HOUSE OF COMMONS

# Science and Technology Committee

## Oral evidence: The science budget, HC 340

## Tuesday 15 September 2015

Ordered by the House of Commons to be published on Tuesday 15 September 2015.

Written evidence from witnesses:

- Campaign for Science and Engineering
- Universities UK

Watch the meeting

Members present: Nicola Blackwood (Chair); Victoria Borwick; Jim Dowd; Chris Green; Liz McInnes; Dr Tania Mathias; Carol Monaghan; Derek Thomas; Matt Warman.

Questions 141-223

Witnesses: **Professor Graeme Reid,** Chair, Science and Research Policy, University College London, **Naomi Weir**, Acting Director, Campaign for Science and Engineering, and **Nicola Dandridge**, Chief Executive, Universities UK, **Professor Sir Mark Walport,** Government Chief Scientific Adviser, Government Office for Science, **Professor Brian Cox,** Physicist, gave evidence.

Q141 **Chair:** Can I welcome the panel to the third session of our inquiry into the science budget? We are quite pressed for time, and we have been ambitious with our schedule today, so could I jump right in and start with you, Professor Reid? You are now chair of CaSE, but I know that in a previous life you co-ordinated the science budget bid for the 2010 spending review, which we are all wrestling with at the moment. What would be your advice to a new BIS Secretary of State who is facing the twin challenges of a 25% to 40% cut in his departmental budget and, at the same time, needs to do whatever he can to protect what is known to be a world-leading UK science base?

> ***Professor Reid***: Thank you, Chair, for holding this inquiry. I think the Secretary of State has a third challenge, because he also has to contribute to a prominent Government agenda to grow the productivity of the economy. With those challenges in mind, I would make some pretty tough decisions and focus resources on the things that so demonstrably contribute to productivity, and have already been recognised as such by the Treasury. Against that background, I would back science.

Q142 **Chair:** In a recent research paper you put the quite challenging question: why should a taxpayer, among all other priorities, fund science and research? Could you give us your answer?

***Professor Reid***: My answer to that goes all the way back to Adam Smith. The argument has not changed since he first advocated it, and it has been repeated around the world by prominent economists ever since. The argument goes like this: there are some areas of life where the people undertaking the work will stand no chance of recouping the cost of it because the benefits are spread very widely. In the case of science, the knowledge that is created will be impossible to capture, because the process of scientific publication ensures that it is promulgated widely. You have an activity that is of high risk where it is impossible to capture the benefits in the way an investor would demand, but the benefits are very large. Therefore, the taxpayer intervenes, on behalf of the community, if you like, in order to pay the bill.

To bring that rather theoretical picture up to date, if we look at some of the benefits that come from science you can see that they are indeed difficult for an individual investor to capture. A strong science base makes this country attractive to global corporations that are choosing whereabouts in the world they wish to do their R and D. This country, compared with other G8 nations, has an unusually large proportion of business R and D conducted by firms headquartered overseas. That investment goes straight on to the bottom line of GDP; it does not make its way to GDP through lots of intermediate stages. That foreign investment is a direct contribution to GDP.

Another thing that comes out of the science budget is the population of highly qualified and skilled people who go on to serve businesses and public bodies across a very broad front in public services and in the private sector. An investor would find it difficult to contribute to that at a research level. Different arguments apply at undergraduate level. That is before you get to the creation of new businesses, improving the performance of existing ones and the huge contribution to public services in areas like healthcare, the environment and international development, all of which would be difficult for a private investor to earn a return from. Therefore, the taxpayer intervenes.

Q143 **Chair:** How will you advise BIS, which will have to make savings of between 25% and 40% in the Department, to make that money go further and still protect the virtuous cycle which you have described?

***Professor Reid***: There is a lot of discussion about efficiency in public spending circles. The first observation I would offer is that efficiency savings are sometimes used as a euphemism for cuts; in other words, you can only improve efficiency if you reduce the budget. In science that is demonstrably not always the case. If the highest level of efficiency is the goal, it is a pretty good goal for public spending, and we need to recognise that sometimes efficiency is driven up if you increase the budget rather than reduce it. For example, in your own constituency, Chair, on the Harwell campus you have very expensive pieces of scientific equipment, such as the ISIS neutron source and the Diamond synchrotron, which will not be utilised fully if there is insufficient recurrent expenditure to pay for their operation. If you want to drive up efficiency, in that case you need to spend more money rather than less.

Q144 **Chair:** You know the way to an MP's heart—talk about their constituency. You have brought me, very astutely, to my next question, which I am going to put to Nicola Dandridge from Universities UK—welcome. In your evidence to the Committee you have written that on a per unit spend basis UK-based research is 2.7 times as productive as USA-based research. On the basis of the evidence we have just heard from Professor Reid and from the

Minister in the first session, the question has to be: does this mean that as a country we can spend less and still maintain a competitive advantage with other nations, because we seem to be doing pretty well?

