including funding, regulation and cohesion of different sectors working across actual or perceived boundaries.

One of the key challenges identified by the Research Councils for commercialising research ideas is the time required to take research forward to the point of commercial output. This can vary widely and is often over a long timescale, with significant consequences for securing commercial funding and interest. Commercialisation of a research idea or innovation also carries considerable scientific and technical risk and the less developed the idea, the greater the risk. At a time when the economic climate is challenging, the risk appetite across all sectors of business may be expected to be reduced, with the consequence that engagement with, and investment in, early stage ideas will be more challenging. In various sectors, the challenges of time, investment and risk can combine to create serious "valleys". We believe public intervention from the Research Councils—in coordination with others—to support the timely de-risking of scientific[96] and technical breakthroughs, and to aid commercialisation of research outcomes, can result in substantially greater impact. In addition, our support can enable the leverage and deployment of further funding from both the public and private sector.

1. Research Councils UK (RCUK) is the strategic partnership set up to champion the research supported by the seven UK Research Councils. RCUK was established in 2002 to enable the Councils to work together more effectively to enhance the overall impact and effectiveness of their research, training and innovation activities, contributing to the delivery of the Government's objectives for science and innovation.[97]

2. This evidence is submitted by RCUK on behalf of all the Research Councils and represents their independent views. It does not include, or necessarily reflect the views of the Knowledge and Innovation Group in the Department for Business, Innovation and Skills (BIS).

The Research Councils' Role in the Innovation System

3. The commercialisation and exploitation of the UK's world leading research is critical for enabling innovation, contributing to the growth of the economy and tackling societal challenges.

4. The Research Councils believe the inquiry is considering commercialisation as the process by which the outcomes of research activity are brought to the market place through the development of new or improved products, processes, services or technologies. The innovation process is non-linear and complex, as explained for example in the BIS Innovation and Research Strategy December 2011. The term "valley of death" can be a useful way of looking at issues of commercialisation in some sectors, for example, we consider the Catalyst fund[98] to be an effective solution in the biomedical area. However, this approach is not necessarily appropriate for all sectors, and in some sectors the concept of a "valley of death" can be misleading through its implication of a linear journey. Other sectors have different complexities and challenges which require appropriately tailored solutions.

5. Whilst the commercialisation of outcomes is an important mechanism through which research delivers benefit and impact, there are a wide variety of other ways through which research can deliver benefit to society and the economy. A broad range of knowledge and support models are necessary. A critical aspect of this is the role of highly skilled people as carriers of knowledge and tacit information, and as the potential recipients and interpreters of new knowledge, providing critical absorptive capacity in business.

6. The Research Councils have several different roles in supporting the UK's innovation landscape. First of all we provide leadership in funding world-leading research that has the potential to lead to innovative products, processes, services or technologies. We also provide a number of interventions to develop research outcomes

[95] Innovation and Research Strategy for Growth Economics Paper (No. 15) www.bis.gov.uk/assets/biscore/innovation/docs/e/11–1386-economics-innovation-and-research-strategy-for-growth.pdf

[96] Adhering to the BIS definition of science "encompassing research and practice in the physical, biological, engineering, mathematical, health and medical, natural and social disciplines, and research in the arts and humanities".

[97] www.rcuk.ac.uk

[98] www.mrc.ac.uk/Newspublications/News/MRC008394

into economic and societal impact. Some of these interventions are outlined below (see Appendix 1 for further information on the Research Councils interventions). The Research Councils:

6.1 *Fund collaborative research and knowledge exchange* which provides opportunities for the co-production, application, exploitation and commercialisation of research between business and academia. To achieve this we usually fund the higher education sector directly to support collaborative research projects.

6.2 *Provide flexible finance to allow the outcomes of research to be developed towards wider benefits within the higher education sector* including supporting the very early stage of turning research outputs into a commercial proposition. This funding helps take an idea to the stage at which the potential for commercialization is more clearly defined, enabling the possibility of securing further funding to progress.

6.3 *Support initiatives and opportunities for early commercial development of research produced by research staff working in their institutes*, for example through the Rainbow Seed Fund,[99] MRC-T,[100] and STFC Innovations Ltd.[101]

6.4 *Train the next generation of researchers and innovative people* through investment in doctoral training. This is an extremely important route for the provision of highly skilled people into business. Indeed, 56% of doctoral graduates, three years after graduating, are employed outside of higher education.[102] The Research Councils training portfolio also includes major collaboration with business for example through CASE studentships[103] and Industrial Doctorate Centres.[104]

6.5 *Maintain a broad, deep and direct relationship with the business sector* and work in partnership with major UK and global companies to support relevant pre-competitive research. We work in partnership with business at all levels from business members on our Councils, strategic partnerships with sectors or individual companies, to facilitating relationships with business at the individual project level. The Research Councils portfolio includes collaboration with over 2,500 companies including many small and medium sized enterprises (SMEs).

6.6 *Build connectivity in the innovation ecosystem by working with innovation and knowledge infrastructure partners* including the Technology Strategy Board,[105] Funding Councils, and the Design Council, and *key Government departments* including the Department of Business Innovation and Skills (BIS), Ministry of Defence (MOD), Defra and the Department of Health (DH).

6.7 *Promote a culture within the research base where commercialisation can thrive* and commercial research outcomes are recognised and rewarded appropriately. The Research Councils are working closely with other key stakeholders such as the Higher Education Funding Council for England (HEFCE)[106] and the other Higher Education funding bodies to achieve culture change within the research base; key drivers include Pathways to Impact, the Research Excellence Framework (REF) and Higher Education and Innovation Funding (HEIF). For example, Pathways to Impact was implemented in 2009 within the application and assessment process for Research Council funding. This policy encourages researchers to explore pathways for realising the impact of their research, including where appropriate, pathways towards commercial application early in the research process.

6.8 *Operate or fund innovation-led campuse,s*[107] *centres, institutes and facilities, which create a critical mass* of facilities, equipment, skills, and innovation-led research and provide a platform for businesses, universities and the research base to undertake collaborative projects. These investments make a key contribution to the UK innovation system in a global context, ensuring that our research contributes to UK economic growth, national security and societal well-being. Research Council operated campuses, centres, institutes and facilities are complementary to the Catapult Centres that are being established by the Technology Strategy Board.

6.9 Include within our portfolio *research into innovation and commercialisation*. Our research centres in these areas have been encouraged to input independent and expert advice into this inquiry.

[99] www.stfc.ac.uk/Funding+and+Grants/1192.aspx
[100] www.mrctechnology.org/
[101] www.stfcinnovations.co.uk/
[102] www.vitae.ac.uk/policy-practice/291901/What-do-researchers-do-Doctoral-graduate-destinations-and-impact-three-years-on-2010.html
[103] www.rcuk.ac.uk/kei/ktportal/Pages/DoctoralStudentships.aspx
[104] Industrial Doctorate Centres: www.epsrc.ac.uk/funding/students/centres/Pages/indd.aspx
[105] In the 2007 Comprehensive Spending Review RCUK set a target of committing a minimum of £120 million in collaborative and complementary activities with the Technology Strategy Board, between April 2008 and March 2011. The target was exceeded by 27%, collectively reaching over £165 million.
[106] Joint RCUK/HEFCE statement on impact: www.rcuk.ac.uk/kei/maximising/Pages/Impactstatement.aspx
[107] Examples include: Babraham, Cambridge; Daresbury, Cheshire; Harwell, Oxfordshire and NRP, Norwich.

7. Further information is available on the knowledge exchange and impact section of the RCUK website.[108] This includes the RCUK impact strategy, Pathways to Impact, and the Knowledge Transfer Portal which is a gateway to further information on Research Councils support for knowledge exchange.

Commercialisation of Research: Key Challenges

Q1. *What are the key difficulties of funding the commercialisation of research and how can they be overcome?*

8. RCUK note that the "valley of death" is helpful in understanding and responding to the challenges of commercialisation within some sectors, but consider that there is no single "valley of death" within the overall innovation system. In addition there are also a number of areas where there is insufficient connectivity[109] which hinders the commercialisation of research.

9. RCUK recognise that there are a number of challenges associated with the commercialisation of research across the entire innovation spectrum which relate to funding. These include:

9.1 *Duration to market*: the time needed to take forward a research idea to the point of commercial output can vary widely and can take decades to be realised. This can have significant consequences for securing commercial funding and interest. This represents challenges for the commercialisation of research which require solutions from all parts of the innovation system. The long time to market from initial research ideas can problematic for companies funded by short term VC investment. Pelamis Wave Power Ltd, now 14 years old, is one of the world's leading wave energy developers. The company, a start-up from the University of Edinburgh, has been funded by venture capital. However, short term VC funding was not well suited to this complex engineering challenge. For example, the need to demonstrate progress and achievable revenue to secure continued VC funding led to a move to an array of machines sooner than was optimal for the overall wave energy device development[110]. In a different sector, Beneforté super broccoli, which has potential health benefits for people with cardiovascular disease and cancer, was introduced in a UK supermarket in October 2011—27 years after the first research was undertaken.[111] The development of the product involved fundamental research, specialist commercial and legal expertise, product development and extensive marketing, every step of which required funding and commitment.

9.2 *Risk*: commercialisation of a research idea carries considerable risk and the less developed the idea, the greater the risk. This will reduce the take up of early stage ideas by the commercial sector and at a time when the economic climate is challenging, the risk appetite across all sectors of business could be expected to be further reduced. To mitigate this element Research Councils, working with partners like the Technology Strategy Board, provide direct support to bridge this gap in terms of follow-on funding for proof of technical and market concepts, and also specialist support for emerging technologies through Innovation and Knowledge Centres. The current MRC translational funds, and the future Catalyst fund also tackle this gap in the biomedical area. The Rainbow Seed Fund (RSF), which is collaboratively managed by three Research Councils and other research partners, also acts as a catalyst by investing directly in early stage companies. Commercial sector investment can also be facilitated through seed cord VC funding, and specialist sector bodies like MRCT. The Rainbow fund has encouraged over £100 million worth of private equity investment and the development of a number of different spin-out companies; new companies facilitated by MRCT have won similar amounts of private investment.

9.3 *Management of intellectual assets*: For the research that we support, we make it a condition of funding that the research organisation will make every reasonable effort to ensure that the intellectual assets obtained in the course of the research, whether protected by intellectual property rights or not, are used to the benefit of society and the economy. Identifying and managing intellectual property can be central to delivering commercial benefit from research outcomes in certain sectors such as pharmaceuticals, chemicals, personal care products, aerospace and defence and energy technologies. We welcome the novel approaches some research organisations are adopting; for example Easy Access IP.[112] We encourage other organisations to consider innovative and appropriate ways of managing intellectual assets including recognising circumstances where free access might be the most effective approach to ensure that potential economic and societal benefits can be realised by beneficiaries. There are still considerable challenges in managing IP in a European and global context. We welcome the Hargreaves review as making a key contribution to this.

[108] RCUK Knowledge Exchange and Impact www.rcuk.ac.uk/kei/Pages/home.aspx

[109] Connectivity relates to the richness of the network of connections, via formal or informal relationships, partnerships, agreements, etc that exist between the different agents (individuals, companies, universities, etc) in the innovation landscape.

[110] (Energy Research Partnership, October 2011).

[111] www.bbsrc.ac.uk/news/health/2011/111123-f-super-broccoli.aspx

[112] www.gla.ac.uk/news/headline_181588_en.html

10. RCUK also recognises the issues outlined below in addition to funding are important:

10.1 *Culture*: The Research Councils are working with other key stakeholders to achieve culture change within the research base and ensure that the academic community has the time, interest and expertise to ensure that the outputs from their research are taken forward and commercialised if appropriate. A 2010 study for ESRC and EPSRC found that industrial engagement is common and increasing among UK academics working in engineering and physical sciences.[113] We expect this culture change to be reflected within institutions' recognition and reward policies to ensure that this culture change is supported.

10.2 *Absorptive Capacity.* Many commercial innovations will involve researchers working with existing businesses. Therefore, business will need absorptive capacity to work with researchers. Research Councils help to contribute to the solution through the training of PhD and post-doctoral researchers and by facilitating movement of highly skilled people at all career stages between the research base and business and other users.

10.3 *Research Environment*. Key to increasing the speed and likelihood of research commercialisation is to create an environment which brings researchers and business together to meet informally and to work alongside each other in multidisciplinary teams. This creates a suite of effective knowledge transfer activities that deliver impact and could include: longer term collaborative research, shorter term problem solving projects and expert staff available to aid commercialisation. An example of this in action is through the Innovation and Knowledge Centres[114] which are supported by the Research Councils and the Technology Strategy Board to accelerate business exploitation of emerging research.[115]

Q2. *Are there specific science and engineering sectors where it is particularly difficult to commercialise research? Are there common difficulties and common solutions across sectors?*

11. The Research Councils fund research into policy, regulation and new business models all of which are essential for a successful innovation system. As noted above there are various challenges associated with the commercialisation of research, and the impact on sectors varies considerably from sector to sector; therefore a common solution is not to be expected and different mechanisms are needed in different circumstances. Any interventions for improving the commercialisation of research must be sensitive to both the context of research and business sectors.

Q3. *What, if any, examples are there of UK-based research having to be transferred outside the UK for commercialisation? Why did this occur?*

12. Research and business both operate in a global innovation system. The UK has a particularly high level of R&D funding from overseas[116] and many of our largest active R&D businesses are global companies. We should expect UK research to sometimes be transferred outside of the UK for commercialisation and for UK business to draw on research from overseas.

Q4. *What evidence is there that Government and Technology Strategy Board initiatives to date have improved the commercialisation of research?*

13. Public intervention from the Research Councils and others to support the commercialisation of research outcomes contributes to reducing the risk and enable the leverage and deployment of further funding, including from the private sector. Appendix 1 provides examples of RCUK interventions and Appendix 2 provides RCUK examples to illustrate the breadth and diversity of potential commercial applications of Research Council funded research. There is evidence that follow-on funding helps researchers to bridge the funding gap between traditional research grants and commercial funding by supporting the very early stage of turning research outputs into commercial proposition. This is achieved by support to develop the commercial potential of a concept and establish both commercial feasibility and scientific/technical merit through a mix of technical and business development activities.

14. A 2009 external evaluation of the EPSRC follow-on fund reports that 78% of projects led to further commercialisation activity. An investigation of the economic impact of 32 case studies arising from EPSRC Innovative Manufacturing Research Centres (about 10 % of the total IMRC investment) showed that this work had generated £70 million of additional sales for industrial partners, £43 million of licensing fees, cost-savings of at least £17 million to the public sector and £10 million to the private sector, and 20 new technologies and products were brought to market.[117] From MRC's translational schemes, there is good evidence that early stage, shorter term (<two year) investments have helped commercialisation; assessments of outcomes from the portfolios of longer-term projects (three years) will be made later.

[113] The Republic of Engagement. Exploring UK Academic Attitudes to Collaborating with Industry and Entrepreneurship. AIM Research and UK-IRC for ESRC and EPSRC 2010.
[114] www.epsrc.ac.uk/funding/grants/business/schemes/Pages/ikcs.aspx
[115] www.epsrc.ac.uk/funding/grants/business/schemes/Pages/ikcs.aspx
[116] The UK R&D Landscape: Enhancing Value Task Force (February 2011, CIHE, UK-IRC).
[117] Economic Impact of the Innovative Manufacturing Research Centres, DTZ report for EPSRC 2011.

15. The Research Councils work together with the Technology Strategy Board to ensure that there are initiatives and opportunities to improve the commercialisation of research, for example through Knowledge Transfer Networks, Knowledge Transfer Partnerships, Innovation and Knowledge Centres, Innovation Platforms and Collaborative R&D funding. By working strategically with the Technology Strategy Board we are improving the journey towards commercialisation in key areas, for example, the development of the Catapult Centres[118] and co-funding the Biomedical Catalyst Fund. The RCUK Economic Impact Report 2011[119] outlines the close working relationship between RCUK and the Technology Strategy Board, and the various impacts we have achieved together.

16. Research Councils and the Technology Strategy Board have complimentary but distinct roles within the innovation system. The Technology Strategy Board has key strategic areas of focus[120] where there are well evidenced technology and innovation opportunities for UK wealth creation. Research Councils fund a much broader research base, and aim to provide flexible support to help commercialise developments from research as they emerge, working with the Technology Strategy Board and other partners when appropriate.

Q5. *What impact will the Government's innovation, research and growth strategies have on bridging the valley of death?*

17. RCUK welcomes the Government's innovation, research and growth strategies. The Innovation and Research Strategy[121] clearly sets out the Government's approach to boosting investment in innovation and enabling UK success in the global economy. We welcome the clear intent of the strategy to achieve closer working in the innovation system, for example, through support for Innovation Vouchers, Venture Capital investment finance, emerging technology areas with the Technology Strategy Board. The critical role of research and the ecosystem approach highlighted within the Innovation and Research Strategy for growth economics paper is also particularly important.

18. To stimulate long-term growth, further investment is important but tailored solutions for specific sectors will be required. For example, RCUK welcomes the £180 million Catalyst fund to help the next generation of British medical breakthroughs.[122]

Q6. *Should the UK seek to encourage more private equity investment (including venture capital and angel investment) into science and engineering sectors and if so, how can this be achieved?*

19. Both venture capital funding and investment by existing companies played an important role in commercialisation of our portfolio. Venture capital funding appears to be relatively healthy and strong in sheer volume in the UK compared with many other countries; the UK saw large venture capital investments in 2008[123] (0.2% of GDP) although this market is directed towards European as well as UK businesses. It is important to look at the potential for further investment from large global business as well as venture capital and angel investment.

20. The Government has a role to play in promoting greater awareness of UK investment opportunities in the international capital markets by marketing UK innovation capabilities. However, as mentioned in paragraph 9.1 the long time to market from initial research ideas can problematic for companies funded by short term VC investment.

Q7. *What other types of investment or support should the Government develop?*

RCUK makes the following recommendations to help improve the commercialisation of research:

21. The Government and the research community need to build on the progress already made in developing the environment and culture within the research base that encourages the exploration of impact from research and in which commercial research outcomes are recognised and rewarded.

22. The Government should continue to invest in and promote the UK's research base. The UK's research base is a vital component of the UK's innovation landscape and makes an important contribution to economic growth through our research outputs.

23. The Government should continue to encourage innovative and appropriate ways of managing intellectual assets—to ensure that potential economic and societal benefits can be realised by beneficiaries. RCUK support the Hargreaves Review in making a contribution to this.

24. The government should maintain its current focus on the innovation system and on addressing issues of connectivity, funding, timescales and scientific risk within sectors. Sectors vary considerably, therefore a common solution is not to be expected; different mechanisms are needed in different circumstances and any

[118] www.innovateuk.org/deliveringinnovation/catapults.ashx
[119] www.rcuk.ac.uk/Documents/publications/RCUK%20Impact%20report%202011.pdf
[120] www.innovateuk.org/ourstrategy.ashx
[121] www.bis.gov.uk/assets/biscore/innovation/docs/i/11–1387-innovation-and-research-strategy-for-growth.pdf
[122] www.mrc.ac.uk/Newspublications/News/MRC008394
[123] Innovation and Research Strategy for Growth Economics Paper (No 15) www.bis.gov.uk/assets/biscore/innovation/docs/e/11–1386-economics-innovation-and-research-strategy-for-growth.pdf

interventions for improving the commercialisation of research must be sensitive and tailored to both the context of research and business sectors.

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APPENDIX 1

RESEARCH COUNCIL INTERVENTIONS FOR THE COMMERCIALISATION OF RESEARCH

BBSRC National Research and Innovation Campuses provide strategic funding for 8 institutes based at 6 separate and distinctive campuses across the UK.
www.bbsrc.ac.uk/organisation/research-innovation-campuses/campuses-index.aspx

The Science and Innovation Campuses at Daresbury, Cheshire and Harwell, Oxfordshire are creating a critical mass of facilities, skills and business, in synergy with the universities and research base.
www.stfc.ac.uk/3574.aspx

STFC operates several **world-class research facilities** in the UK; industry makes use of these facilities to develop their products and processes, often working collaboratively with university researchers and STFC facilities staff.
www.stfc.ac.uk/3574.aspx

STFC Innovations Ltd (SIL), a wholly owned technology transfer company, SIL was set up in 2002 and its role is to support STFC in identifying and brokering deals to exploit and manage our IP rights, including gathering revenue through spinouts and licensing agreements.
www.stfcinnovations.co.uk/

The **Innovation Technology Access Centres (ITAC)** are unique, fully equipped space for innovation, research and development providing flexible access to offices, laboratory space, clean rooms, workshops, "hot-labs" and high specification scientific equipment. The facilities are designed to suit start-up companies, SMEs and also research & development teams from established companies. I-TACs are based on the Daresbury Science and Innovation Campus and Harwell Oxford. www.itac.stfc.ac.uk/

The Rainbow Seed Fund (RSF) was launched in May 2002 and comprises a partnership of publicly funded research laboratories with funding of £10 million provided by the Department of Business, Innovation and Skills. The Rainbow Seed Fund provides investment to support the early stages of commercialisation of technology and services from its partners.
www.stfc.ac.uk/Funding+and+Grants/1192.aspx.

Biomedical Catalyst Fund will deliver growth to the UK life sciences sector through supporting and driving the development of innovation life sciences products and services. Support will be available to both academically and commercially-led research and development. This is a joint programme between MRC and TSB and builds on MRC Translational Funding.
www.mrc.ac.uk/Newspublications/News/MRC008394

MRC Translational Funding—following the Cooksey Review, MRC provides extensive grant support for developing medical discoveries into new treatments, diagnostics and devices, on a larger scale than general Follow-on Funding (see below). Grants to HEIs or HEI/business collaborations can help take important medical discoveries into early-phase clinical trials if needed, as well as providing smaller awards that add enough knowledge to ensure commercial investment follows.

MRC Technology—was formed in January 2000 and is the technology transfer agent for the Medical Research Council's intramural researchers employed in MRC Units and Institutes and has a string track record in translating cutting edge scientific discoveries into commercial products.
www.mrctechnology.org/about/how-we-work

Follow-on Funding provides financial support at the very early stage of turning research outputs into a commercial proposition. This funding helps take the idea to the stage at which the route to commercialisation is clearand it is possible to secure further funding to progress, , for example, through a spin-out (seed or venture finance) or licensing opportunity.
www.rcuk.ac.uk/kei/ktportal/Pages/Followon.aspx

Collaborative Training Schemes—enables researchers to develop the relevant skills to undertake excellent research, work effectively in business (and/or the government or other important sectors), and exploit the outcomes of their research. Training opportunities include vocational courses, collaborative studentship projects between academia and industry, and training in entrepreneurship.
http://www.rcuk.ac.uk/kei/ktportal/Pages/home.aspx

Support for Enterprise includes a range of activities and opportunities to allow researchers to develop their entrepreneurial skills and to access business advice while commercialising their existing research, initiatives include enterprise fellowships, Young Entrepreneurs Scheme (YES).
www.rcuk.ac.uk/kei/ktportal/Pages/home.aspx

People and Information Exchange—All Research Councils encourage increased levels of university-business interaction; support the exchange of researchers between academia and industry, and stimulate partnerships between business and researchers. This includes support for brokering and networking activities, fellowship/ secondment schemes that enable researchers to work in a commercial environment, and support for Knowledge Transfer Partnerships.
www.rcuk.ac.uk/kei/ktportal/Pages/home.aspx

Collaborative Research: The Research Councils fund collaborative research which is academic research undertaken in partnership with other research organisations, with business, with government and/or with the third sector (eg charities). Collaborative research can take a number of forms, from a basic grant between two partners, through to a complex multi-partner research programme.
www.rcuk.ac.uk/kei/ktportal/Pages/home.aspx

Knowledge Transfer Accounts (KTA) provide flexible funding for institutions to make sure the research we fund is fully exploited. KTAs utilise a wide variety of approaches, including workshops, seed funding, training and development in KE skills, and people exchange, including funding Knowledge Transfer Partnerships (KTPs).
www.epsrc.ac.uk/funding/grants/business/schemes/Pages/knowledgetransferaccounts.aspx

Knowledge Transfer Secondments (KTS) are focussed on ensuring the research we support is fully exploited, but are focussed on the secondment and exchange of people between academe and users. KTS also utilise KTPs as a way of delivering people exchange.
www.epsrc.ac.uk/funding/grants/business/schemes/Pages/knowledgetransfersecondments.aspx

Innovation and Knowledge Centres (IKCs) (now in partnership with the Technology Strategy Board) are centres of excellence to accelerate and promote business exploitation of emerging research and technology. Their key feature is a shared space and entrepreneurial environment.
www.epsrc.ac.uk/funding/grants/business/schemes/Pages/ikcs.aspx

Centres for Innovative Manufacturing aim to maximise the impact of innovative research for the UK, supporting existing industries, and opening up new industries and markets in growth areas.
www.epsrc.ac.uk/funding/centres/innovativemanufacturing/Pages/default.aspx

APPENDIX 2

RCUK EXAMPLES OF SUCCESSFUL COMMERCIALISATION

Conformetrix: Dr Almond's unique technology, to determine the dynamic 3D shapes of drug molecules, is the culmination of a large body of work produced during a BBSRC David Phillips Fellowship. Within the space of three years, Dr Almond's research has gone from laboratory concept to the edge of commercial reality, which promises to have a substantial contribution to drug discovery and, ultimately, patient health. His research group's discovery of the flexible 3D molecular shape of hyaluronan quickly led to a UK patent and the all-important "proof of concept" that their new methodology could be generalised to any small flexible molecules, such as antibiotics and hormones With the support of two Follow on Fund awards and a BBSRC/RSE Enterprise Fellowship, Dr Almond has made rapid progress towards commercialisation and, with his colleague Dr Charles Blundell, formed the spin out company Conformetrix to exploit the technology. They went on to raise seed funding from Aquarius Equity Partners.

Beneforte Broccoli "super broccoli" was launched onto selected UK supermarket shelves in October 2011, and represented more than two decades of work by a collaboration between two BBSRC-supported research world-class institutes and a specialist technology transfer company, part-owned by BBSRC.
www.bbsrc.ac.uk/news/health/2011/111123-f-super-broccoli.aspx

Eight19 Ltd is a solar energy company, spun out of the Cambridge Integrated Knowledge Centre (one of the EPSRC IKCs) that builds on the development of clean technology to enable a new generation of low-cost, flexible plastic solar cells that have the potential to dramatically reduce the manufacturing cost and increase the throughput of solar technology. The IKC funding enabled fundamental science to be transformed into a sustainable manufacturing process and a strong team to be built. This de-risked the investment in a commodity market (unattractive to VC funding) which, together with support from the Carbon Trust catalysed further significant inward-investment from the specialty chemicals company Rhodia. Eight19's current product, IndiGo, is an affordable pay-as-you-go source of solar electricity to provide electrical lighting and phone charging for communities that are not connected to power grids. It's much cheaper than kerosene, the most common source of lighting, and far cleaner and safer. IndiGo has already changed the lives of several hundred Kenyan families and over the next two months 4,000 solar units will be distributed in Kenya, Malawi and Zambia. Eight19's work won the Rushlight Solar award[124] in February 2012 and is also endorsed by Solar Aid.[125]

NERC has recently spun out an international geological consultancy from the **British Geological Survey,** BGS International, which is based on the skills and experience of a small team from BGS identifying new opportunities for surveying, especially in African countries funded by those countries or the World Bank. As

[124] www.rushlightawards.co.uk/
[125] http://solar-aid.org/

a result, the company can access multimillion dollar contracts from the World Bank and African countries. This is a knowledge-based consultancy bringing funding from overseas sources into the UK. It requires a different approach to commercialisation than that which is based on IP. Whilst the data available from the BGS is free to access, significant value can be achieved for house builders, mining companies, oil and gas and other industries through providing specific added-value products eg high value data and information products from geological data and knowledge. This brings significant income to the UK and BGS and is a more straightforward route to market than is possible with IP-based commercialisation.

Next generation solar energy harvesting projects will improve quality of life and generate economic benefit: EPSRC and the Technology Strategy Board launched a joint £7 million investment through a staged approach in 2010 to transfer world class knowledge from universities into business led early stage projects to research the use of **nanoscale technologies**. The technology focus was to develop and scale up the next generation of solar energy harvesting. The purpose of the investment was to connect UK based supply chains and position industry as a dominant force in next generation solar energy harvesting for worldwide markets and as a cost effective course to the UK renewables energy mix for 2020/50. Building on the success of this competition, EPSRC and the Technology Strategy Board have teamed up to deliver a joint £9 million investment in nano-enabled healthcare diagnostics and targeted delivery of therapeutics in November 2011.
www.rcuk.ac.uk/Documents/publications/RCUK%20Impact%20report%202011.pdf

BAS has recently licensed some innovative tracking technology to a UK SME This licence deal was facilitated by the TSB's Electronics, Sensors, and Photonics KTN, who helped run a wide-ranging and transparent bidding process for the right to manufacture and sell the technology. This collaboration allowed BAS to fairly licence a technology which had been developed using public money, retain accountability to the taxpayer and bring in money from a private company to continue to support UK science.
www.antarctica.ac.uk/about_bas/news/news_story.php?id=1648

Through STFC Innovations Limited, the STFC's wholly owned technology transfer office, the STFC has launched 15 spin-out companies since creation in 2002. These companies last year employed 88 people in the high-technology jobs in the UK. Examples of STFC Innovation's success include:

Cobalt Light Systems, which develops equipment for non-invasive analysis of materials. They offer unique and proprietary analysis systems with applications in many market areas. Cobalt's technology can rapidly and accurately measure chemical composition without touching or changing the sample. This ability allows the content of bottles, pills, containers to be determined without damaging the products which makes them especially well suited to pharmaceutical assay, pharmaceutical lot release and QC and fine chemicals analysis and identification.
www.cobaltlight.com/

CellaEnergy was the winner of the 2011 Shell Sprinboard Award and makes safe, low-cost hydrogen storage materials which could produce a viable and practical alternative to fossil fuels. Cella's materials use nano-structuring to safely encapsulate hydrogen at ambient temperatures and pressures. This sidesteps the requirement for an expensive hydrogen infrastructure. Cella has A round funding from an established UK chemical company. http://www.cellaenergy.com/

Heptares Therapeutics (formed in 2007). Heptares Therapeutics is a drug discovery company focused on novel small-molecule drugs targeting G-protein-coupled receptors (GPCRs), the largest family of druggable targets. The Company has developed a unique, transformational and proprietary technology for making purified, stabilised and functional GPCRs (known as StaRs™, Stabilised Receptors), overcoming a major limiting factor to the development of new drugs targeting this group. It is an MRC Technology spin out based on MRC intellectual property from MRC LMB and NIMR. The company received seed funding from the venture capital firm MVM Life Sciences Partners LLP of some £2.2 million. In 2009, it raised a further £21 million ($30 million) of equity finance in a successful Series A private round from three blue-chip international venture capital firms. Clarus Ventures led the syndicate, which includes the founding investor, MVM Life Science Partners, and the Novartis Option Fund. It has reached substantial commercial deals with Novartis, Takeda Pharmaceuticals, Shire, and AstraZeneca.
www.heptares.com

Bicycle Therapeutics: Formed in 2009 Combes the most desirable features of small molecules and biologics, to create highly specific and highly stable peptide drugs. It is an MRC Technology spin out, based on the research of Sir Greg Winter, at MRC LMB. The company announced a collaboration with Pepscan Therapuetics (Netherlands) in November 2009 to use its constrained peptide technology for the development of new therapeutics. In 2010 Bicycle Therapeutics signed a License agreement with the Ecole Polytechnique Federale de Lausanne (EPFL) in Lausanne, Switzerland and secured additional seed funding from SR One, the independent corporate venture fund of GlaxoSmithKline, and SV Life Sciences.
www.bicycletherapeutics.com

Activiomics Ltd: Formed in 2010 provides a mass spectrometry based phosphoproteomics service to industry and has in house programs for biomarker discovery and validation. The company's scientific founders are Dr Pedro Cutillas and Professor Bart Vanhaesebroeck from QMUL. Professor Vanhaesebroeck is a world leading expert in PI3K signalling (a major disease target in oncology and inflammatory diseases) and has MRC funding. Dr Cutillas is an expert in quantitative mass spectrometry and conceived the technology that is the basis of

Activiomics. In 2010 Activiomics secured agreements with UCB and GSK to apply its technology to identify new drug targets. In 2011 Activiomics secured investment from the IP group Plc.
www.activiomics.com

Oxford Nanopore Technologies: Formed in 2005 to develop a disruptive, proprietary technology platform for the label-free analysis of single molecules. The company was founded by Professor Hagan Bayley, who is currently Professor of Chemical Biology at the University of Oxford, in partnership with IP Group Plc. Professor Bayley is MRC funded and the company supports a number of postdoctoral workers in Professor Bayley's laboratory. Until May 2008, the company was named Oxford NanoLabs Ltd. In 2011 the Company announced it had raised a further £25 million from issuing shares to existing investors, the latest in six rounds of funding that has raised a total of £75 million. The funding will be used to develop the company's technology for nanopore DNA sequencing, protein analysis and solid-state nanopore research.
www.nanoporetech.com

Novacem, company developing a new carbon-negative cement, spun out of Imperial College London. EPSRC funding has played a key role in developing both the cement itself and the manufacturing process via a PhD studentship, Follow-On Fund award (with the London Development Agency) and latterly two industrial research grants jointly with the TSB. The cement absorbs CO_2 from the atmosphere during manufacture.[126] Novacem is still in the development stage but has partnerships with the biggest cement companies in the world (including Laing O'Rourke, Lafarge and Rio Tinto)[127] and believes that within 20 years, 25% of the world's cement needs could be based on Novacem technology. It currently employs over a dozen people, has a prototype plant that can produce five tonnes per annum and is developing a facility that can produce 200 tonnes per annum. Likely demand means that, in time, Novacem will have to licence its technology for manufacture all over the world. In 2012 Novacem is on the Global Cleantech 100 for the second year running. It was a World Economic Forum Technology Pioneer for 2011 and featured on MIT Technology Review's list of the 10 most important emerging technologies for 2010. It was also a Wall Street Journal Technology Innovation winner and a Bloomberg New Energy Pioneer for 2010.

Energy efficient lighting—with long-term EPSRC sponsorship, the teams of Professor Sir Colin Humphreys (Cambridge University) and Professor Philip Dawson (Manchester University) have been developing gallium nitride (GaN) for use in light emitting diodes (LEDs) suitable for solid-state lighting (savings of $20 billion for US/£3 billion for UK p.a. predicted)[128] and other applications. The groups have collaborated with businesses across the lighting industry and its supply chain.[129] For example, SMEs like Forge Europa have grown by over 100% in a three year period and PhotonStarLED, founded in 2007, is enjoying phenomenal growth,[130] from 5 employees three years ago to around 90 now. Professor Humphreys' research group has helped AIXTRON to achieve sales of over £800 million in 2010 alone via collaboration on systems for growing GaN-based LEDs and a new division of Plymouth based Plessey will utilise the Cambridge Group's technology to grow GaN on silicon, rather than costly sapphire, in a bid to drastically reduce the cost of making LEDs for lighting in offices and homes.