***Nicola Dandridge***: Indeed, we are doing very well. I apologise that Professor Sir Ian Diamond is not able to be with you today. His flight was cancelled. I know that he would very much have wanted to be here to give evidence. The answer to your question is no, we cannot assume that that efficiency can translate into what we would call under-investment in our science base. It does feel very fragile at the moment, and the long-term erosion of proper investment in research in this country risks doing substantial damage. I speak on behalf of universities in the UK. They are maintaining a fantastic position in the world. None the less, if we look at what our international competitors are doing in the far east—in China, for instance, where they are investing substantial amounts in their research infrastructure and capacity—we see that they are increasing their international leverage, their international reputation and the reputation of their universities. Even though we are doing very well, there is a real risk that that efficiency, which as Graeme described can be a cover for cuts, can start having a serious impact on our performance. I think we are reaching the stage where that efficiency could tip over into something which is significantly damaging.

For instance, the QS global ranking of universities came out today. There is a phenomenal rise in the universities in the far east and China. There is a correlation between the investment they make in their research and the performance of their universities. We should be concerned about that. While acknowledging that UK universities are very effective and efficient, we cannot push that very much further without it starting to have real impact on our global as well as our national performance. For all the reasons Graeme outlined, if we do not invest in our research it will have quite a serious impact on the contribution that universities are able to make to growth, productivity and all the other benefits that universities and science bring.

Q145 **Chair:** Putting aside for a moment the question of the correct rate of investment, which we will come to later, is your evidence to this Committee that there is no room for further efficiencies in universities, or do you think that, in addition to where the investment rate should be, there is room for further efficiencies?

***Nicola Dandridge***: There is always room for further efficiencies. We at Universities UK are pursuing an agenda that looks particularly at further asset-sharing and at collaborative procurement. That agenda will continue, but they are not mutually exclusive. You should be pursuing an agenda of efficiencies while maintaining proper investment in our universities, so I would not want to establish that dichotomy and say that carrying out further efficiencies therefore justifies a lack of proper investment. We need to do both.

If we are looking at things from a global perspective, we are leading the way in efficiencies in many respects in the world. None the less, the comparison between what we are investing in our universities and what other countries are investing is now so stark and so extreme in terms of percentage of GDP—I am sure you have those figures—that looking at it through the lens of whether we can make greater efficiencies is quite dangerous. We need to do both. We need to carry on the agenda of efficiencies, but we absolutely need proper investment, and proper sustained investment. What matters is that third parties and private investors see the confidence that the science ring fence exudes. It

leverages their investment. We need to be talking about sustained, long-term and confident public investment in our universities, and then it will have the beneficial impact that we have been describing.

Q146 **Chris Green:** Naomi, the Campaign for Science and Engineering provided evidence which shows that, "The total research base budget, which includes resource and capital investment, has increased in cash terms from £5.5 billion in 2010/11 to a planned £5.9 billion in 2015/16." Surely, that raises a concern, looking at the rest of the challenges the economy has had and other impacts on Departments, if you are complaining about the loss of increased investment when other Departments have seen cuts. How would you defend that position?

***Naomi Weir***: In looking at the overall position, there have been some increases in the scope of what is considered within that budget, particularly around international development. Some of that spending comes in. But taking a step back and looking particularly at investment in science and R and D across Government, particularly the science base budget, including capital as you describe, and what the Government have stated they want to achieve—whether that is productivity, economic growth, the creation of high-value jobs, skilled individuals and various other areas, including efficiencies in public sector services, particularly within the health service—investment in R and D is not a spend in that sense; it is actually investment in areas of Government priority beyond science itself. That is the lens through which we have to look at science investment. It is not a spend to be reduced but an investment that can be used to achieve Government aims, including ways of ensuring the efficient use of public spend across other Government Departments as well.

Q147 **Chris Green:** The spending is increasing in cash terms, but there has been an increase in private sector investment. Does that demonstrate that we do not necessarily need an increase in public sector investment if we just encourage the private sector to invest more?

***Naomi Weir***: That is an interesting question. There is good economic evidence, some of which we commissioned, and a growing evidence base, showing that public investment is an attractor for private sector investment. That describes what you have seen: public sector investment has drawn in additional private sector investment. But, equally, one cannot substitute for the other. If you reduce public sector investment, you will not get an increase in charitable or private sector investment to fill the gap. Instead, because of the additive, or attractor, effect of public investment you will lose not only the public investment in the science base but the additional private sector investment it would otherwise have attracted, so your reduction is multiplied by the loss of private sector investment as well. On the other hand, increases in public sector investment have been shown to attract investment, so any increases are additive; you would then multiply the amount of private sector investment that is attracted, bringing the wider benefits we discussed earlier. There is good economic evidence showing the link between the public and private sector but also that they work together and cannot be substituted for one another.

Q148 **Chris Green:** Is there an ideal ratio or proportion of GDP to attract that additional spending?

***Naomi Weir***: Various economic studies have looked at this type of question. If we look internationally at the total investment in R and D—public, private and third sector—in the UK, as well as, say, Germany and the US, it is about a third public, and about two thirds

private, charity or other investment. We have the same approximate ratio as other nations. It is accepted that that is what seems to happen in terms of ratios if you look internationally, so you would expect increases in our public investment to bring in those sorts of levels. I believe that studies by BIS looked at the returns, with the optimum level for total investment being around 2.3% to 2.6% of GDP. We are nowhere near that; we are about 1.6% of GDP. Interestingly, that is the level of our international leading peers, so at the moment we are nowhere near approaching what economic studies seem to suggest is the optimum level.

***Professor Reid***: To add a small embellishment to Naomi's point, the OECD average is total research spending of 2.4% of GDP. Germany and the United States are around that level; one is a little above and the other is a little below. The academic analysis suggests between 2.3% and 2.6% as an optimum level, so you can see a clustering of data around, say, a little less than 2.5%, and the UK level is 1.6%.

Q149 **Liz McInnes:** CaSE's figures for the current Parliament suggest a growing disparity between capital and resource budgets, assuming that the resource budget is maintained at current levels. How sustainable do you think that is?

***Naomi Weir***: Our analysis looks at the cumulative erosion of public investment in science through the science budget and the capital budget over the last Parliament. If you add those together, it looks like a £1 billion shortfall compared with if the budget had been maintained in real terms. If you roll that forward with flat cash for the resource side of the budget and take the commitment from the Government to inflation-proof £1.1 billion a year on the capital side, over the 10 years from 2010 to the end of this Parliament you see about £2.3 billion less being spent on science than if they had both been maintained in real terms.

On the disparity between capital and resource, if you just look at resource, over £3 billion less is being spent—an erosion of £3 billion over 10 years; but it is made up for by the inflation-proof capital commitment. What we have is increasing distance between investments in those two funding streams, which means that potentially we have the situation Graeme alluded to where capital, perhaps facilities and equipment, does not have the resource to make sure that it is used well. It is a very inefficient way of investing public funds.

The capital investment is a forward-thinking commitment recognising the various benefits that investing in scientific infrastructure brings to underpinning UK scientific success, but if that is not aligned with a resource budget it will not be used optimally or efficiently, as Graeme described. That is recognised in the science and innovation strategy that the Government are holding to, saying that this spending review is their opportunity. They recognise that capital alone needs sufficient resource funding to go along with it, so the spending review is their opportunity to do that. Certainly, we would like to see the Government committing to sufficient resource to ensure that the capital can be well spent, but also that the wider scientific capacity of the UK is not damaged.

Q150 **Liz McInnes:** What are your reasonable hopes and expectations for the science budget? Do you think there is a possibility that the resource budget could be reduced, which would exacerbate the problem you have just described? What reasonably do you expect?

***Naomi Weir***: We heard the context set out by the Chair at the beginning in terms of what the Department for Business, Innovation and Skills had been asked to look for in terms of cuts. If we look at what the Government have stated they want to achieve in terms of productivity, creating high-value jobs and highlighting science as a personal priority for all the various benefits it brings, meeting those aims will become increasingly difficult without firm commitment over the long term to science. A reasonable ask, even within the current constraints, would be for the science and research base to be properly resourced. I would like to see the total investment in R and D across Government increased by the end of this Parliament above inflation, particularly with low inflation at the moment and the predictions for growth. There is a real opportunity to make sure that science and innovation can make its full contribution to that, to make sure that the UK has the means by which to grow, be productive and create jobs.

Q151 **Chair:** To be clear, do you want to see the innovation and science budgets linked in a single ring fence, or not?

***Naomi Weir***: At the moment, the science and innovation budgets have very different audiences; one is very business-focused and the other very focused on the research base, so they have very different stakeholders with whom they interact. Putting them in one ring fence would not necessarily be the answer. The total ask is to look at R and D spend across Government, because about 60% of Government investment in R and D is housed within BIS in the science, capital and innovation budgets, but about 40% of it is across other Departments, notably the Department of Health and the Ministry of Defence but also other Departments. We come to that later in your inquiry, so maybe we can discuss it later.

Q152 **Jim Dowd:** Can I look at the ring fence? Professor Reid, you have spoken on this in these very precincts in the not too distant past. How important has the ring fence been as a mechanism for protecting the science budget, and, therefore, how important is its continuation?

***Professor Reid***: I think the ring fence has been fundamental to explaining why this country has a high-performing science base and low levels of investment. The ring fence does several things. It provides a degree of protection for the funds held within it, but almost as important as that, it sends a signal to organisations in business and the charitable world about the persistence and predictability of the funding. If you are an organisation in business or charities, whether in the UK or overseas, the ring fence is sending a signal that when the budget is set it is going to stay. That allows you to make longer-term plans for collaboration. It also allows university leaders and the leaders of research institutions to make plans, secure in the knowledge that the budget they were told they were going to get in three years' time is the budget that will arrive.

Q153 **Jim Dowd:** It is a very important element.

***Professor Reid***: It is a fundamental part of the science ecosystem in the UK.

Q154 **Jim Dowd:** Is it more important to science spending than other areas of public spending?