Written evidence submitted by Rolls-Royce

Introduction

Rolls-Royce welcomes the opportunity to submit evidence to the Committee's inquiry. As one of the leading engineering and high-technology manufacturing companies in the UK, we have significant experience in pulling through innovative new technology into high value products and services. This experience has taught us that to pull through technology and to compete effectively in a global industry requires partnerships with our suppliers, academia and government.

"The Valley of Death"

NASA introduced the concept of Technology Readiness Levels (TRL), which became a lingua franca across many of the sectors and industries Rolls-Royce is involved in. TRL describes the progression of technology from the bright idea (TRL1) through scientific investigation (TRL2–3) to laboratory scale testing (TRL4), large scale rig testing (TRL5), full scale system demonstration (TRL6), flight or in service test (TRL7), product development and prototyping (TRL8) to mature product in service (TRL9). The scale is useful, and in Rolls-Royce R&T programmes go through a rigorous gate review as they pass from one TRL to the next. The programme cannot continue to the next (usually more expensive) level without a successful pass at the previous level. In most of the sectors Rolls-Royce is involved in, this progression takes many years. For a novel material, the journey from laboratory formulation to flying engine component can take 20 years.

[126] –0.11 tonnes of CO2 is produced manufacturing one tonne of Novacem cement—compared with 0.8 tonnes for one tonne of Portland cement.
[127] www.smithsonianmag.com/science-nature/Building-a-Better-World-With-Green-Cement.html?c=y&page=1
[128] US DoE Report 2010 "Energy Savings Potential of Solid-State Lighting in General Illumination. Applications 2010–30".
[129] UK Parliamentary Office of Science and Technology, POST Note 351, Lighting Technology, January 2010.
[130] Its award winning colour tuneable LED product ChromaWhite has recently been nominated as part of Vince Cable's Made by Britain project.

The valley of death can be expressed in TRL terms. It normally reflects the difficulty of getting a new technology through TRLs 4 to 7. In this area the investment required is high, but the certainty of success remains low. In many of the sectors Rolls-Royce operates in, the valley of death is deepened and widened by the long timescales referred to above and the safety-critical nature of many of the applications. As we look around the world, we see that bridging the valley of death in sectors we operate in almost always requires some degree of Government intervention, or partnership. Companies and countries that do not offer such mechanisms can be at a severe competitive disadvantage.

Manufacturing Capability Readiness Level (MCRL)

A focus on technology readiness alone is not sufficient to bring a technology to market. In parallel, a manufacturing process must be developed and matured so that the product can be manufactured economically, in volume and with consistent quality. In order to put some structure into this process, Rolls-Royce has developed a set of Manufacturing Capability Readiness Levels (MCRLs), also on a nine-point scale. MCRL 1–4 represent the conception and assessment of the manufacturing technology. MCRL 5 and 6 are the critical "pre-production" phase, where expensive full-scale equipment and processes must be used, but ahead of product launch, or factory investment. MCRL 7, 8 and 9 implements the process on the shop floor and confirms volume production with assured quality. Again, there is a valley of death around MCRL 4 to 6, where investment is high, but there is no certainty that the product will be launched, or that the proposed process will be successful.

TRL and MCRL must be managed together. Letting MCRL get too far ahead means wasted investment if the technology is not eventually proven. Letting TRL get too far ahead means delayed entry to the market, or worse, launch of a product with low quality and unduly high cost.

The Rolls-Royce Research Model

Rolls-Royce develops its technologies through close collaboration with Universities through its University Technology Centres (of which there are 19 in the UK across 14 Universities). A consequence of this approach is that the Universities must be prepared to take the technology to higher TRLs (3–4) before it is brought into the Company for large-scale rig testing and demonstration. We have found our UTCs willing to do this and the Universities willing to invest in the larger scale facilities required.

A second leg of the model addresses MCRL. Again, working with Universities in partnership with other Companies, we have created a series of Advanced Manufacturing Research Centres, jointly termed AxRCs, where full-scale development and maturation of manufacturing processes for novel products, or using novel manufacturing technologies, can be achieved before bringing the capabilty to the shop floor.

1. *What are the difficulties of funding the commercialisation of research, and how can they be overcome?*

1.1 The prime difficulty is to provide the correct funding profile so that as certainty of the technology increases (TRL), the investment can be ramped up. High investment too early brings a risk of wasting money. Inadequate investment though the critical TRL 4–7 levels and the technology will never emerge from the valley of death.

1.2 In sectors with long technology maturation timescales, such as those in which Rolls-Royce operates, normal investment mechanisms are inadequate to provide this financial support. The risk/reward profile is not one that most financial investors would accept.

1.3 Continuity of funding over long periods of time is essential. It cannot be turned on and off due to external pressures.

1.4 A company will attract shareholders who understand this process and are not in the game for quick returns, but are willing to see their investment in a technologically-based company grow as technology levels in products are increased.

1.5 In most of the sectors Rolls-Royce operates in there is a need for and evidence of Government support as technology is brought to market. Where this support is inadequate, or not available, there is a risk of severe competitive disadvantage.

1.5.1 Rolls-Royce invested over £900 million in R&D in 2011. Only half of this from shareholder funds, the remainder from Governments and external partners.

1.5.2 In the UK, support from the MoD for defence-related R&D within the Company has fallen significantly over the past 20 years. In 2011 it was less than 20% (in real terms) of the investment in 1990. In the USA, defence-related R&D support remains strong, despite recent cut-backs.

1.6. The TSB has developed efficient mechanisms for supporting collaborative research. Their funding, at just over £300 million per annum is, however, inadequate for the task in hand.

1.6.1 The Government is spending over £3.5 billion on low TRL research, and cannot hope to adequately capture the benefits from this investment when spending so little on support through the valley of death.

1.6.2 A recent TSB call for manufacturing technology was oversubscribed 20 times, despite having £24 million available, showing the appetite in the UK for technology pull-through.

1.6.3 An area for improvement in the TSB mechanism is that it relies on a series of technology-focused calls. We understand the need to focus resources, but recommend improving the long term visibility of subject areas to improve planning and industrial alignment.

1.7 One novel funding mechanism and model in the UK was the formation the Energy Technologies Institute (ETI) and is a consortium of six industrial partners (up to 10 are envisaged). Each company pledges up to £5 million each year, with this sum being matched by Government. The Government's investment is managed by the TSB. Over the 10 year life of the programme up to £1 billion can be invested in maturing promising energy-related technologies.

1.7.1 One great advantage of the ETI model is that because the funding is "pre-geared" grants up to 100% can be provided to promising projects without tripping over EC funding rules. The model has proved very successful and responsive.

1.7.2 One example is the ReDAPT (Reliable Data Acquisition Platform For Tidal) project which is allowing Rolls-Royce with its research partners to build and deploy a full-size tidal-stream turbine of the Orkneys.

1.7.3 The same model might be applied to other focused technology maturation areas. We would suggest consideration be given to technology institutes in (for example) nuclear technology, advanced electrical machines, cyber defence and mass transportation.

1.8. The AxRCs have had no single, consistent funding source or model. They have been pieced together with support from the RDAs, TSB, EPSRC and their industrial partners/subscribers. The RDAs have been particularly useful in providing underpinning capital investment for machine-tools and infrastructure.

1.8.1 The high value manufacturing Catapult (see 1.9), may bring some stability and long-term assurance to the funding for infrastructure and under-pinning capability growth and expansion.

1.9 The recent launch by the Government of Catapults (Technology Innovation Centres) is welcomed. This model envisages a funding stream coming one third from an underpinning, long-term Government grant, one third from industrial members and one third through the collaborative bidding by the Catapult and its industrial partners being successful in other funding competitions, creating an overall 50/50 public private funding model.

1.9.1 The first Catapult is focused on high value manufacturing. It provides the underpinning support (especially capital and infrastructure investment) for a network of seven advanced manufacturing centres around the UK.

1.10 The abolition of the RDAs has removed an important source of localised funding for innovation and technology pull-through. The RDAs were particularly useful in being able to support the capital elements of R&D programmes, but often found it difficult to provide revenue support. Combining industrial partner money, TSB funding, research council money and RDA support in individual programmes was complex, but proved to be successful.

1.10.1 Under the National Aerospace Technology Strategy, the aerospace industry developed a relatively efficient mechanism for coordinating all of this.

1.10.2 The Rolls-Royce led Environmentally Friendly Engine programme (EFE) is a £125 million programme which enjoyed support from four RDAs, the TSB and industrial partners. It was able to equip a test-bed in Bristol and enable several builds of a full-scale, Trent engine core to prove novel combustion and high-temperature component technologies which will reduce the impact of aviation on the environment.

1.10.3 On a smaller scale, the relocation of the QinetiQ light piston tunnel for turbine blade aerodynamic testing from their site in Farnborough was achieved with support from SEEDA, Oxford University, Rolls-Royce and the TSB. This has provided Oxford University with a vital facility for TRL4–5 work.

1.10.4 Whilst we are not advocating the re-establishment of RDAs, a mechanism for fast-access to funding for capital-intensive R&D would help maintain key capabilities in the UK.

1.11 Our overseas competitors benefit significantly from access to rigs and facilities in National research centres which are funded and maintained at the state-of-the art out of the public purse (eg NASA in the USA, DLR in Germany, ONERA in France). In the UK, such facilities have largely been privatised. It is no surprise then that many of these facilities have been, or are being closed as they cannot be maintained as a commercial operation, or else face under-investment so that they become uncompetitive. Such facilities are essential to take technology through the TRLs 4, 5 and 6. Below are some examples:

1.11.1 The UK no long has an engine altitude test facility

1.11.2 The Noise Research Centre in QinetiQ is under repeated threat of closure.

1.11.3 The Aircraft Research Association in Bedford finds it difficult to raise the level of investment needed to modernise its facilities.

1.12 In the EC Framework 7 programme a new instrument was introduced, specifically focused on large-scale technology demonstration, the JTI (Joint Technology Initiative). In aerospace, a JTI called Clean Sky was formed. It has €1.6 billion available, with half of this coming from industry, and half from the EC.

1.12.1 The JTI is managed by its twelve founding industrial members, of which Rolls-Royce is one. 75% of the programme budget goes directly to these prime industrial members and their associates, with the remaining 25% being released through open calls managed by the industrial consortium.

1.12.2 The programme is committed for seven years, giving long term stability, but allowing flexibility to change shape and direction of the programmes as market needs and technology developments might dictate.

1.12.3 A similar mechanism at a National level in the UK should be considered.

1.13 The EPSRC is an essential part of the technology maturation pipeline. With its increased focus on "impact" of research and ability to co-fund university research activities with the TSB, or in direct partnership with companies, it provides a significant stimulus to taking technology through TRL 3 and 4. Improved focus on EPSRC funded Centres for Innovative Manufacturing (CIM's) is welcomed, however, we would recommend better alignment to the AxRC's and the development of a requirement led framework based on a gap analysis rather than open bidding process.

2. *Are there specific science and engineering sectors where it is particularly difficult to commercialise research? Are there common difficulties and common solutions across sectors?*

2.1 The valley of death gets deeper and wider as the timescales for technology maturation in a particular sector increase. In fast-moving consumer electronics, technology can be brought to market relatively quickly and normal investment mechanisms can apply. In sectors like aerospace, with stringent safety requirements and the need for rigorous, large-scale, system-level demonstration; or pharmaceuticals, with its need for lengthy clinical trials, the investment and return horizons do not favour conventional funding mechanisms.

2.2 Venture capitalists will normally be looking for a return in three to five years. They will tend to find aerospace and energy technologies unattractive for such investment.

2.3 The most extreme investment return sector for Rolls-Royce is nuclear where it is not unusual for a new technology or design to take 30 years to make it into service. This sector has always seen the need for significant Government intervention.

2.4 Each sector is different. One common theme is the increasing use of computer simulation, rather than physical testing, to reduce the cost and time-to-market across most sectors. Access to major computational infrastructure by Companies as well as Universities is essential. (see 5.4)

2.4.1 We welcome the increased investment in e-infrastructure in the Government's "Innovation and Research Strategy for Growth". However, unless companies have adequate access to this at affordable rates, it will not drive the innovation required.

3. *What, if any, examples are there of UK-based research having to be transferred outside the UK for commercialisation? Why did this occur?*

3.1 Rolls-Royce has recently transferred the centre of gravity of its solid-oxide fuel-cell development to Ohio, USA because of the significant opportunities for Department of Environment investment.

3.2 Compressor and fan aerodynamic and noise testing facilities have been consolidated in Brandenburg, Germany because of the support and funding mechanisms available.

3.3 Outdoor noise-testing of large engines has been transferred to Stennis, Mississippi because of noise regulation and planning difficulties in the UK.

4. *What evidence is there that Government and Technology Strategy Board initiatives to date have improved the commercialisation of research?*

4.1 The Rolls-Royce led Environmentally Friendly Engine programme (EFE) is a £125 million programme which enjoyed support from four RDAs, the TSB and industrial partners. It is able to equip a test-bed in Bristol and enable several builds of a full-scale Trent engine core to prove novel combustion and high-temperature component technologies which will reduce the impact of aviation on the environment.

4.2 The ETI REDAPT project is allowing Rolls-Royce, with its research partners, to build and deploy a full-size tidal-stream turbine off the Orkneys.

4.3 There are numerous examples from the TSB part-funded Advanced Manufacturing Research Centre in Rotherham where novel manufacturing technology has already helped bring significant reductions in the cost of our products, thus ensuring our continued competiveness in our very price-conscious, high technology markets.

4.4 A good example is the Advanced Simulation Research Centre (ASRC) in the South West that brings together industry and academia around advanced simulation using high power computing. It benefits multiple sectors including rail, marine, aerospace and wind energy.

4.5 Significant programmes in a number of the AxRCs have been conducted or are in progress that are key to the investments in new Rolls-Royce UK factories , eg Advanced Blade Casting Facility—Rotherham, Civil Nuclear Facility—Rotherham and UK Disc Production Facility—Washington, Tyne & Wear.

5. *What impact will the Government's innovation, research and growth strategies have on bridging the valley of death?*

5.1 The Government's publication "Innovation and Research Strategy for Growth" December 2011 sets out the latest policy in this area and this document is referred to below.

5.2 Science investment needs to be supported as part of the wider innovation infrastructure, whereby research results can be efficiently brought to market. This is best done by aligning research with national strategies such as NATS (National Aerospace Technology Strategy), which has been a successful partnership between Government, Industry and Academia, transitioning research into technology demonstrators and through to products that bring economic growth, exports and sustains jobs in the UK.

5.3 The proposal from Government for more Catapults is welcomed. This model envisages a funding stream coming one third from an underpinning, long-term Government grant, one third from industrial members and one third through the collaborative bids by the Catapult and its industrial partners being successful in other funding competitions.

5.3.1 The first Catapult is focused on high-value-added manufacturing. It provides the underpinning support (especially capital and infrastructure investment) for a network of seven advanced manufacturing centres around the UK. However, there is concern that the funding model is now shifting away from capability growth and towards capability maintenance. We strongly believe this shift towards revenue-based funding will reduce ambition and stifle growth.

5.3.2 Offshore Renewable Energy is another area where a Catapult has recently been announced and is well matched to the UK capabilities and resources.

5.3.3 The Catapults have, as part of their inspiration, the German Fraunhofer institutes. However, we must not be under any delusion that we are going to emulate this system. Total direct funding for Catapults at £200m over the next five years, even when geared by the third/third/third model, pales into insignificance when compared to the €1.6 billion annual turnover of the Fraunhofer network.

5.4 We welcome the Government's increased investment in e-infrastructure of £158 million.

5.4.1 Companies must have adequate access to this at affordable rates, or it will not drive the innovation required.

5.4.2 Even this funding will not put the UK in the world top 20 in supercomputing.

5.5 The return of "Smart" grants for SMEs is welcomed.

5.5.1 The document, however, perpetuates the myth that all/most innovation originates from SMEs. Large companies have a significant role to play in innovation in the UK. Very few SMEs and inventors have a direct route to market. Their technology must be integrated and proven as part of a bigger system (normally provided by a large company) before it can be taken to market.

5.5.2 Large-scale technology demonstrators enable elements of the supply chain, including SMEs and universities, to come together in order to integrate and demonstrate technologies at the systems level. They allow fair, transparent and mutual partnership; SMEs develop their technologies quicker, gain exposure through showcasing their capabilities and assimilate invaluable knowledge; systems integrators are able to integrate those into products that meet market demand.

5.5.3 US Small Business Innovation Grants recognise this and allow the SME to use part of the grant with a larger company for system-level verification.

5.6 The Government policy document pledges £25 million for "large-scale demonstration" without any further explanation as to its application.

5.6.1 From our experience, large scale demonstrator programmes require funding a scale of which is greater than this amount of funding. The already-mentioned EFE technology demonstrator will cost around £125 million, for a single demonstrator.

5.7 The Universities receive too little attention in the policy document given that they are a key part of the UK's innovation landscape. Close working between Rolls-Royce and its UTCs is essential to delivering proven technology.

5.7.1 We await with interest the report BIS commissioned from Sir Tim Wilson on University/ Industry interaction which should recommend the policy context to redress the balance.

5.8 The role of the EPSRC in funding research and partnering with industry to focus on impact of research is also understated.

5.8.1 The Strategy seems almost apologetic about the EPSRC's recent statements on "Shaping Capabilities". The focus on research with real impact and areas UK industry has the proven capability to exploit and access to growing global markets in order to contribute to growth is essential. This is particularly true against a budget which is decreasing in real terms despite bold statements on ring-fencing science and engineering.

5.9 Proposals in the document for increasingly "Open Data" must be implemented with great care. If such proposals help all companies access the mass of data in the public domain more effectively and free up Government-owned data for easier access, they are to be welcomed. However, if they make it easier for our overseas competitors to access and exploit the research base in the UK, especially those elements where UK companies, like our own, have made a significant contributions, then, far from promoting growth in the UK, they could be severely damaging our competiveness.

5.10 The EU "Horizon 2020" (Framework 8) proposal will go to the Council of Minsters for approval this year. The document promises full engagement of UK business in the programme, which is welcomed. We need, before then, to endorse the significantly-increased budget and ensure that the topic areas chosen for research funding reflects those where the UK industrial base has a proven track-record to develop and exploit.

5.10.1 The perpetuation of the new JTI mechanisms in the Horizon 2020, especially the Clean Sky programme, is seen as essential for encouraging collaborative research at TRL 5, 6 and 7.

5.11 The document lists the selection of three key emerging technologies: "synthetic biology, energy efficient computing and energy harvesting", seems narrow and idiosyncratic. No explanation is provided as to why these three were selected. Nor is it obvious they meet the test of a UK industrial base well-positioned for exploitation.

6. *Should the UK seek to encourage more private equity investment (including venture capital and angel investment) into science and engineering sectors and if so, how can this be achieved?*

6.1 Cuts in public funding for research give the private-sector less confidence to invest its own money, or drive it to consider such investment overseas, where Government's support and incentives for such investment are stronger. This will ultimately hurt UK economic growth, exports and jobs.

6.2 If mechanisms can be found to encourage private equity investment in science and technology with longer term gestation periods, then this will be welcomed. A radical view of the necessary tax incentives will be required, along with a stimulus package to initiate private investment.

7. *What other types of investment or support should the Government develop?*

7.1 The Government should consider whether a funding mechanism and governance structure like the Clean Sky JTI might be applicable at a national level for sectors where there is a strong UK supply chain to benefit.

7.2 Government should consider whether the successful ETI model and governance structure could be extended to other sectors beyond sustainable energy.

7.3 Government should take an urgent and radical view of the UK nuclear power generation industrial sector to consider how to create wealth from investment in the next generation of reactor technology and associated fuel cycle. This has the opportunity to stimulate both a significant export industry and more rapidly meet climate change targets. We welcome the announcement that the Government will publish a long-term strategy and R&D roadmap for civil nuclear.

7.4 Government should look to stop the further decline in S&T funding in the MoD. Among major developed nations with significant defence industries, the UK alone considers its defence S&T to be simply a cost rather than a national wealth creation opportunity. We believe that this area deserves significant review.

7.5 Government should ensure that the capital support for collaborative research programmes, previously provided by the RDAs is replaced by some other mechanism.

7.5.1 The Catapults are doing this within their individual scopes, but a broader mechanism, possibly through TSB need to be supported.

7.6 Government needs to support test equipment and test infrastructure (eg wind tunnels) which are vital to UK business, but which are unable to be operated and invested in to keep them at the state-of-the-art status purely on a commercial basis.

7.6.1 Our competitors enjoy access to such facilities embedded within publicly funded National research centres.

7.7 Tax credits need to be converted in to a real cash benefits to assist those less-profitable companies that cannot directly benefit from the tax credit in the near term.

February 2012

Written evidence submitted by Dr. Andy Richards, Biotech Entrepreneur and Business Angel

Dr Andy Richards is a serial Biotechnology entrepreneur and business angel. He is currently Chairman of Altacor, Novacta, Abcodia and Ixico and is a director of Arecor, Summit Corp plc, PsychologyOn-line, Cancer Research Technology (commercial arm of CR-UK) and Babraham Bioscience Technology.

Dr Richards spent his early career with ICI (now AstraZeneca) and with PA Technology. He was a founder of Chiroscience and an executive director through to the sale to Celltech in 1999. Since that time he has invested in and helped to found more than 20 UK based biotechnology and healthcare companies including Chiroscience, Arakis, Vectura, Geneservice, Biowisdom and Cambridge Biotechnology Ltd.

He is a council member of the Biotechnology and Biological Sciences Research Council (BBSRC), a Trustee of the British Science Association, a founder member of the Cambridge Angels, and an advisor to both Vectura plc, and several Venture Capital Funds.

This submission is being made by Dr Richards in his personal capacity as a business angel and investor and is not a submission made by any of the companies of which he is an investor or a director or the organisations that he is associated with.

BACKGROUND TO RESPONSE

1. This submission is made, based on experience as an active angel investor, a founder and board member of both public and private SMEs and an advisor to both technology transfer organisations and venture capital funds. This experience is mostly in the life sciences and healthcare arena.

2. The financing environment for the commercialisation of science and technology projects and the financing of science and technology start-ups is constantly changing. It has been termed "the financing continuum" but is rarely a continuum and at any one time there are gaps making it difficult to finance certain sorts of companies, businesses models or technologies. It is assumed that these gaps are the subject of the "valley of death" enquiry. The funding environment is not as negative as is often portrayed and recent announcements of a series of new life-science funds targeting the UK are consistent with a healthier outlook.

1. *What are the difficulties of funding the commercialisation of research and how can they be overcome?*

3. The strong research base in the UK, combined with a more vibrant and active community interested in the commercialisation of science and technology has resulted in an increasing number of commercialisable projects, technologies and companies. This community is made up of entrepreneurs interested in science and technology, academics who are becoming more entrepreneurial, industrial scientists who are leaving large companies as those companies either downsize or move to an open innovation model and an increasingly professional set of technology transfer organisations. Whilst there are more and diverse sources of financing than are generally recognised, this level of commercialisable opportunity still results in a supply and demand problem such that many promising projects and companies are finance limited.

4. It is important to recognise that by no means all technology capable of being commercialised is spun out from the academic base. In my experience an increasing number (probably the majority) of UK quality investible opportunities are being initiated by entrepreneurs with a specific business in mind who then seek out appropriate intellectual property/technology from industry or academia, and very often from international sources. This is an important and positive development; as such entities when founded by experienced entrepreneurs have a higher success rate.

5. The financing environment has changed significantly from a traditional business school view of a seed financing followed by Series A, B & C venture capital financings followed by a likely IPO. If this model ever dominated it has now broken down for certain and companies/ventures are rarely set up with a view to following this financing path. In addition there is a much greater diversity of sources of private financing than are recognised. Classic venture capital only accounts for a proportion (almost certainly a minority) of investment. Important sources of investment now include corporate venture capital (CVCs) angel and high net worth individual investment, publicly quoted investment companies (eg Imperial innovations and IP Group etc.). Data on this breadth of investment sources are rarely collated effectively and this alongside a fashion by venture capital for stealth investments means that the statistics of private and venture investment levels in science and technology companies are significantly under estimated.

6. On the public markets (LSE and AIM) investment levels are easier to track and whilst there are some successful UK quoted companies (eg Shire, BTG, Abcam, and Vectura), many of the UKs more promising companies have been acquired and the appetite for investment in new home grown ventures (IPOs) has not been sustained. This is an important discontinuity in the financing continuum and is one reason why when companies reach a certain stage they are either sold or migrate to eg The US instead of raising further growth capital from the UK markets.

7. As the old sequential model of finance broke down, entrepreneurs and active early stage investors evolved financing models that were appropriate for the new financing environment. This has resulted in a whole series of resilient capital efficient often virtual companies or businesses based on "soft start" financing and early revenues rather than intensive venture investment in R&D.

8. There are now several somewhat disconnected investor ecosystems A), angel and small funds investing in capital efficient businesses aimed at early revenues B), larger venture funds backing businesses often created in stealth mode aimed at early trade sales whilst avoiding multiple financings and C), public market investors funding companies which when successful get acquired without replenishment from new IPOs. The lack of communication and transfer between these investor silos is a barrier to growth.

2. *Are there specific science and engineering sectors where it is particularly difficult to commercialise research. Are there common difficulties and common solutions across these sectors?*

9. A number of technology areas typified by medical technologies and therapeutics, but including others as well have characteristics that make gaining sufficient investment a challenge when the financing environment is unfavourable, these have all or some of the follow characteristics:

- — High technical risk and uncertainty eg drug discovery or therapeutic development.
- — The need for a strong intellectual property position (both established patents to protect, as well as access to patents to gain "freedom to operate").
- — A heavily regulated value chain eg medical.
- — High development costs or technical proof of principle that occurs late in development.
- — When there is no early potential of revenues particularly where the value chain is dominated by a small number of big customers eg energy, pharmaceuticals or healthcare systems.
- — A proposition that requires global market access to achieve a return on investment.

10. Alongside new medicines and medical technologies in other areas where higher financing levels are critical for commercialisation include novel materials, new forms of energy generation etc.

11. Gaining investment for new ventures can be particularly difficult when there is no established financing community in that sector or where interested investors are diffuse and are poorly connected. Such sectors in the UK include novel foods and agricultural biotechnology and certain aspects of bioenergy. These more challenging ecosystems are hampered further when there is a lack of entrepreneurs with experience of that sector.

3. *What if any examples are there of a UK based research having to be transferred outside the UK for commercialisation? Why did this occur?*

12. There are numerous examples of where UK based research has been transferred outside the UK for commercialisation. Good examples would be the Solexa DNA sequencing technology which was migrated to the US and then commercialised by Illumina. Antibody success stories which originated in the UK provide further examples. Leading antibody products originated in the UK which were all commercialised by non UK corporates include Humira now the world's leading selling drug marketed by Abbot; Campath launched by Genzyme (now Sanofi) and Cimzia commercialised by UCB. In addition, the leading early UK companies in antibodies Celltech and Cambridge Antibody technology (CAT), whilst having successfully achieved IPO's on LSE were both acquired by larger pharmaceutical companies before products could be launched.

13. It is typical in sectors with long development cycles, such as in new medicines, for technologies or products to be passed through multiple companies before they reach the market. (Campath is an excellent example). Products or technologies (or in many cases companies) are acquired by or licensed to a succession of companies with a greater access to finance and a greater market presence. At times the London stock markets (LSE and AIM) have been less supportive of aggressive growth propositions than the US Nasdaq (and some other European exchanges) thereby restricting the growth and financing options for UK companies. Consequently companies have often been sold early in the UK.

14. This passing on from one company to the next in the value chain until a product reaches the market is typical. Each transaction in itself can be seen as a commercialisation event even through a product has not reached the market. This should not always be looked on in a negative light providing that capital, technology, expertise and people are recycled back in to the sector. The antibody example is again useful here where the next generation of antibody companies Domantis (already sold to GSK) Pangenetics (already sold to Abbot), Kymab, Bicycle and Crescendo, all having been spawned in one way or another from the earlier successes/ ventures.

15. In addition to financing barriers, the other main reason for transferring research outside of the UK for commercialisation is to access more receptive large markets. In the medical world the uptake of innovative products in the UK is both low and late and hence the UK market is a relatively unattractive place to initiate marketing and commercialisation of a new product.

4. *What evidence is there that government and technology strategy board initiatives to date have improved the commercialisation of research?*

16. Continued strong support by government for the science base is a key aspect that must be maintained. The strength of the science base in providing skilled scientists, scientifically literate entrepreneurs and technologies to be commercialised are at the heart of the opportunity. In the medical and therapeutic fields

ensuring that this extends into an innovative culture of translation with the NHS is a challenge but a prize worth fighting for.

17. Government driven incentives such as R&D tax credits have had a sustained impact and the recent introduction of "patent box" incentives should be significant. Refinements to both of these would be welcome.

18. Mechanisms to encourage and support private investment such as the EIS scheme have provided an important stimulus particularly to the angel community and this has helped the start-up phases of businesses as well as the growth phases of those with relatively capital efficient business models. Further refinements to EIS, such as the recently announced Seed Enterprise Investment Scheme, and moves to ensure that EIS is targeted towards real growth companies and not "investment schemes" that just exploit the tax benefits are also welcome.

19. The TSB (Technology Strategy Board) is an important body set up to engage with applied technology and commercialisation. The existence of such an organisation is very positive, however, its strong established links to the engineering community has often made it seem less orientated towards the life sciences where its criteria of "close to market" innovation is often less appropriate for life sciences. In this latter area it may be useful to consider innovations that are "close to commercialisation" where commercialisation is some form of transaction.

20. In relation to the TSB's SBRI scheme in the medical field, this should also be re-evaluated given the challenges of innovation within the NHS.

21. It is too early to say whether Catapult Centres are being effectively implemented and the Biomedical Catalyst fund will be a key test for both the TSB and MRC.

5. *What impact will the Government's innovation and growth strategies have on bridging the valley of death?*

22. The Government has established a series of promising initiatives that should maintain positive momentum in the growth of innovation particularly in the life science sector.

23. Government initiatives to encourage funding and investment are particularly important and should be used to leverage other sources of investment from either inside the UK or from venture investors outside of the UK. The Biomedical Catalyst fund will have a key role in achieving this and it is hoped an effective process can be established between the TSB and MRC to ensure that the fund works for quality fast growing companies at the time when they need it, and without too much bureaucracy.

24. Government initiatives to encourage more innovation within the NHS and early uptake of innovations within the NHS could make a very significant difference to both time to market in the UK and the invest ability of UK R&D initiatives pushing forward with the "early access key" is therefore very important.

6. *Should the UK seek to encourage more private equity investment including venture capital and angel investment into Science and engineering sector and if so how can this be achieved?*

25. The UK Government should be strongly encouraged to seek more private equity investment into UK science and technology ventures, and whilst there is funding available the UK sector is still "innovation rich and funding poor" with too many of our quality ventures being constrained by limited financing. In addition, uncertainty in the financing environment encourages cautious behaviour amongst entrepreneurs and company directors who build smaller, more virtual, capital constrained companies and exit these by trade sale at any earlier stage. A more vibrant financing continuum with fewer gaps would encourage the growth of bigger more sustainable technology companies.

26. In encouraging more private investment from within the UK it is important not to just focus on traditional venture capital funds and to ensure that a diversity of financing sources is available and stimulated. This should include angel financing through enhancements to the EIS scheme and mechanisms to support "soft start" companies.

27. Private investment into the UK from funds outside the UK is also be encouraged and here there is an important role for UKTI to target potential investors and provide them with a compelling story along with clear case examples of how investment in the UK can provide superior returns. Specific investor classes should be targeted and in the first instance corporate venture capital funds (CVCs) who are already dominating the early stage life science investment environment and internationalising US VC funds that have started searching out investments in Europe should be an initial priority.

7. *What other types of investment support should the covenant develop?*

28. The relative lack of enthusiasm from public market investors for home grown UK science and technology based growth companies is a challenge that needs careful evaluation. A situation where high quality companies once more consider an IPO as a viable route alongside a potential trade sale exit would be a healthy development.

April 2012

Written evidence submitted by Dr D J Tapolczay CEO, MRC Technology

MRC Technology (www.mrctechnology.org) is a technology transfer company responsible for adding commercial value to cutting edge scientific discoveries through strategic patent protection, creative licensing of intellectual property (IP), partnered research or further scientific development.

As well as offering technology transfer services to the UK's Medical Research Council the Company has recently broadened its activity to include helping other charitable and academic organisations (such as AICR) with IP management and commercial development of healthcare-related science, thus bringing valuable income back to the organisations to help fund further research.

QUESTIONS PROVIDED BY THE COMMITTEE

1. *What are the difficulties of funding the commercialisation of research, and how can they be overcome?*

There are numerous difficulties associated with funding the commercialisation of research. Some of the hardest questions that must be addressed first are what research is worth commercialising and what are the benefits or what is the return on investment that would make funding of the commercialisation worthwhile? The answers to these are frequently dependent on the type or mechanism of funding to be used. Venture Capital or angel funding is clearly looking for a straightforward financial return on the investment whereas state funding or funding from charitable sources will be predominantly interested in societal benefits such as job creation or benefit to the population or sectors of the population. In order to be successful in securing the necessary funding it is critical to address the specifics of the return on investment and make sure that they are appropriate to the source of the funds.

Some very exciting basic research may not have a clear or obvious path to commercialisation or the return on investment proposition may not be clear. In these cases there is often a need for an "act of faith" investment in carrying out a clearly defined small programme of work to evaluate the "feasibility" of commercialisation. This type of funding is extremely difficult to find in the UK. Unless there is access to this type of funding some of the most exciting commercial opportunities may fail to be exploited in the UK. One example of this type of funding is the MRC Technology development gap fund (funded by the MRC but managed by MRC Technology Ltd) which funds very early stage commercial validation of MRC funded research programmes. This and the MRC development pathway funding scheme DPFS are already proving very successful in the biomedical field. However the scale of the funding is still limited and can only fund a fraction of the science worthy of exploring the potential for commercialisation. With more funding available more could be done!

It is also important to recognise that commercialisation of research is a process that has a sequence of events associated with it and that these events all need to be adequately funded for success to be achieved. Each step along the pathway is like a link in a chain and unless the whole chain is intact the process will not complete and commercialisation will not be achieved and indeed money may well be wasted!

2. *Are there specific science and engineering sectors where it is particularly difficult to commercialise research? Are there common difficulties and common solutions across sectors?*

Life sciences or health care have specific difficulties associated with commercialisation. Firstly in the drug molecule space the costs of commercialisation are significant! These may include the capital costs associated with access to the necessary equipment and the labour costs of a highly skilled workforce. Secondly there is the time to commercial return. Most venture funds function on a five year cycle time to return yet the time for return in the pharmaceutical space is frequently much greater than eight years. As a consequence, securing venture capital has become increasingly difficult for life science companies in the last five years. There are notable exceptions such as Heptares, Bicycle Therapeutics (both MRC spin outs facilitated by MRC Technology) and Convergence (spun out of GSK) but the point is that these are "notable exceptions"!

However, I believe that the current economic situation in the UK provides a possible solution to this. There are now plenty of redundant pharmaceutical research facilities in the UK that could be exploited for translational research!