***Professor Reid***: You would have to analyse that area by area, but one of the things that distinguishes science from others is the leverage of business and charitable funding that

Nicola and Naomi have referred to. That signal being sent to people who are going on to co-invest with the science budget is a characteristic that is not shared by all other areas of public spending. It is quite a rare characteristic on the scale that we see in science.

Q155 **Jim Dowd:** Could you elaborate on your fears of what you have called tucking in? For those who do not realise what it is, it is your fear that the budget is preserved and protected but made to cover more activities.

***Professor Reid***: There are very clever civil servants whose job it is to present whatever the conclusion is in the most positive light. One of the devices that has been used historically is tucking under, whereby you protect the budget, or you might even increase the budget, but you also increase the number of things that must be covered by the budget. That provides you with a headline about protection, or even increase, but if you are a budget consumer it jolly well does not feel that way. In 2010, when I am afraid I was writing the document—

**Chair:** So it was you, Professor Reid.

***Professor Reid***: We protected the budget at flat cash, but if you look closely, you will find that £100 million a year for the UK space agency appeared inside the budget for the first time. It had to stretch a bit further, but the headline was flat cash.

Q156 **Jim Dowd:** So the budget needs to be protected from people like you.

***Professor Reid***: No, it needs to be protected from people like I used to be. I am an entirely reformed character.

Q157 **Chair:** Speaking of things that appeared in the budget in 2010, what is the position of Universities UK on the nature of what should be included, or not, in the ring fence after 2016?

***Nicola Dandridge***: In terms of what is in the ring fence, it has to represent the fluidity of investment in a whole spectrum of issues, including blue skies research and vocational research. Any artificial distinctions between the different categories of research would undermine the strength of what we do. What is in and what is out has to be tested against what will have the most impact and not necessarily create artificial barriers. We would approach that question by looking at the impact of any categorisation, and we would want to ensure that it is responsive to the particular requirements and strengths of the research base. That is a rather theoretical answer, but it depends on testing what has the most impact in terms of quality of the research.

***Naomi Weir***: Looking back to 2010, the shape of the ring fence as well as perhaps the dilution of it was changed slightly, in that capital was taken outside the science ring fence. That led to capital funding receiving large cuts in 2010. Those were added back in with ad hoc investments over the term of the Parliament. That led to the very unstable investment profile and capital budgets for institutions over the last Parliament. Part of that is, I suppose, a case study demonstrating the value of the ring fence for stability; taking things in or out of the ring fence can be a destabiliser. Now we have capital that is not necessarily in what is currently called the ring fence but has a long-term trajectory that seems to be stable until 2021, so taking something out of the ring fence now so that short-term cut

pressures can take precedence over long-term commitment and investment in areas that have long lead times would be very damaging and concerning.

Q158 **Carol Monaghan:** Professor Reid, in June this year you talked about science and research spending possibly being treated as capital investment in the future. How feasible and desirable is it to link together capital and resource budgets for science?

***Professor Reid***: My understanding of this is that it is a done deal, and it comes from a new accounting protocol from Brussels, the European Standard of Accounting 10, or ESA10, under which Government investment in R and D will be classified as capital across the EU. My understanding is also that the UK is going to introduce that protocol at some point after the spending review, so we are going to do the spending review under current protocol, and at some point it will transfer to this capital-only regime. I do not think anyone knows what that will mean. It is easy to speculate that somehow it is going to transform the landscape in which we make the case for science. I am not entirely convinced that it is going to be such a transformation. I am going to wait and see how it is implemented.

Q159 **Carol Monaghan:** How have research departments and universities been affected by having separate cash flows for capital and resources?

***Professor Reid***: It makes it more difficult to deliver efficiency, because you are being given two cheques and you end up having to spend the money on what you can spend it on rather than what you should spend it on.

Q160 **Carol Monaghan:** Is it as clear cut as that? You cannot be creative in your budgets.

***Professor Reid***: It is absolutely not in the interests of a university to play games with the public accounts. The relationship between the funders and the universities is too important to play games with. I am not an expert in university finance; Nicola might know more. I see the accounting requirements of public funding treated very seriously indeed in my university, which is the only one I have observed.

***Nicola Dandridge***: I would echo that. There is no sense in which universities are going to mess around with those sorts of requirements, but you hear stories about investment in capital that then cannot be adequately resourced. That is both an inefficiency and a frustration, which is why having that fluidity, for the reasons Naomi and Graeme described, is really important.

Q161 **Matt Warman:** Is that, therefore, an example of a genuine potential efficiency saving that is not a cut masquerading as an efficiency? It would be something that would free you up in a meaningful way.

***Professor Reid***: If ESA10 was implemented in a way that removed the barrier between capital and recurrent expenditure, I would have thought it would allow more flexible management of finance at local level, and that would create the potential for efficiency. I have to say that I think it would create a risk as well. It would create a risk that people would build up recurrent expenditure and not make provision for long-term capital investment. It would require new forms of discipline to be exercised at local level, which are currently exercised at central level. As with so many things in life, it has good points and bad points.