There are also a large number of highly skilled and highly trained scientists recently displaced from large pharmaceutical companies with the necessary knowledge and ability to take on the challenges of translating the output of basic research activities in the UK and even those from other nations. This opportunity, created by the current economic circumstances in the large pharmaceutical corporations, could see Britain become the innovation and translation centre for the world if a suitable mechanism for funding these activities can be found! Britain has a long and very distinguished history of innovation in this area. A survey by BIS reported that 20% of all prescription medicines on sale throughout the world can trace their origins to the UK. This is despite the fact that UK spend on pharmaceutical R and D is 1/16th that of the USA!

I believe that a generic single "fix" across all sectors will be very difficult to achieve. In fact it may be so generic that it will be difficult for each sector to see how to make it benefit. The principle of funding for translational research available to all sectors is fine but individual sectors should have funding systems tailored to their specific needs. A good example of this is the recent creation of the MRC/TSB Biomedical Catalyst for life sciences. Similarly the announcement by the Wellcome Trust of the creation of a new Venture Capital fund

is good news. It is important to remember that the creation of a fund is not the "fix" in itself. How the fund operates and its ability to select what warrants funding and on what basis (of return) will determine the degree of success achieved. There are many examples of Venture Capital funds that despite having substantial funds have failed to make an adequate return on their investments in biotech and lifesciences.

3. *What, if any, examples are there of UK-based research having to be transferred outside the UK for commercialisation? Why did this occur?*

I have personal experience of where this has happened. It may not all be totally negative but I question whether better economic return could have been achieved in the UK by continued exploitation in the UK. I was personally involved in the creation and development of two companies in the UK. Cambridge Discovery Chemistry and Cambridge Material Science were start ups in the UK that became successful profitable SME businesses in Cambridge. In July of 2000 both of these companies were acquired by Millennium Pharmaceutical Inc, a Massachusetts based biopharmaceutical company. Post the acquisition, both of these UK companies were closed and the knowledge base transferred to the US with the loss of 130 UK jobs.

MRC Technology also provides several good examples of where UK innovation can lead to economic return in the UK but where the availability of suitable funding and a greater appetite to risk could see much more substantial economic gain. MRC Technology incubates early stage research using both MRC and MRC Technology financial resources and MRC Technology physical resources (namely industry trained scientists employed by MRC Technology). In the pharmaceutical and Biopharmaceutical area, these early stage assets are taken through to early pre-clinical stage before being partnered with major pharmaceutical companies. Two such examples are the monoclonal antibody products Tysabri and Actemra. The MRC Technology income from these two products totaled approx £22 million in the 2011–12 financial year. This income is derived from a small % royalty that was negotiated by MRC Technology at the point of licensing. Had MRC Technology had the access to suitable UK funding to develop these products to clinical phase 2, the revenue stream from a deal for such Phase 2 assets would have been potentially three to six times higher. Both of these assets were licensed to US and European companies.

4. *What evidence is there that Government and Technology Strategy Board initiatives to date have improved the commercialisation of research?*

The MRC funding of MRC Technology activities provides substantial evidence of improved commercialisation of research through both the creation of new companies and hence employment in this sector in the UK (eg Celltech, Cambridge Antibody Technology, Domantis, Heptares and Bicycle Therapeutics), the commercialisation of new technologies (phage display and cdr grafting for antibodies) and new therapeutic products (eg Herceptin, Humira, Avastin, Actemra, Tysabri and Benlysta). This has generated more than £550 million in income in the UK.

MRC Technology has a triage system for analysing all new opportunities for translating basic research towards commercialisation and there are more projects that pass the triage than MRC Technology can fund using its own resources. MRC Technology are currently exploring links to other UK charities in order to identify additional sources of funding in order to take more of these projects forwards.

5. *What impact will the Government's innovation, research and growth strategies have on bridging the valley of death?*

In some respects it is too early to tell. Undoubtedly the injection of cash into translational activities will show measurable results but the more difficult question will be were these the best possible results? By this I mean look at the life science VC community as an example. Many large funds have made investments in life sciences but not all are successful; indeed some has ceased investment in this sector or at least decreased it whereas others such as Abingworth have been disproportionately successful. The creation of new funds especially from the public sector is difficult enough in the current economic circumstances but it therefore becomes even more important that they are appropriately applied!

6. *Should the UK seek to encourage more private equity investment (including venture capital and angel investment) into science and engineering sectors and if so, how can this be achieved?*

Yes without doubt this will help provide opportunities for additional exploitation of basic research here in the UK. It should be remembered however that VC funding is notnecessarily applicable across all areas of translation in the life sciences. The time to return on investment in the VC community means that VC funds are increasingly targeting later stage investments in life sciences. This means there is an increasing need for "bridging" funding to cover the gap between basic research grant funding and the later stage VC investment. Also VC investment is primarily interested in straight financial return to the fund investors, not necessarily in other societal returns such as job creation or even patient benefit in areas where there is unmet medical need but small patient populations.

The corporate venture companies of the major pharmaceutical companies are a good and, in my view, in the UK "under invested" group. The government could approach the corporate ventures arms of the major multinationals looking to get them to apply more of their funds here in the UK.

In my view it has for some time been true that there is an increasing need for public private partnership funding of translational activities. The public funding is there to look for the "societal" returns on the investments made and the private funding to maximise financial return. In this way both parties can minimise risk of exposure in a particular investment, and in doing so increase the number of opportunities funded.

7. *What other types of investment or support should the Government develop?*

The government has always been active in facilitating investment in the UK from foreign investment funds and companies. This has been very successful in many sectors. I think that there is still more to be one in the life sciences sector. As I mentioned earlier, the current situation in the UK with site closures and job losses provides a tantalising opportunity to see the UK become a global leader of translational innovation in healthcare. A new business model exists to exploit this opportunity and bring foreign investment to the UK. It should be used for the benfit of the UK before other nations see the opportunity!

April 2012

Written evidence submitted by GlaxoSmithKline (GSK)

1. Introduction to GlaxoSmithKline (GSK)

GSK is one of the world's leading research-based pharmaceutical and healthcare companies, developing and supplying medicines to improve patients' quality of life. We employ over 96,000 people in over 100 countries. Our products cover a wide range of healthcare areas: prescription medicines, vaccines, rare diseases, dermatology, and consumer healthcare, and we produce medicines that treat six major disease areas—asthma, virus control, infections, mental health, diabetes and digestive conditions. In addition, we are a leader in dermatology and we are developing new treatments for cancer and rare diseases.

GSK is the largest pharmaceutical company by value in the UK, is British-owned, and is headquartered in the UK, employing more than 14,700 people. We are the largest private sector funder of R&D in the UK, spending £1.8 billion in the UK in 2010; over 40% of our global R&D expenditure.

2. The Changing Pharmaceutical R&D Model

The pharma business model is changing—declining R&D productivity, patent expiries, increasing regulatory demands and increasing demands from payers, a shift to new technologies such as biologicals that will require new skill sets (in both R&D and manufacturing) and new technologies; this is coupled with downward price pressures, but also external opportunities, such as the ever-increasing rate of technological innovation.

This has a range of implications:

- Need to boost innovation and spread risk resulting in increasing importance of collaborations with external partners, both in industry and in academia, to access the best science and develop differentiated medicines which patients need.
- Need to find cost-savings across the business, which is driving increased efficiency in R&D, manufacturing, and in our commercial operations.
- Need to demonstrate value of our products to payers as well as healthcare professionals, and ensure that payers understand the need to balance delivering value for money in health systems with the need to value and reward medical innovation.

These developments place increasing emphasis on the importance of an effective and efficient life sciences ecosystem in the UK—from early discovery research, through clinical trials, manufacturing and commercial use once licensed—where industry flourishes, patient outcomes improve and the economy thrives.

The UK has historically been a strong environment for GSK—a world-class science base, skilled workers, a national health service that provided an opportunity for first global launches of new medicines, a strong IP framework, and an established and trusted relationship with Government.

In recent years other countries, such as Singapore and Ireland, have attracted a significant share of investment by companies such as GSK; the UK Patent Box will make a significant contribution to ensuring the UK can continue to compete to maintain and grow its share of global life sciences investment. Furthermore, the Growth Review commitment to decrease clinical trial times will have a positive impact on patient numbers recruited into clinical trials, once changes are implemented.

However, the global environment for medicines is extremely challenging and the industry is shrinking; it is likely that in 10 years, the landscape will look very different with fewer players. Part of this is the natural evolution of the industry as a response to an environment that has changed significantly; 10 years ago any medicine with regulatory approval was available to patients.

There is a still a need for new medicines for many diseases that have no treatments or where treatments could bring patient benefits. There is a wealth of good science around the globe. With 11,000 people in GSK R&D, we still only represent <1% of science and we know we cannot come up with all the good ideas.

Academia and biotechs are increasing their partnerships with larger pharmaceutical companies (and *vice versa).* Biopharmaceuticals will represent the largest type of new medicines in future.

3. How GSK has Changed its R&D Model

GSK is changing our R&D model, making it more agile, focussing our efforts in areas where the patient need is greatest and science is more fertile. This will improve our productivity and our return on investment. We have re-personalised R&D—created an entrepreneurial environment in drug discovery, pursuing the best scientific opportunities whether internal or external. We are focused on furthering our R&D efforts through externalisation in pursuit of the best science. We take a long-term, customer-driven approach to building external alliances.

We have been leading the industry in forming progressive new alliances and collaborations with biotechs and academia to further the best science that can help us deliver new medicines to patients. We are building our biopharmaceuticals s investment and research and seeking to continue investing in this area to diversify the platforms we can use to make medicines. We have made fundamental changes to how we allocated our R&D expenditure, directing it to our late stage pipeline; reducing cost and risk through externalising parts of our early-stage discovery; dismantling infrastructure; and terminating development in areas with low financial and scientific return.

Internally we have created Discovery Performance Units (DPUs) which are groups of between 5–70 empowered scientists, with each group focusing on one particular disease or pathway, or platform technology and responsible for driving discovery and development of potential new medicines through to early stage clinical trials (up to completion of Phase IIa). Externally, over the past 10 years, GSK has signed more late stage collaborations than anyone else in the industry, and about 70% of them are still active today. In fact, a large portion of our current late stage pipeline comes from these collaborations.

4. The Development of Open Innovation within GSK R&D

GSK has been active in assessing the potential of pursuing an open innovation strategy to help speed up R& D for diseases of the developing world (DDW). This includes being more flexible with our intellectual property and providing access to our know-how and resources, and sharing our data with the research community. At our DDW—focussed R&D facility in Spain (Tres Cantos) GSK has been developing an "Open-lab" concept. The open lab has space for visiting scientists from universities, not-for-profit partnerships and other research institutes to come to the site, work on projects with us, learn from our expertise and share our world-class facilities.

GSK's Academic DPU/Discovery Partnership in Academia initiative provides an opportunity for world-class academic researchers to work very closely with GSK. For example, GSK outlines assets available for collaborative partnerships with the academic group proposing innovative ideas for evaluation of their therapeutic potential or academic groups with disease and biology (target) understanding work jointly with GSK to discover new medicines, with both partners providing their key areas of expertise.

The Stevenage Bioscience Catalyst (SBC) is being developed as the first UK bioscience open innovation campus. The campus will create a unique bioscience community providing small biotech and life sciences companies and start-ups with access to the expertise, networks and scientific facilities traditionally associated with multinational pharmaceutical companies.

GSK and Wellcome Trust are founders of SBC and the phase I development opened for business in February 2012 with the completion of an incubator and accelerator building. Phase I construction was funded by GSK, EEDA, BIS, TSB, and the Wellcome Trust.

5. GSK Views on the Availability of Funding for Bioscience Companies in the UK

Funding at the early stages can either be through VCs (independent or corporate VCs) but is more often through Angel funding or the provision of grants from, eg, the Wellcome Trust or the MRC. GSK notes that VCs tend to be very selective in choosing the early companies they invest in but securing investment from a VC (independent or Corporate) usually means that the biotech will have a stronger support system and be better able to access the knowledge it needs to grow and to then be able to secure Series A and future follow-on funding. GSK understands fully the desire of VCs to focus on companies with excellent science and strong, experienced leadership.

GSK considers that funding by Business Angels and through grants can be positive. However, we suggest that early stage bioscience companies need to be encouraged to access good advice about how they structure these early financings with a view to what will be needed to raise further capital as the company develops. Otherwise they can often fail to secure follow-on funding and Angel/grant funding alone is insufficient to support anything other than very early stage companies.

GSK's Corporate Venture group SR One invests globally in emerging life science companies that are pursuing innovative science which will significantly impact medical care. SR One has a team of investment professionals, located in the US and Europe, with experience spanning basic science, industry and the market.

SR One takes an active role in its portfolio companies and works with management teams and fellow venture investors to create significant value. SR One's current portfolio includes approximately 30 private and public companies and since its founding in 1985, the fund has invested over $600m in the biotech space. SR One's expanded remit also focuses on maximizing the value of GSK technological innovation to establish new businesses and revenue opportunities across a range of industries.

In the UK, SR One has a lot of experience in seeing proposals for follow-on funding from companies that were created with Angel/grant funding where the companies have not progressed their assets or technology sufficiently to secure follow-on funding and has thus declined to invest. Many such companies seen by SR One were considered un-fundable for a number of reasons including the credibility or experience of management, an overly complicated company structure, an inflated valuation or expectation of value by founder investors or management, poor asset differentiation, a business model not well enough constructed, or the fact that the company had been in existence for some time with little progress to date. While there is undoubtedly a lot of great science in the UK, a number of elements need to come together to make a fundable company. This is one reason, along with the limited number of early stage VC investors with which to syndicate deals (see below), why investing the £50m GSK has committed to spend on UK biotechs will remain a challenge for SR One.

GSK is not in a good position to quantitatively assess the amount of funding available to the sector, but there is no doubt that there are now less VCs operating in the biotech space; the players investing in early stage opportunities have reduced from around 12 to 4–5 in the last few years. This is due to a number of issues, primarily the 2002–08 financial crises and the pressure on financing generally. There has though been some recent good news with new investors emerging including the Wellcome Trusts Sigma Fund, CRT's Pioneer Fund and the TSB/MRC's Biomedical Catalyst Fund.

However, our experience is that money follows great science, coupled with experienced leadership. SR One will invest based on the science, the heritage of the leadership in the company and the ability to pull together a syndicate of experienced investors. Experienced leaderships where the UK tends to fall short compared, for example, to the talent pool available in US biotech hubs such as Boston and San Francisco as there are still only a limited number of experienced biotech entrepreneurs in the UK.

It is worth remembering that the end customer of most biotechs is the pharmaceutical industry; a few companies do make it and grow into successful stand-alone companies but most are purchased or partner with pharma to develop and commercialise assets thus understanding how to make this model succeed is critical.

6. What would a Successful UK Life Sciences Sector Look Like?

The UK would be a true life sciences ecosystem, with trusted and collaborative partnerships between and within industry, specialist life science investors, academia and the NHS that turn cutting-edge ideas into commercial products that are used by the NHS, delivering patient benefit and contributing to UK economic growth. In particular, it would have:

- A culture within academia and within the NHS that proactively seeks engagement with industry and understands the contribution that collaboration with industry can bring to advance research, improve patient outcomes, and drive growth in the economy.
- A strong cohort of entrepreneurial academics driving forward the translation of excellent science into clinical benefit, supporting a vibrant SME sector that is able to secure sustained funding.
- A vibrant advanced manufacturing sector in life sciences, able to forge well-funded public-private partnerships to develop new technology that can then be deployed in the UK swiftly with minimal regulatory delay.
- A pricing and reimbursement environment for medicines which ensures that the NHS's need to deliver value to the taxpayer also considers the significant economic impact of the life sciences sector and the UK's potential to impact the global profitability of the sector.
- An NHS environment which embraces new technology and medicines more rapidly than other European countries, providing benefits to patients, to research and to the growth of UK-based companies.

April 2012

Written evidence submitted by Matthew Bullock

Starting a technology business without venture capital funding has been a familiar challenge in the Cambridge area since 1960s, but the Phenomenon there was and is still largely not funded by venture capital, although the periodic availability of venture capital is welcomed as additional funding for growth.

It would thus be wrong to regard the technology pathway as blocked at the outset because of a lack of venture capital funding. It is always the "first best" solution for companies if it can be raised, but the number of companies that get venture capital will always be a small minority, and too little time is spent examining the "second best" option adopted by the great majority, and whether there are steps that could be taken to improve that.

In my experience, venture capital more commonly comes in at the later stages of a company's development, building on a market and product position that has been developed more gradually along the alternative route, and then kicks the company's growth trajectory onto a higher plane.

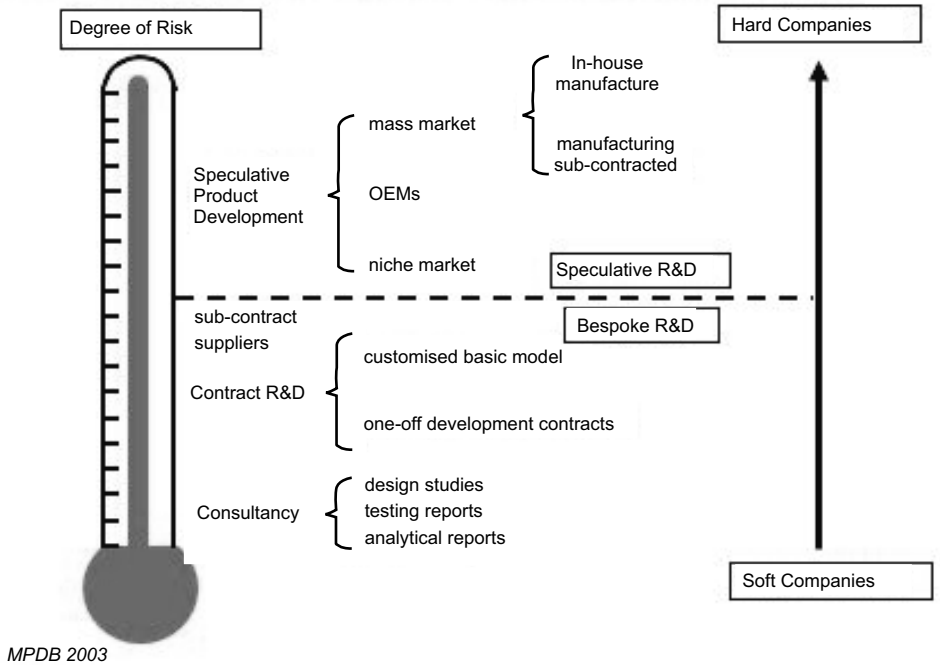
What is the alternative route and how does it come about? How is it financed? And what could policy do to improve it?

I christened this route the "Soft Company Model" in 1984, to distinguish it from the "Hard Company Model" that I saw had come to be favoured by US venture capitalists after around 40 years of predominantly soft company growth in the US.

The soft company model grows out of the nature of most technology **sales**: these predominantly involve the delivery of an intermediate industrial component or system to a large lead client—corporate, institutional or governmental; there are very few technology companies that sell to consumers, at least in the early stages. The sale is usually, therefore, based on an R&D or technical equipment contract for delivery over a period with agreed milestones, often with stage payments. It is not a sale from a catalogue, with simple payment on delivery.

The *product* is frequently quite specific to that lead client's needs and is based on the founding technologist's understanding of how to apply a broad corpus of technical expertise to a client's particular problem. This problem solving of specific issues often starts off as a consultancy service, or offering a testing or design service. The company may then build a one-off system that embodies their design skills. This can then transition to a more routinised delivery of their service, before the company reaches the point where it feels sufficiently confident from its own experience to launch a discreet product with defined features that will address most of the demand from its clients.

Relative riskiness of different forms of R&D start-up



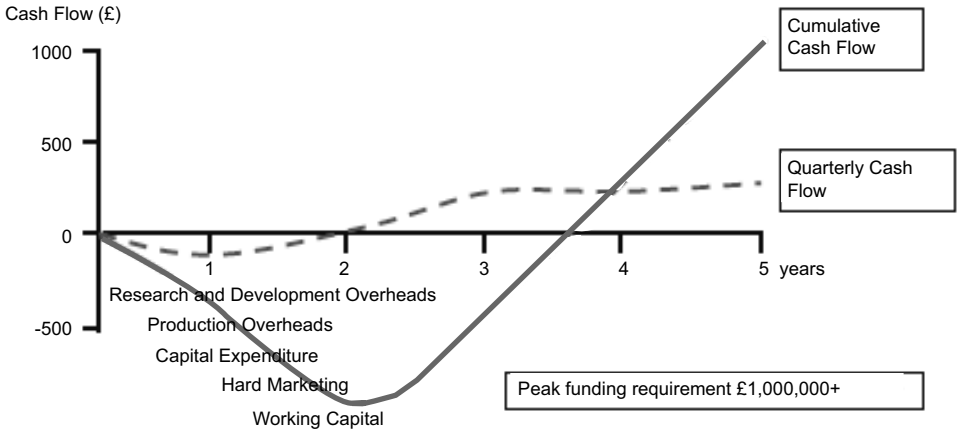
MPDB 2003

How quickly this happens depends in part on the evolution of the technology. Most initial science in a new area is quite inchoate; a lot of initial work goes into measurement and other instrumentation as the problems get more defined. In these circumstances there is a risk in rushing to "reify" issues and solutions too early; the smarter move is to place a series of lower risk bets around solving particular problems with the developing technology, than to bet that Product X is the solution to all current problems in the field.

This gradual product "Hardening Process" can take a long time to achieve: in TAP Biosystems it took us several years before we and the market were ready for standard products; in other technologies a clearly defined product need may emerge over two to three years. Hardening may also be paced by the internal development of the company: in TAP's case a great many internal changes were necessary to alter our processes appropriately after we decided to manufacture standard products, following years of designing and building customised systems.

This progressive approach also sits more comfortably with the development of the scientific entrepreneur's own personal *skills*. In my experience scientists can become better than average business people once they have applied themselves to it, but it takes time and experience to learn, even for quick learners like them, and the risks of building "softly" are much more manageable than plunging into a "hard start".

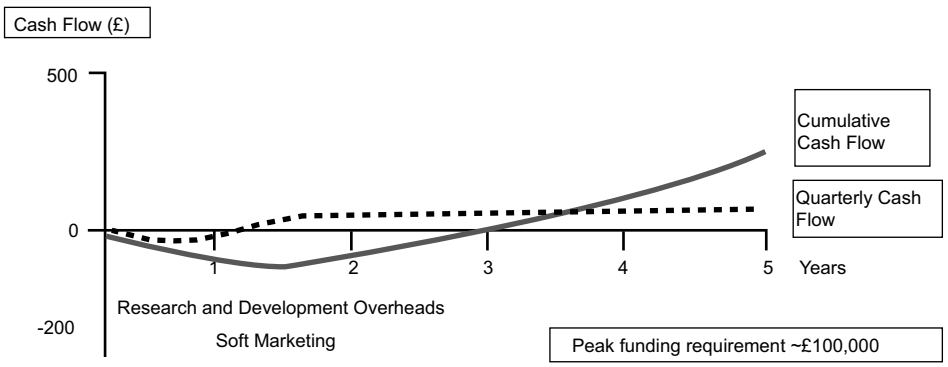
Typical cash flow profile for a Hard Company start-up



MPDB 2003

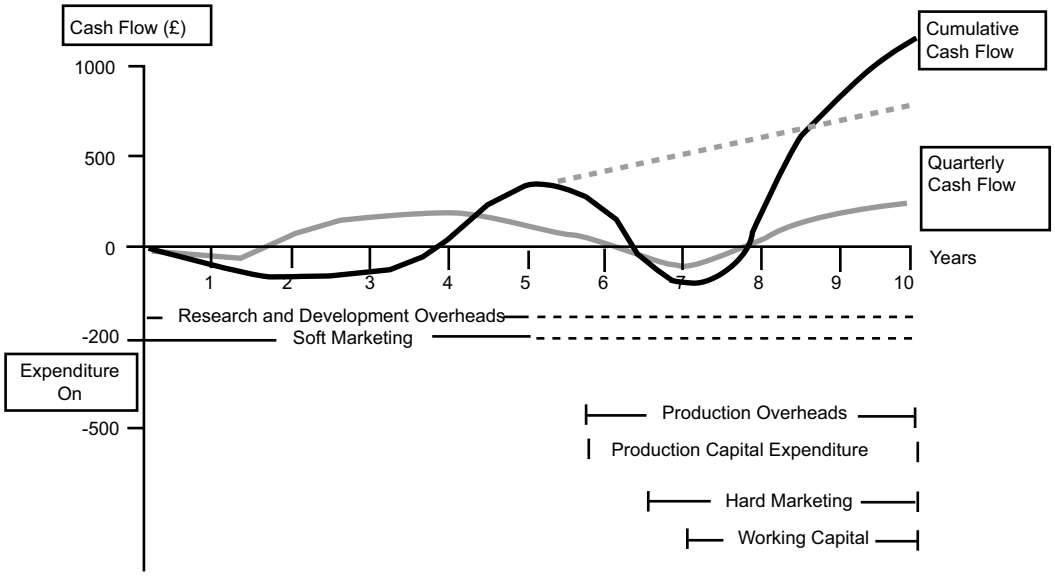
The financial *risks* are quite different: assuming the research costs have been incubated elsewhere, the first costs will be the salaries and overheads of development work, plus such equipment as is needed for this; in a "hard company" start up there will then be expenditure on manufacturing equipment and staffing, distribution and sales staff, and marketing expenditure to launch the product; on top of this will be stock/work in progress and debtors, maybe partially offset by trade creditors. The rule IBM adopted for a new product launch was 1:3:10: 1 to stabilise the product; 3 to get it manufactured; and 10 for marketing. That would not be untypical for a novel piece of equipment; it would be substantially greater for a novel pharmaceutical product, because of the clinical testing required. And for a start up, all that has to be incurred with an untested management team, no certainty of customers or sales at the end, and losses increasing each month until the launch is successful.

Typical cash flow for a Soft Company start-up



For a "soft company", the development costs are the same, but the manufacturing costs are lower and the marketing and working capital costs are much lower; the processes are more familiar to the management team; crucially, the costs are primarily incurred against a certain sale to a credit-worthy client; and, depending on the contract terms, the company can be making monthly profits and getting stage payments as it reaches the agreed milestones.

Typical cash flow profile for the Hardening Process



Moreover, soft companies are usually quite *profitable* from the outset and, once they have a better feel for the market, they can use their profits to invest in the internal development of a hard product idea, with which to kick up their subsequent growth rate; in my experience the resilience of the soft company model meant that several attempts at hard product launches could be tried without wrecking the business; and often it was at the successful launch of such an internally incubated hard product that venture capital could be brought in.

As a result, while the first company's business plan has to be *financed* by equity, the second, soft company is usually financeable by a bank with a closely monitored, secured working capital facility from early on in its life, and with personal equity and/or a government loan guarantee scheme, even from start up. This was how Barclays was able to support the growth of Cambridge companies well before the availability of venture capital in the late 1980s—as indeed the Bank of Boston and Bank of America had done in Boston and California in their pre-venture capital days.

What policy changes would make this Soft Company Model easier to start and succeed?

An important point to make is that the development of technology products and equipment on contract—what the great, soft majority of smaller technology companies do—does not appear anywhere in the R&D statistics: the activity does not conform to the Frascati definition used by BIS/ONS to measure R&D activity; for the small supplier the activity is recorded as sales; and in their large customer's accounts it may appear as capital expenditure or revenue expense. The Frascati definition requires the activity to be speculative, without a firm sale in prospect—ie to be crossing the Valley of Death.

Since no one measures soft company activity, there are no tax allowances or other incentives for it.

The first suggestion would be to develop a method of measuring the activity.

The second suggestion would be to encourage the growth of the market for technology procurement from small companies by larger companies, research institutions and government departments: development contracts in my experience are much more commonly available from US corporations as a way for them to develop access to new technologies than in the UK—so-called "open innovation"; in particular, British government procurement has long operated a closed innovation system for procuring technology in defence and has shown remarkable unwillingness until recently to consider using its procurement capability in an open way to seed new technology or policy areas—no doubt because the civil servants fear being arraigned before the Public Accounts Committee for wasteful expenditures. Contrast this with the very effective open procurement activities of such agencies as DARPA, ARPA and ONR in the US, which have been used as a conscious stimulus to advanced technological and economic growth since the 1940s. The Maddock Report made a similar suggestion in the UK in the 1970's. More active funding of SBRI contracts in government departments, agencies and the Research Councils would be a first step in this direction.

A further suggestion is to revive the pre-production prototype financing scheme that was once offered by the DTI. This was available to large UK companies that placed prototype development contracts with small technology suppliers to cover the cost of experimental pieces of equipment. Adapting the TSB's multi-partner collaboration R&D mechanism to fund bilateral partnerships between small technology suppliers and large companies would help the latter to move towards more open technology procurement models.

Lastly, a word in the ears of some of the banks to get back to doing more of this sort of lending would be useful.

April 2012

Written evidence submitted by Dr Peter Dean

When I was a reader in Biochemistry in Liverpool University (1968–1984), I was fairly certain that none of my colleagues knew the meaning of innovation. Scientists were supposed to study science not invent, patent and take inventions into the marketplace. I had a modest sized research group working on three main areas; steroid hormones, squalene cyclases, affinity chromatography. My main criticism of the system of control of Intellectual Property at Liverpool is that there was none. Research discoveries were reported on an *ad hoc* basis to a senior administrator. He and his committee would decide what if anything to do with an invention. The innovation process was foreign and I suspect somewhat distasteful to the academics in my department if not throughout academe. For example, one of my colleagues (Dr Duncan Troup) and I invented the "Backfriend" orthopaedic support. We funded the start of a company (Medesign) ourselves without any support from the University.

My biochemical research resulted in my being asked to consult for a number of commercial companies (Genentech, GD Searle, Amicon, HM Government and Ayerst Harrison & McKenna amongst others). As a result of discussions with the latter company in Montreal, I was asked to research ideas for a possible test to monitor diabetics for glycated haemoglobin. The proposal was that if I could discover such a test then the company would protect any discovery by applying for patents at their expense and we would decide about innovation if and when the invention was filed. After about three months, I discovered that immobilised boronate bound glycosylated haemoglobin and showed (with Professor Sir Alistair Bellingham) that diabetic patients could be very rapidly and more accurately assessed using my procedure than the electrophoretic methods used at the time. Indeed we showed that one of my students (Sarojani Angal) was not diabetic but beta-thalassaemic (Alistair had observed "fast" haemoglobin in her blood which was easily confused with diabetes). The patents were filed with more than 9 months to run before completion. In other words there would have been plenty of time to find another sponsor (eg BTG). The company informed me that their research objectives had changed and they were happy for me to take over the patents as inventor. I approached the University development officer and was told very firmly that it was my invention and they were not interested in pursuing or supporting the patent. Bear in mind that a UK patent filing could easily cost £20,000 per year for foreign filing costs at the time (about the size of my salary as a reader). I then approached Amicon for whom I had been doing some consultancy and they agreed to take on the product. Without any help from the University towards the negotiations, I agreed to sell the patent to the Americans for a token sum with the understanding that they paid my laboratory 5% of sales and 40% if the company was taken over. Two years later, W.R.Grace acquired Amicon and vigorously defended the US patent (the Americans failed to file outside the USA). Whilst my lab and I did accrue some reward from US sales, we had absolutely nothing from worldwide sales although the method was very widely exploited and still is the basis for the HbA1c method, what irks is the complete failure of the establishment to recognise a major worldwide contribution to diabetic health and no academic recognition was offered from fellow academics for 20 years of invention and innovation. There was a stigma attached to commercialisation which caused me to leave the University system. Towards the end of my stay in Liverpool, I was invited to help develop a new company (P & S Biochemicals) which attracted a number of awards including the Prince of Wales Innovation Awards and The Mersyside Entreprise Award. Despite all the attention from the media, I do not feel the University ever really understood the objectives of the company which was to create a manufacturing base for making tools for genetic engineers. When the Finnish Sugar Company offered to fund a personal chair for me with a large research grant to continue my work, the Vice Chancellor and his pro-vice (a Prof Harris) decided that 40% of the grant must be given to the University without discussion. Since this would have compromised the research and since I also was not that impressed by the change in title, I immediately applied to work elsewhere. This I regard as an excellent example of why the University could not innovate even if you paid them to do so. I understand that nowadays venture capitalists offer "development" funds to some universities with the proviso that they get full commercial rights. This cannot be the best way. Attempts in the past such as BTG, 3i and AGC have failed to live up to expectations and have left academic inventions devoid of innovation.

Another innovation failure at Liverpool was my experience with steroid hormones. My group and I made many antibodies to steroid hormones over the years I was at Liverpool. We were the first to construct assays for oestriol, oestradiol, cortisol, and many others. The University failed to set up a system to protect or commercialise these discoveries and all innovation was conducted single handedly.

I left the University in disgust (1984) to start Agricultural Genetics in Cambridge. We had an ideal opportunity to create an innovation laboratory which failed to materialise and led me to form Cambio three years later. Soon after, Professor (now Sir) Martin Evans brought the design of the UK's first PCR machine to me and whilst the University did not stand in our way, the technical assistance we received was rather out of date and unimaginative so that we went to a local electronics firm to develop the machine rather than stay "in house".

In 1992, Cambio was approached by Professor Malcolm Fergusson-Smith then Professor of Pathology at Cambridge, with a novel series of chromosome paints. We successfully commercialised these worldwide and were happily paying the laboratory in the region of £200,000 per year being a large proportion of sales of the product. The University technology transfer group (CUTS) decided to get involved in order to force an increase in the contribution made to the University. Their approach to negotiation caused Cambio to withdraw completely from the market, losing both sides considerable amounts of money. The Professor failed to keep the laboratory going as a result. The technology transfer officer was trained as a broker in the City and unfortunately did not understand negotiation is a two way process.

One general point worth mentioning is our British patent system. We have to complete a patent within 12 months of filing. In the USA, Japan and Canada to name but three, there is an extended grace period which allows inventors to talk about their inventions without compromising the patent which is some cases is three years retrospectively. Hence a UK filing from these countries can be significantly ahead of competitive inventions from the UK system.

Another point is that UK universities are very slow to innovate because the academic way is to explore every possibility, discuss the pros and cons ad libitum whereas the commercial need and method is to make decisions quickly even if the process has flaws.

British inventors lose out because the patent process is not clearly understood, because there is no clear way to innovate processes or products (the classic example is the failure to patent monoclonal antibodies). There is a dearth of good patent lawyers whereas in the USA there are probably too many. The perfect innovation team might include: The inventor, someone experienced in reducing inventions to practice, a good lawyer who has worked in the area, a lateral thinker who can get outside the box, a designer and marketing expert to bring the idea towards the final goal Pamela Ramsden's book on top teams spells out the perfect group. AGC was classically unbalanced with 1500 AFRC scientists feeding all their inventiveness into one small office—no wonder it failed.