Q162 **Matt Warman:** How would you guard against that?

***Professor Reid***: One thing we have not brought out so far is just how competitive the science and research system is, and the way that competition, both inside the country and internationally, is a major driver of efficiency. The incentive for universities and research institutes is to be efficient in order to get the most science for the money, in order to beat the competition. That incentive is enormously powerful for individual academics and university leaders. Whatever the accounting protocol, that incentive will remain. Both university leaders and individual scientists have a long-term view because research is a long-term endeavour. It is not that it would become an entirely undisciplined endeavour but one of the checks and balances would shift location from the centre of Government to local spenders.

Q163 **Derek Thomas:** I note that CaSE and Universities UK would like us to concentrate on, or at least adhere to, the primacy of the Haldane principle where researchers are better placed to decide how money is spent than politicians. I guess we sign up to that. When you have a Government that wants to focus its efforts on, and put its weight and money behind, using science and innovation as a tool for generating local and regional growth, how does that compromise the Haldane principle? Can that work, or is it just compromising what you have been saying?

***Naomi Weir***: The Haldane principle holds that Government, and politicians in those roles, certainly have an important role in setting the strategic direction of the science strategy for the UK, so they do not have to be at odds. There is certainly a political role in guiding that strategic direction. Alongside national strategic priorities, there will be a role for that, for elected politicians and the elected Government working in partnership with research leaders, building on the UK's strengths. There obviously are also international dimensions to some of the questions.

It gets very tricky where you have much lower level research priorities in what science is funded versus strategic direction. The science community gets very nervous about political decisions being made at that level, because they will not be based on what is the best science to be funded, which has long been shown to be an efficient and good way of ensuring that your investment is well used. That is where the nerves comes in. It is not that politicians are involved at all; as elected politicians who invest a large amount of money in science across Government, there is certainly a role for Government in setting strategic direction along with research leaders, but then it is a matter of making sure that decisions at a lower level about what science is funded are based on very long-held principles of funding excellence, wherever it exists, based on peer-reviewed assessment of excellence. One of the reasons we have such a high-performing science base is due to that long-held principle, which not all nations follow in the same way. There is certainly a risk where that gets challenged by political decision making.

***Nicola Dandridge***: I totally agree with that analysis. One of the issues is about the length of time in which returns are sought. Often, the returns on investment in science contribute to productivity and growth and have an amazing impact on the wellbeing of all the citizens in the country and the world, but that impact is very much longer than perhaps politicians want. I think some of the tension arises in terms of the rate and speed of return. If a politician is focusing on a very short-term return, that may conflict with the inevitable and necessary time scale of serious research, which will produce those returns but over a much

longer period of time. It comes back to the science ring fence and the long-term strategic guarantee of some sort of ring fence, because it allows for those returns but acknowledges there will be a period of time before they are identifiable and produced.

Q164 **Derek Thomas:** Are the Government right to pick winners by electing to focus more resources on so-called great technologies? Is that something you would encourage?

***Professor Reid***: The eight great technologies are easily interpreted to mean Government picking winners. They were selected with a considerable amount of input from the research councils. I do not see any conflict between the eight great technologies, as articulated by David Willetts, and the Haldane principle. What David Willetts was setting out to do, and I think did successfully, was to use them to put colour and excitement into an otherwise abstract discussion about science. I did not sense any attempt to subvert the meritocratic decision making that was going on. I understand entirely why that question arises, and I hope my answer gives some comfort.

Q165 **Dr Mathias:** You spoke about making something abstract and visualising it. My question, perhaps to all of the panel, is about the innovation budget. What is your opinion about that in absolute terms but also relative to the science budget ring fence itself?

***Professor Reid***: The innovation budget, to my mind, is a very clear part of the BIS departmental agenda; it is there to support business and the economy. The science budget, on the other hand, is held in custody by BIS on behalf of more or less all Government Departments. That is why the science budget includes the arts and humanities, animal health, medical research and so on. It is a profoundly different rationale for public spending, and the innovation budget is to BIS as the international development research budget is to DFID, and so on. That is why I would separate them and handle them differently. On relative size, it is ever so tempting to draw a comparison between the science and innovation budgets, but another comparison, which I would favour, is between the BIS budget and research budgets in other Departments. I would compare the innovation budget with the budget for health research in the National Institute for Health Research, because that serves a departmental objective. Science is serving a Government-wide objective and is simply held in custody in BIS. I think I am right in saying that over the last 25 years the science budget has resided in five different Government Departments.

Q166 **Dr Mathias:** Do you share that analysis?

***Naomi Weir***: CaSE is funded by our members who are right across the science and engineering landscape, including industry. The industry members are, I suppose, the prime stakeholders in the innovation budget in that sense rather than research institutes. They see the science and innovation budgets very much as complementary. They do not seek to do the same thing; they do not operate in the same area, but they are complementary. Both are needed to ensure that we get the maximum benefits from Government-wide investment in R and D.