April 2012

Written evidence submitted by Katie Potts, Herald Investment Management Ltd

1. *What are the difficulties of funding the commercialisation of research, and how can they be overcome?*

From Herald's perspective the UK is one of the most attractive markets in which to invest, with a strong regulatory framework, and low valuations particularly relative to bonds in spite of having to fund the cost of the welfare state, and relatively high salaries. There is also a reasonably high level of innovation and entrepreneurial spirit in the UK, particularly compared to Continental Europe, if not Israel and the US. There seems to be a greater sense of inferiority that overseas markets have greater attractions than is justified from the micro perspective of investing globally in smaller TMT stocks. We are proud that we have made long term returns, without Government subsidies, well ahead of all the wider indices in early stage investments. Nevertheless, we have been on the defensive, as we ourselves have directly been victims of the pension funds selling Herald shares, and they have gradually been replaced by private investors, who are regrettably less stable. Furthermore we have had to defend our overweight position in the UK to certain investors in Herald's funds in spite of the evident solid long term returns.

It has been our stock in trade at Herald to provide early stage (ie pre-profits) capital, mainly at IPO and follow on secondary offerings in the quoted market through Herald Investment Trust plc. Historically we have co-invested with other investors, and taken stakes up to 10% of the issued share capital. In the current environment IPOs are unattractive for two reasons (a)There are insufficient co-investors to raise the needed capital (b)There are too many cheap stocks in the secondary market (which we want to protect against predators), which have less risk. Furthermore, at Herald's venture meetings I have repeatedly said "I can't get my mind round investing £2 million in a pre revenue company on a valuation of £10 million, when I can buy companies in the quoted market that are already profitable and growing on similar valuations."

It is only with healthy secondary market valuations that IPOs are attractive, and thereby justifies the risk of venture investing early stage. There is a disincentive to attempt to commercialise research if follow-on funding is uncertain or expensive.

(i) Shortage of capital

Equity Shortage

There is much media discussion about the difficulties small companies have in raising bank debt. Bank debt has never been available for early stage technology companies, and furthermore it is an inappropriate form of funding for companies pre profits. The current environment shows an absence of equity. This is reflected in the virtually closed market for quoted IPOs since 2007, and a similarly meagre venture pool. Unfortunately the bubble of IPOs when the TMT sector was too fashionable, led to poor returns, which has led investors to perceive the sector as risky. AIM had a similar but less pronounced bubble and bust. There has also been a shortage of major successes in the UK versus the US. This has led US investors to have greater confidence

and therefore US technology companies have had a lower cost of capital. However, even in the US the number of US IPOs in the last decade is 80% lower than in the1980s or 1990s, with investors in US IPOs having equally inadequate returns. It is frustrating to have watched the bubble of investor interest into emerging Asia, even from UK based investors. As global investors we find the lack of established regulation, and the lack of IP in markets such as China a pretty unattractive investment proposition, and despair to see limited UK resources going there, and not to lower risk propositions in the UK. In Continental Europe there are very few emerging technology companies, and closed public equity markets.

Why the shortage of equity investment in the UK?

However, there is an even greater issue, which has led to the shortage of equity. It is the evaporation of pension fund and insurance company asset allocation into UK equities, and an even greater reduction in the exposure to smaller companies. These institutions were professional long-term stable investors, with good corporate governance skills who controlled executive remuneration etc. It is a tragic and devastating unintended consequence of the abolition of ACT relief, combined with the rising liabilities for defined benefit pension schemes as life expectancy has grown, and investment returns have diminished. The accounting requirement to disclose these liabilities with valuation methodologies which discourages equity investing has been the final death knell, which has led to the disappearance of institutional investors on the registers of our investee companies. In addition, historically fund flows into UK equities were to some extent guaranteed as pension trustees had positive cash inflows, and believed that sterling liabilities should be matched by predominantly sterling assets. It was also in their members' interests to have a strong UK economy, so there should be an allocation to small companies which will provide growth to the economy, and there is strong historical evidence that small companies over the long term do outperform large companies: For example the Numis Smaller Companies Index (previously HGSC Index) has returned 404.8%% over since 31/12/1994, versus 255.3% for the FTSE 100. On an even longer term basis over the 57 years from the start of 1955 to the end of 2011 the Numis Smaller Companies Index, representing the bottom 10% of UK companies by market capitalisation, has generated a total return of around £3 million for each £1,000 originally invested (dividends reinvested), while the overall market (FTSE All-Share) has given a total return of approximately £0.6 million for each £1,000 originally invested. The return from smaller companies over this period has therefore been five times greater than the market overall. Annualised returns over this period are 15.1% for the NSCI, and 11.9% for the All-Share. This does not feature in Trustees' consideration today, and allocation seems determined by actuaries and accountants and not fund managers, and the pressure for consistent short term returns. Furthermore, defined contribution schemes means that companies care less about maximizing performance, and more about minimizing risk. It seems to me to be a frightening mistake which we shall come to rue.

I stress I am more despondent about the funding environment for UK technology companies than at any stage in my career, which now spans nearly thirty years, and believe there is a bigger problem than realised. (I am despondent as a taxpayer. As an investor having some money when others don't has its attractions, but at times I fear we have a watering can in a desert!).

To me the obvious simple solution is to require pension funds, in order to maintain their existing favourable tax treatment, to allocate at least say 1–2% of total assets to equity investment in small private and public UK companies. This could be extended to European small companies if EU rules require. The definition of small company should be £0 million to c£500 million in valuation, and care needs to be taken in defining UK—eg % of employees. In practice this investment should phased over a reasonable time period. This would allow professional investors to make commercial judgments and investments at no cost to the taxpayer.

As a matter of urgency Government needs to encourage greater equity ownership, especially by long-term high-quality investors such as pension funds.

(ii) Shortage of commercial management

It is evident that the cluster of successful companies in northern and southern California, to take the most extreme example, has occurred because there has been a succession of fast growing companies, which has taught a succession of management teams about how to scale a business. There is no such UK training ground. It is depressing how few first generation businesses have become large companies in the UK compared to the US. A radical suggestion would be to make private investors pay income tax rates on realised gains on assets that are held for less than three years, and lower the CGT rate from 28% on assets held for longer than 10 years and/or at least index the book cost in line with inflation. (NB At current rates of inflation CGT rates of 28% are in real terms higher than income tax for long term investments.) In addition pensions could be charged a gains tax on profits realized within five years. This would encourage longer term ownership, and help develop a generation of management that can scale a business.

In 2002 we were approached by the Russell Group to consider managing a fund to invest in technology transfer out of university laboratories. We were flattered to be considered, and undertook an extensive process to consider the viability of such funds. This included meetings with successful universities overseas (Colombia, Harvard, Massachusetts Institute of Technology, New York and Stanford in the United States and Technion in Israel. Our conclusion was that money alone could not solve the problem. Commercial management was equally necessary. Academics can underestimate the skills associated with developing, producing, marketing and selling. We also observed how effectively Columbia, for example, had commercialized IP through royalties.

It is an obvious way to reduce the business risk if you can leverage an existing corporate structure and sales force to launch a new product. However, it is a challenge in the UK because there is a shortage of large companies who could be incentivized to commercialise products. We were impressed by the commercial approach at Technion which is reflected in a remarkably successful technology sector in Israel in relation to the size of the economy. In contrast the UK universities seemed far less commercially aware or astute. I suspect that efforts made over the last few years mean that UK universities have improved. Overall, regrettably we came to the conclusion that we, at Herald, had inadequate resources to take on the challenge.

(iii) Shortage of skills for the development and marketing phase

Every day we meet companies who complain about the difficulty of recruiting qualified UK schooled staff. Often we hear that immigrant labour is better qualified with a better work ethic, and overseas offices are often opened for skills not just cost (eg Poland and India). From the micro perspective of a TMT fund manager the education policy has been daft in not offering more places, and incentivizing students, to study disciplines where there are skill shortages. Maybe statistics published for employment rates a year after graduation for each course from each University should be more proactively analysed and published, and places be expanded where there are high recruitment rates, and reduced or closed where there are poor employment rates. In addition there is a shortage of large UK companies to undertake graduate training. For example GEC/Marconi was a great training ground, but no more.

In a knowledge world there is a mismatch between rising remuneration where there are skill shortages, and simultaneously rising unemployment. There is a similar disconnect in the corporate world where cash rich companies cannot invest cash to grow. Innovation is not a function of money but ideas. Small companies can be more innovative and productive than large ones, but they are cash limited. It is an investment challenge to invest in ideas, where no reliable discounted cash flow projection can be modelled. Economists are disappointed by subdued capital expenditure, but in the knowledge based TMT sector in which we invest R&D is more relevant than capital expenditure. Manufacturing for so many volume products is now in the Far East, with lower cost labour.

There is no shortage of creativity and IP generation in the UK. It has been said that the indisciplined UK culture, whilst bad for productivity, has been good for stimulating creativity.

2. *Are there specific science and engineering sectors where it is particularly difficult to commercialise research? Are there common difficulties and common solutions across sectors?*

Technology offering solutions to a large addressable market are more commercially viable, albeit certain niches can be less competitive. Clearly products where there is a long development and design-in cycle require more capital, and hence makes capital less available.

3. *What, if any, examples are there of UK-based research having to be transferred outside the UK for commercialisation? Why did this occur?*

We have been frustrated by the plethora of takeovers in the quoted market, at valuations that might have constituted a premium to the stock market valuation, but were disappointing in terms of invested capital, and our expectations. In particular it is frustrating to have invested at a risky pre profit, and sometimes pre revenue early stage, and to have seen the company through to cash flow profitability only to see the less risky upside taken, generally, by US corporate and private equity houses. The UK financial sector has very limited expertise in the technology sector, and is particularly poor at ascribing value to progress other than profitability.

4. *What evidence is there that Government and Technology Strategy Board initiatives to date have improved the commercialisation of research?*

From my perspective invisible. I have been in the technology investment industry since the mid 1980s. If initiatives have been helpful they have been more than offset by the evaporation of capital looking to invest in early stage and smaller companies equity.

5. *What impact will the Government's innovation, research and growth strategies have on bridging the valley of death?*

From my perspective the Government would see better returns from nurturing 50 -100 man companies who have a greater chance of doubling and doubling again. Too much resource has been focused early stage only for them to gobbled up by overseas buyers.

6. *Should the UK seek to encourage more private equity investment (including venture capital and angel investment) into science and engineering sectors and if so, how can this be achieved?*

Private equity in City parlance relates to leveraged buyouts of established companies with positive EBITDA (cash flow), whereas venture capital is providing capital to start-ups and early stage companies that have not reached profitability. Now that pension funds are taxed on dividends, but not interest there is a fiscal incentive for companies to own corporate debt rather than equity. This combined with low nominal interest rates, and

low public equity valuations has been a stimulus to private equity. There is zero need for Government to encourage private equity. On the whole they have short term time horizons. Cynically the parallel is a property developer who covers up the cracks, and sells on at a profit. Long term ownership like that of home ownership, is more desirable for businesses. In fact there is a case for making interest costs a non tax deductible expense to level the playing field with equity ownership. The short term shock to leveraged sectors such as property and private equity would be too traumatic, and have knock on negative effects on the fragile banks, but maybe tax deductibililty could be removed on all but loans secured on tangible assets. In contrast the Government must encourage venture investing, which is vital for the emergence of new businesses, added value job creation and exports.

The outside world has a tendency to see the City as homogeneous in attitudes and practices. Within the financial sector there are very evident divergences. We our long term in our approach we endeavour to invest in companies that will be making sustainably higher profits on a five to ten year view, and are supportive to that end. We cynically view so many short term investors as psychologists ie they endeavour to work out what other people will pay more for tomorrow than they do today.

Building successful businesses takes time. Pension funds and insurance companies have appropriate long term funds and professional managers. Angel investing is difficult and expensive to attract, and does not have sufficient depth for follow on funding.

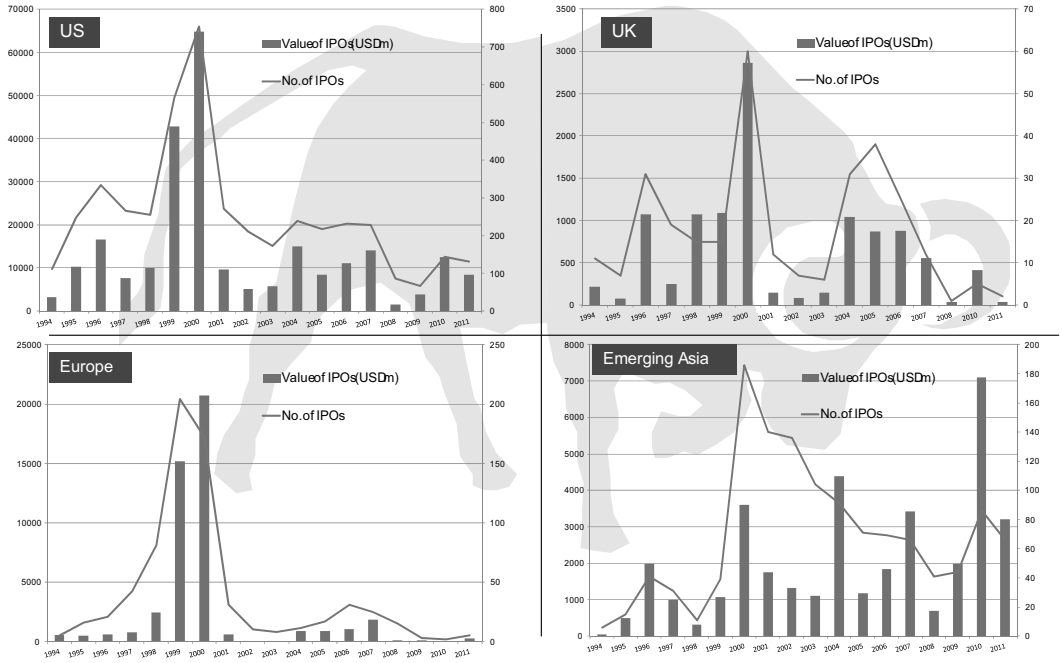
At Herald we have managed two venture partnerships. After twelve years the IRR on the first fund (on unsubsidised investment) was a modest 3.6% per annum. This fund was launched in September 1999, and the return does exceed the total return on the UK equity market over that time frame, and according to BVCA data makes the fund respectably top decile. However, frankly, it has been an inadequate return on effort, and insufficient to get investors enthused about reinvesting. Idealistically I know that the economy needs venture investment, and I feel that we are well placed with our skill set and knowledge of the global sector through the quoted markets to be relatively proficient, and have useful experience. However, experience makes me realize that it takes many years to establish a sustainable business, and many of the stresses have been associated with inadequate capital, and the struggle to raise follow on funding. My judgment is that this makes it too risky to embark on early stage investing without sufficiently deep pockets to see an investment through to profitability, because external follow on funding may either not be available, or too expensive in terms of dilution. Equally it is uneconomic to have committed capital idle for up to 10 years when the final round might be needed. If the health of the market improved as described previously with better funded smaller quoted companies market, then this problem would be addressed. Candidly I would be unable to raise a fund of sufficient scale without this improvement. Idealistically I should like to raise a further fund, but selfishly I do not want the distraction or the stress, and cannot honestly present a case to potential investors with the same belief that I have in the potential performance of our quoted funds.

7. *What other types of investment or support should the Government develop?*

At Herald we have considered raising a VCT but have resisted the temptation. Why? The market is limited in scale, and the tax subsidy is devoured by the cumbersome expensive structure, and the high cost of marketing to retail investors. Furthermore, the time horizon is short, the availability of capital for follow on funding uncertain, and the size restrictions too dangerous. Hence my preference for encouraging the deeper pockets of pension funds who have long term money to fund the follow on investment required. In addition it would make investing more appealing to angels if they have knowledge that there would be a competitive market for follow on funding at higher prices. In other words I think existing VCT and EIS incentives would be more attractive, and yield a better return for the tax payer if the follow on market improved.

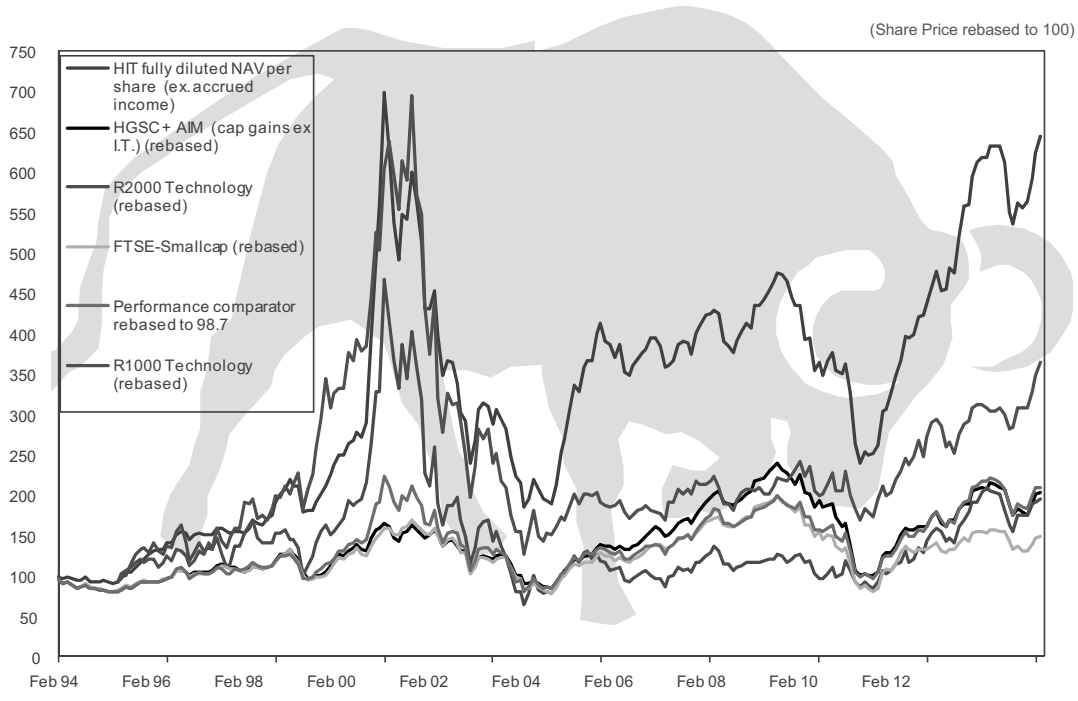
23 April 2012

Technology IPOs by Region



Source: Bloomberg

HIT -v- Indices since inception



Source: Bloomberg, Herald Investment Management Limited

Source: Herald and Bloomberg

Written evidence submitted by Dr Trevor Francis, Technical Director, Byotrol Technology Ltd

THE PERSPECTIVE OF A SCIENCE-BASED SME

EXPERIENCE OF FINANCIAL FUNDING

Context

— Byotrol plc. is a biosciences technology SME with a market cap of ca. £10 million.