Q167 **Dr Mathias:** But you would not want them together in the same budget.

***Naomi Weir***: For reasons previously discussed, their administration, focus and stakeholder groups are very different. Even if they were held together and were called the same thing, you would have to have very different processes that would in effect make them separate

budgets in order to achieve what you get from those budgets as they are currently administered.

Q168 **Dr Mathias:** Do you take the same view?

***Nicola Dandridge***: I think our position is exactly the same.

**Dr Mathias:** Thanks. That fits with the research councils last week.

Q169 **Chair:** Professor Reid, I want to follow up your point that innovation is a BIS priority, whereas the science budget is a Government-wide priority. The evidence we have received so far is that it is quite hard to unpick the innovation budget, and there are pots for innovation scattered across Government. My view, quite clearly stated when I was appointed to this job, is that innovation is interdisciplinary. Where would our gaming industry, which has grown 13% since 2010, be without Tolkien? We need to see that interdisciplinary link from innovation all the way back to the arts and others. Do you not acknowledge the link between them, or have I misunderstood you?

***Professor Reid***: There is a close link, but there is also a close link between the Department of Health's National Institute for Health Research and the science budget, between DEFRA's animal health work and the science budget, and DFID's international development research and the science budget. Because they are located in the same Department it is easy to overstate that one link, when actually it is one link of many within Government.

Q170 **Victoria Borwick:** For clarification, is there any evidence that the BIS science budget is being used increasingly to fund work that in the past was paid for by other Government Departments?

***Professor Reid***: I am not aware of that evidence, but I am aware of that risk.

Q171 **Victoria Borwick:** We want a bit of clarity around the table. If anybody has a view, we would welcome it.

***Professor Reid***: It may have happened. I could not point to an instance of it happening, but I could point to the risk. The risk comes from reductions in Government Departments' spending on science and research, but a consistent demand for scientific evidence, and Government Departments, therefore, turning to the research base and asking it to fill that gap. My university has been approached by several Government Departments asking if we can do work that at one time would have been done inside the Department. Those approaches are thoroughly welcome and we look forward to building those relationships, but we want to know who is going to pay the bills.

Q172 **Victoria Borwick:** To what extent does research expenditure in various Government Departments reduce the amount of money that Innovate UK and the innovation budget generally would otherwise need? Does one balance the other?

***Naomi Weir***: My view is that they do very different things.

**Victoria Borwick:** We touched on this a bit earlier.

***Naomi Weir***: Some of the research that Departments might want to commission might be around the evaluation of policy effectiveness, or very early stage research in a particular area; in DEFRA or the Ministry of Defence, there might be some very early stage research that they need to do that would not cross over with the innovation budget. I think they do very different things.

Q173 **Victoria Borwick:** We were very concerned about whether budgets were being taken from one thing to another, and we wanted it clearly minuted as to whether there were risks.

***Naomi Weir***: My understanding of departmental R and D, particularly outside BIS, is that over recent years some Departments have seen substantial and maintained cuts over and above the total departmental settlement for the budget. Some of the cuts are up to 50% year on year, so their budget might have quartered over a couple of years. My understanding is not that that funding is channelled through into R and D in another way, but instead that R and D investment by a Department is now being used perhaps on shorter-term departmental measures rather than protected for the use of R and D.

Q174 **Victoria Borwick:** Nicola, do you want to add anything to that?

***Nicola Dandridge***: No.

**Chair:** Thank you so much for coming to give evidence today. The whole Committee is seized of the significance of the CSR for the UK science base, and your contribution today is very valuable to us in trying to get to the bottom of all the different issues at hand. We may write to you to clarify some different points in the evidence today and your written evidence. Thank you very much.

**Examination of Witness**

*Witness:* **Professor Sir Mark Walport,** Government Chief Scientific Adviser, Government Office for Science, gave evidence.

Q175 **Chair:** Sir Mark, welcome. Thank you for coming to give evidence today. This is the third session in our science budget inquiry, but it is also your first appearance before the new Committee. I hope that it will be the first of many, both formal and informal sessions. Before we get into the details of spending and you give us words of wisdom from your experience, you kindly sent through a document, which came only to me and the clerks, with some details about priorities for the Government Office for Science in this Parliament. Could you give a little overview for colleagues who have not seen it?

***Sir Mark Walport***: Thank you very much, Madam Chairman. May I start by welcoming and congratulating you and the members of the Committee? I look forward to assisting you with your inquiries over the course of this Parliament. I would also like to thank you for your letter on the publication of the SAGE minutes relating to the Ebola crisis, and to let you know these have been published on the web today, so they will be available in time for your inquiry on the use of science in emergencies.

**Chair:** Thank you very much.

***Sir Mark Walport***: We are similarly publishing the five-year plan for the Government Office for Science, which will be available very shortly. My job, broadly, is to advise the Government on all aspects of science, engineering, technology and social science for all

Government policy. In some senses, you can divide the job into science for Government policy—how it affects electricity capacity margins and things like that—and what this inquiry is about, which is policy for science. That is only part of my job.

My priorities are those of the Government, which are essentially to protect the security and safety of us, the population, grow the economy and raise productivity. Science, which I will use in a slightly all-encompassing way from now on, has a crucial role in all of these. I have a particular role to ensure that the Government have the science capability they need to tackle the cross-cutting issues from their perspective at the heart of government.

You have seen the work plan and I will not spend a lot of time on it now. Essentially, it focuses on four key Government priorities. On supporting national growth and increasing the UK's productivity, we are doing a lot of work at the moment through a technology innovation futures project, looking at future disruptive technologies and how they can be applied for the benefit of the economy, but also for the benefit of how Government and others do their work: for example, how Government use data to make better policy and, equally, how they use it to deliver services more effectively.

On supporting regional growth, for example the foresight cities project is looking at what cities will be like in 2065, which is a little way off. We have been conducting seminars in cities around the country, and that is important for the regional agenda. On using technology to develop modern and more cost-effective public services, we are, for example, partnering with the Office for Life Sciences to deliver the NHS testbed programme, which will be an environment to help the NHS get the most of digitisation. An important part of our work is on trying, hopefully, to prevent crises but addressing them when they happen, and mapping security risks. We work through the Scientific Advisory Group for Emergencies—SAGE—to provide inputs into COBRA and provide support to the National Security Council through a body with the acronym NSCOS&T, which stands for National Security Council Officers (Science and Technology). That is it in a nutshell. I imagine you will want to spend more time on it on another occasion.

**Chair:** It is quite a large nutshell.

***Sir Mark Walport***: Yes, it is.

Q176 **Chair:** I am sure colleagues will want to pick up various of those points, but I am going to stick to the inquiry, because we are pressed for time today. We received evidence from BIS for the inquiry which included a paragraph which said that the Government's Chief Scientific Adviser "takes an overview of science and research spending decisions across Government and considers their implications for evidence-based policy making. All departments are required to consult the GCSA and HMT in advance of any potential cuts to research budgets or expenditure, including those that have implications for the funding of cross-cutting research." We received a second set of evidence from CaSE, which tells us: "Departmental R&D spending makes up about 40% of the Government's total expenditure on R&D. Between 2009…and…2012, half of all departments reduced R&D expenditure by 20% or more." Is the submission that we received from BIS accurate in your experience, and are you being properly consulted given the scale of R and D cuts across Government? Do you think that CSAs in Departments are having proper input to the spending review?

***Sir Mark Walport***: My role is an advisory one, and ultimately it is Ministers who decide these things; I am not accountable for the individual budgets. Indeed, I work very closely with the chief scientific advisers in each Government Department. The figures to which you have given the headlines disguise the fact that some Departments are going up and others are going down, so it is not entirely a negative picture. For example, the Department of Health budget went up from £932 million in 2010 to £952 million in 2013, so that has been maintained. I speak regularly both to permanent secretaries and to my CSA colleagues, and it will not surprise you that as the Government chief scientific adviser I think having the best science in order to make the best policy decisions, for example on diseases such as bovine tuberculosis or on the use of pesticides, depends on good evidence. I am always making the case for R and D. Am I always successful in my endeavours to maintain R and D budgets? The answer is that these are ultimately ministerial decisions, and some of them have been cut.

Q177 **Chair:** On the second part of my question, do you think that in addition to yourself CSAs are getting a proper hearing? I accept that their roles are advisory. Nevertheless, do you think they are being taken seriously?

***Sir Mark Walport***: Yes, I do think they are getting a proper hearing. That is a very broad question, and there are lots of different CSAs. Almost without exception, they are well positioned on the senior committees within their Departments. My experience is that they have access to Ministers and their advice is heard, but, as I often say, science is one of the lenses through which policy makers look when making decisions. They also have to look through their political lens and through the lens of policy deliverability. Do they always take the science advice? No, but they are the policy makers; we are the advisers.

Q178 **Chair:** At the last session we had a very interesting set of evidence from Innovate UK and a number of others, during which we all got rather exercised about these diagrams from the Dowling review, which map out the innovation landscape and the funding mechanisms through which researchers and businesses can access support. In your role, what engagement will you have with the Dowling recommendations for the simplification of support for innovation and research, and what do you think will be the impact on the spending review?

***Sir Mark Walport***: I have close and almost daily interactions with the research base in BIS. I am not part of the line of command, but I am in close, regular contact with them. I think that in her report Ann Dowling used a very nice expression—hiding the wiring. When you look around the world—one of the things we have been doing through the Newton Fund, which is a partnership with other countries—you see that almost every country has a rather complex network of different sources of funds. When I was director of the Wellcome Trust, it was sometimes put to me, "Why don't you put all your money together with everyone else?" The answer is that if you do that you get only one chance to fail, whereas when there are multiple schemes you get multiple opportunities. Having complexity is not entirely a bad thing, but I think that the landscape is excessively complicated and some of the wiring can be concealed. That is part of Paul Nurse's review, which we might come to as well, although he has met you directly. BIS is constantly reviewing and making sure that the mechanisms work as seamlessly together as possible. I know that the Government are looking at Ann Dowling's recommendations at the moment and will come back later in the year with a response.