— The company originally started in 2001 as a spin out from a paint company and initially used family money to fund initial set up.

— It has developed a patented anti-microbial technology based upon a combination of commercially available biocides and a polymer that gives a long lasting protection when applied to surfaces (hard surface or skin). The technology has applications that spread from Food and Healthcare and to household and personal consumer products.

— The company has an Industrial Division and a Consumer Products Division (50/50 JV). The Industrial Division sells both to distributors and to service providers, while the Consumer Division is licensing the technology to fmcgs and retail manufacturers for use in consumer products.

— The plc. company has raised over £15 million from AIM in five separate funding rounds.

1. *What are the general challenges of science based SME's for obtaining funding?*

— Science based technology is expensive (laboratory, equipment, scientists, IP, materials etc.) so there is always a need to secure significant funds to keep afloat (cf software companies which generally have a much lower requirement for funds).

— As a generalisation, most "scientific inventors" are creative people with new thoughts on how to develop their innovations. As a result of not achieving sufficient funds, the risk is that many of these new ideas get lost, or if patented will pass into the public domain.

— Once investment has been received, there is a heavy outlay simply to stay still and yet most companies want to grow and invest in additional research streams. So there is never enough to cover what could develop from such science-based start-ups without radically finding new sources of investment.

— The process of raising funds itself is very time demanding and stressful.

— Many companies have suffered due to going too early to the City without properly managing expectations, resulting in having to meet the expectations of the City for short term sales revenue,

— There is often an added pressure in the funding "pitch" to be too optimistic and to make the company prospects seem very attractive, which subsequently leads to harder targets to fulfill.

— Frequently SME's report of being offered more money than they were asking for, which can create a "rich" feeling and not appreciating the need to use the money wisely.

2. *Disadvantages of seeking VC or Business Angel money*

— Quite often, early stage start-ups have nowhere else to go to get seed money.

— VC's are primarily focused on ROI and if a tech company has no assets (not manufacturing) but is knowledge based then providing funding is of less interest.

— IP isn't heavily valued within VC's, while for the company it is often a sizable cost.

— VC's will generally take a significant share of the business and leave the "entrepreneur" with only a small share of the cake. This creates subsequent problems with the founder having "less ownership" of the business that might otherwise be the case. In fact most founders end up with no more than 5% of the company they founded, leading to desire to exit at some stage.

— Getting a realistic funding of the potential of the company is difficult for the entrepreneur and can leave the founder with the feeling of being squeezed in terms of own value.

— VC assessors have really no expertise in assessing the technology and when joining a Board of a company have no understanding of what the opportunities might be—so discussions with the founder and management are frequently difficult with differences of opinion on strategy and longer-term activities.

— VC's tend to provide money in stage-gates that means that the company is frequently chasing for the previous payment, and having to manage additional cash flow dips.

3. *Perspectives of becoming AIM listed*

— AIM tends to be only for companies with a market cap of £10 million so isn't an option for early stage companies, who need alternative sources of seed money, business angels etc.

— AIM tends to be more speculative than VC's and having no track record doesn't put AIM off.

— AIM tends not to get involved in running of the business and leaves the management to get on with leadership decisions.

— Potentially works well but requires the CEO/FD to have a good knowledge of the process otherwise setting of sales revenue targets can lead to " short termism".

— Being a plc. adds gravitas as a company and especially in discussions re licenses and allows the use of "share options' to incentivize employees.

— General process with NOMAD's provides good financial discipline, but disadvantage of AIM tends to be overall cost with annual fees, NOMAD's and NED's and corporate lawyers.

— RNS communications can materially affect share price, so need careful management.

4. *What else can companies do for increased funding?*

— Various range of R & D funds are available from TSB and these generally are working well. Innovation vouchers may be useful to embryonic companies for early stage studies, but creating next stage funding through extending the voucher schemes for larger sums of money and prior to getting into TSB calls would be helpful.

— Byotrol was able to benefit from regional Development Agency Exceptional award that has been really helpful for R & D development including skills and capabilities.

— Our company has just made a European fund application and our perception of these is that the scope allows for bigger awards. This has a disadvantage for UK plc. in that that it encourages cross European working with the risk of technology moving out of the UK.

— Making grant applications is time and resource demanding and requires the company to decide strategically that they present a source of "extra money" and worth doing.

— R & D tax credits offer another source of financial support but for Byotrol they are just being reviewed due to lack of clarity whether the Regional Exceptional award represented "state aid".

5. *How can the Funding process be improved?*

(1) Build Scientific skills of Investment Houses

(a) There is a clear perception amongst SME's that the investment world really understands neither science nor the complexities of scientific companies and wants to value scientific companies as for any other. This leads to poor evaluations and little understanding of the challenges, but also the longer term opportunities open to science and technology companies.

(b) One solution would be to encourage Professional Investors of VC's and Investment Houses that have the skills and technical capability to invest in technology companies.

(c) Additionally, it would be beneficial to require VC's and NOMAD's to carry out technical due diligence on companies that are seeking investment, rather than just financial due diligence.

(d) This would also require the VC's and IH's to work with the management of the company to build a sensible business plan and to take a long term view, not only short term financial goals.

(e) Equally the technical due diligence should include gaining an assessment of the value of the IP that is held within the company.

(f) This would allow the Investors to also build in longer term non-financial targets that focus on the " enablers" rather than just financial results.

6. (2) *Building a longer term ownership of the company*

(a) If UK plc. wants for founders to retain ownership their companies as they grow and not sell on to overseas investors, they need to allow founders to retain a much higher percentage of the original company after funding. One way could be to establish a cap on the amount that VC's and IH's can own of a company.

(b) This would however potentially limit the amount that companies could raise in investment.

(c) Helping the owner/founder to get a better long term evaluation of the company to try and get closer to its true worth could potentially help with the total amount that is raised without breaking the investment cap.

7. (3) *Training for listing and investment*

(a) As mentioned above, most companies that go for floatation have little knowledge of the challenges that they will face in the process.

(b) This can result in under-valuation of the long-term value of the company, selling too much value of their company and setting over optimistic targets etc.

(c) One solution would be to require CEO's and FD's of SME's who are seeking funding for the first time to go on a training course that develops their knowledge of the process, including setting sensible goals for the company and the need to "manage expectations" of the investors.

(d) Another part of the training should be to get CEO's to look at different business models for how he will commercialize it's invention. Few companies take the time to think through what business model will be most appropriate to maximize the value of the technology and it's value.

8. (4) *Management of companies*

(a) As previously stated, starting and running science based companies (non IT) is intrinsically expensive, so access to finance is always going to be needed.

(b) What VC's and IH's require is for each company to have it's own CEO, it's own Finance Director and it's own accountancy function which are both costly and assume that the company founder has the skills to carry out some of these functions.

(c) It is however also questionable whether within the UK there exist sufficient number of quality individuals who understand the challenges of running scientific companies and the interaction with Investment Houses.

(d) One alternative would be to encourage experienced and highly capable individuals to work part time across a number of companies with the right level of incentivisation, thus providing their knowledge and skills to a few non-competitive companies. This could potentially reduce the cost for individual companies and allow the founders to focus on what they do best.

Other than improving the funding Process what else can the UK Government do to improve the Commercialization of UK Innovation?

9. (1) *Change the Culture relating to the view that Innovation only happens in large companies working with universities*

— Innovation can happen anywhere, mostly driven by serendipity!

— Innovation means the commercialization of an idea and in many ways small companies are much faster in doing that than large companies.

— In spite of the contribution SME's make to the UK GDP, much of the UK cultural belief is that Innovation works best with UK Universities working with large companies. In many ways this denies the sector that is most in need of access to University and academic support and that can make the most impact to UK growth—SME's

— The biggest difficulty is that many universities don't know how to work with small companies and is related to how universities are structured while small companies are often unclear, un-strategic and short of money for big research programmes. Creating demand for universities to meet and discuss with small companies their needs should be considered.

— In the NW, the Knowledge Centre for Materials Chemistry (Chemicals NW funded) has played a very helpful role in interfacing the needs of small tech companies with university support. This model should be copied elsewhere.

10. (2) *Give companies, especially SME's greater knowledge of university patents*

— Intellectual Property that has been generated in UK universities is valuable in its own right and should be protected.

— However after a period of time the university can decide that it no longer wants to financially support that patent and let the patent subside. For that to happen means that it the knowledge inside the patent and discovery is passed into the public domain where anyone can access it.

— Universities should be encouraged before that happens to make companies aware that the patent exists and seek a new owner, preferably to one that will benefit from the patent and continue to maintain it.

— A searchable database that companies (including SME's) can access of all current patents within UK universities would help this process.

— Should no company wish to take up the patent, then the UK Government should consider acquiring the patent as it still represents something of potential value, that has already had investment from the UK taxpayer.

11. (3) *Give companies, especially SME's greater knowledge of funding from other sources*

— SME's are very small companies that are always short of resources, both people and money.

— With more access to funding, SME's can set up additional Research projects that are beneficial to both the SME and UKplc.

— Creating a searchable database, that compiles all the funding that is available, across the UK by category would be very helpful.

12. (4) *Create environments that foster innovation*

— Byotrol has been helped in its commercial activities by being located at the Daresbury Science and Innovation Campus.

— There, the site management has done much to encourage networking between tenants, make connections with leaders of other organisations and create opportunities and support for small companies in a range of commercial areas such as marketing.

— The site is proactive in looking to provide new laboratory facilities and previous equipment that at one stage was destined for disposal has been made available at low cost to its SME tenants.

13. (5) *Build the recognition for scientific entrepreneurs in Britain*

— Using Dyson and others as examples, there is a need to shift the general public recognition of the role that science and technology plays in Britain's future. In many other countries, science and engineering are given a higher status that results in students seeking studies in the natural sciences and engineering.

14. (6) *Focus more on commercialization activities*

— There is a risk that the main focus is on spending money on research and this will equals commercial success. In our experience there is insufficient attention paid to taking the technology to market and the skills needed to do it successfully.

— This requires having access to key decision makers for procurement of the technology, a challenge in itself.

— So where Public sector is a potential customer, make it easier to sell innovation to it. For example the NHS, which is one of our potential customers is unbelievably difficult to have our technology accepted.

Please note that in providing this opinion paper, the author knows of no conflict of interest.

April 2012

Written evidence submitted by The Shelford Group

Introduction

1. The Shelford Group represents the Chief Executives of England's leading Academic Medical Centres (AMC's) or Large Teaching Hospitals.

The 10 members collectively employ over 83,000 people with a turnover of £7,279 million. The institutions that make up the Shelford Group are of strategic significance to NHS care, the pharmaceutical industry and the wider UK economy.

2. Members

University Hospitals Birmingham
Cambridge University Hospitals
Central Manchester University Hospitals
Guy's and St Thomas'
Imperial College Healthcare
Oxford University Hospitals
Sheffield Teaching Hospitals
Newcastle upon Tyne Hospitals
University College Hospitals
King's College Hospital

Background

3. For several decades the UK has excelled and benefitted from its status as a global leader in the life sciences industry. The Shelford Group believes that there is great potential to secure this position for the future—especially if opportunities for joint working between industry, academic institutions and the National Health Service can be properly developed.

4. The Shelford Group welcomed the publication of the Government's *Life Science Strategy* and the *Innovation, Health and Wealth—Accelerating Adoption and Diffusion in the NHS* reports, both published in December 2011.

5. The *Life Sciences Strategy,* with the confirmation of a £180 million catalyst fund to help commercialise new medical treatments, is also welcome; though it is a small amount relative to the scale of developing any medicine.. The *Innovation, Health and Wealth* report makes clear the importance of recognising the £4 trillion a year value of the international healthcare market and emphasises that *"the NHS must do more to exploit the commercial value of its knowledge, information, ideas and people."*[131]

[131] *Innovation, Health and Wealth—Accelerating Adoption and Diffusion in the NHS,* Page 27, *December 2012.*

Transfer of Clinical Research and Commercialisation Abroad

6. There has been a dramatic decline in clinical trials in the UK, from 6% of the global total in 2000, to only 1.4% in 2010. Emerging economies are increasingly competitive with developed countries as places for multinational companies to establish their medical research facilities, commission and exploit research.[132]

7. Local experience shows that a significant proportion of high value licences are made with overseas companies. There appears to be a better appetite for funding life sciences risks in the EU and the United States of America than in the UK. This is in part linked to the end point when the products enter the market—where other healthcare markets are more ready to welcome innovation and the potential benefits obtained, rather than the difficulties of reimbursement.

The Technology Strategy Board

8. The Technology and Strategy Board (TSB) could be ideally placed to assist with commercialisation in the medical arena with large pharmaceutical and bio-tech firms, and also with instrument and device partners. Along these lines it has recently developed a stratified medicine programme in collaboration with the Association of the British Pharmaceutical Industry and the Medical Research Council. This requires industrial partnerships and is an interesting and welcome innovation.

9. However, historically the TSB, although used to the element of risk in the translation and commercialisation of research, is less experienced in dealing with medical academia and the National Health Service.

10. The nature of medical and health sectors means that there are a greater number of variables which can affect the course, speed and ultimate outcome of research. Research can be dependent upon regulatory approvals (with their unspecified timelines) and success in recruiting the number of patients required to further develop emerging clinical research.

11. As such, TSB Funding application and management requirements are less suitable for the exploitation of medical research and have demanding time-lines that are quite unrealistic for clinical trials. In addition, the requirements for lengthy quarterly reports and approvals for minor deviation from spending targets and timelines, severely limits the value of the TSB for commercialisation in the sector.

12. However, with their experience of other sectors and developing partnerships, the TSB could be very useful in commercialisation. But this does require recognition that commercialisation of medical and health research requires a more tailored approach, a more realistic and flexible approach to timeframes and a simplified application and monitoring process and acceptance of metrics that better fit clinical/medical research.

Joint Working across Government; Industry; Academia and the NHS

13. Implementing the recommendations of both reports will require departments such as the Department for Business, Innovation and Skills, the Department for Health and the Cabinet Office to work closely across their respective portfolios.

14. Government departments can also assist in bringing together the joint capabilities or clusters of internationally leading trusts, universities and industry. Concentrating on joint efforts helps provide sufficient density of patients, facilities and investigations for industry to examine rare patients and diseases.

15. One example of this would be the *Global Medical Excellence Cluster* (GMEC) which provides a precedent in bringing together leading universities, companies and NHS Trusts into a globally competitive base for biomedical research to attract inward investment.

16. Another model of collaboration is *The Experimental Medicine Hub* between King's College London, Guy's and St Thomas', King's College Hospital and South London and Maudsley NHS Foundation Trusts and a biopharmaceutical services company Quintiles. This collaboration provides a critical mass of research activity in one location. And the National Institute for Health Research (NIHR) Transnational research partnerships, that include a number of Shelford group members, which have been set up to facilitate, collaborative work with industry to accelerate the commercialisation of Intellectual Property.

17. The value of the research needs to be better recognised and one opportunity is during the appraisals of NHS Trusts. As occurs in universities outputs such as approved patents, industry collaborations and commercial activities should be seen as achievements during review.

18. Also, unlike many universities, the NHS does not have the structure to capture the value of investment in Intellectual Property. Currently the NHS invests more than £1 billion each year into primary research, but as an organisation it lacks an agreed structure to capture the value of that investment in Intellectual Property.

[132] This has been highlighted recently by the closure of facilities such as the Pfizer Research and Development site in Kent. Elsewhere significant investments, such as by GSK in China, are becoming more common. China now has a large facility for Clinical Trial of an Investigational Medicinal Products (CTIMP).

ENHANCED TARIFFS FOR ACADEMIC MEDICAL CENTRES TO PROTECT FUNDAMENTAL INFRASTRUCTURE FOR THE UK'S MEDICAL SCIENCE INDUSTRY

19. Academic Medical Centres (AMCs) and large teaching hospitals within the NHS provide the fundamental infrastructure for the UK's medical science industry. As leading tertiary centres they provide state of the art training and education opportunities for the UK's clinicians. However, the current NHS funding system is putting these leading research establishments increasingly at a disadvantage.

20. Case-mix funding systems, such as that used in the NHS, operate through allocating funding via payment systems, where a price per unit of activity is paid for service outputs provided by health services. However, these policies and rules do not adequately take complexity of care into account, and therefore the leading hospitals specialising in these more expensive treatments are consistently under-funded.[133] In addition, the overheads associated with the delivery of clinical research are not taken into account in NHS funding. In time this will seriously impact the ability of the pharmaceutical industry, AMCs and large teaching hospitals to maintain their existing level of research and development in the UK, with long reaching implications for employment, exports and the economy.

21. The Shelford Group believes that a full review of NHS funding systems, to consider these issues, is required with a view to bringing funding in line with international best practice.

February 2012

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[133] The Dutch Government recognised a similar shortfall affecting its AMCs created an "intensity payment" allocation (equivalent to an enhanced tariff).