**Chair:** Derek Thomas.

**Derek Thomas:** You have been very efficient. I think my questions have already been dealt with. Thank you.

Q179 **Victoria Borwick:** To go back to targets and overall spending on research and development in terms of percentage of GDP—it was touched on briefly in one of the earlier sessions—do you have a view on raising with Ministers the idea of a GDP-based target, or do you want another way?

***Sir Mark Walport***: I was taught very early on in science that a percentage rather depends on the denominator; 50% of a little is still rather a little, and 1% of a lot is a large amount of money, so simply having a percentage of GDP target may not be the most sensible thing. Having said that, the OECD figures, which I have here, speak for themselves. The R and D targets are a mixture of the public and the private, but in my role as Government chief scientist, and recognising that our modern world is shaped by the application of science, engineering, technology and the social sciences, it would be rather strange if I did not think it was good to spend effectively on R and D and innovation. We have a superb research base in our universities and institutes, and indeed in industry as well, and we have to make sure that it is applied for all the benefits that it brings. As others have told you, I think it is widely recognised that we have one of the most efficient, if not the most efficient, research bases in the world. In terms of pounds spent we get extraordinarily good value both in the public and the private sector. Would I wish that it was more? Well, I am the chief scientist. But I do not decide; Ministers make those decisions, and they make them in the context of all the other spending priorities.

Q180 **Victoria Borwick:** The EU's aspirational target to spend 3% of GDP on R and D was determined. Do you know what role the UK played in setting that EU target, or did it come directly? Does it come the other way?

***Sir Mark Walport***: That was well before my time. I do not know the answer to that, but the GDP of European countries varies so much that it is difficult to see it as an entirely rational—I hesitate to use that word—approach.

Q181 **Victoria Borwick:** We note that the Office for National Statistics persists in publishing international comparative figures for R and D expenditure as a percentage of GDP. Do you know the reason why it is done in that way, particularly in view of your other remarks?

***Sir Mark Walport***: Unless you know what the GDP is, you have to do a multiplication, but you would need to ask the ONS.

**Victoria Borwick: No problem at all. Thank you.**

Q182 **Chris Green:** Do you have any grounds for believing that the judgment of Ministers on the optimal level of science funding will differ substantially from 2010?

***Sir Mark Walport***: I think that really is a question you would have to ask Ministers. My job is to advise them, and mind-reading is not a subject of scientific endeavour.

Q183 **Chris Green:** We heard last week that British science is still producing excellent research and is still world leading in so many ways. We are expecting to balance the budget in 2018-2019. Surely, that should give us some cause to believe there will be an increase in the budget over that time, but I take it you have to remain neutral on this.

***Sir Mark Walport***: I encourage Ministers to take a positive view on spending on science. If you look at the record of the previous Government and the fact that new money was found, particularly for capital, throughout that Government, I am optimistic by nature.

Q184 **Dr Mathias:** If the science budget were to decrease in real terms—let's hope not—do you have an idea of specific programmes that might be affected?

***Sir Mark Walport***: No, and I do not think that has been decided. It would need to be partly on the balance in fundamental research on maintaining the absolute principle of excellence. Clearly, there would need to be some strategic judgments as well. To some extent, in the review by Sir Paul Nurse, which is looking at how the effectiveness of our excellent research councils can be made even more effective, that is the sort of question he would be thinking about as well.

Q185 **Chair:** One of the comments from the Minister when he appeared before us at our first session was that he felt the research councils could be playing a better role in foresight work, which is part of the role of the Government Office for Science. What is your view, given that this is right at the centre of what the Nurse review is looking at? How do you think research councils could play a better role in foresight and some strategy?

***Sir Mark Walport***: In a sense, there may be two parts to that question. Understanding the science landscape in the UK is absolutely essential in order to make the best decisions. I think that is an important role for the research councils, and I am sure that is something Sir Paul will look at.

In terms of foresight work, I think the challenge in horizon-scanning—call it what one will—is to make sure that is properly joined up within Government. It is something your predecessor Committee looked at. The Cabinet Secretary has an advisory group called CSAG, and I co-chair a group with the equally curious acronym GOSH, which stands for Government Oversight of Scanning the Horizons; I think it is—anyway, let's not go there. I co-chair that with Jon Day, chairman of the Joint Intelligence Committee. Horizon-scanning across Government itself is well joined up.

I think that raises another important question, which is the relationship between the spending of the research councils and the R and D spending of individual Departments. It is important. Government has a lot of scientific questions to which it needs answers, so if we are to solve the problems of, for example, plant and animal health, where there are all sorts of diseases lurking either within or outside our borders, it needs good R and D. There needs to be close working also between the research councils and the rest of Government in terms of the R and D needs of Government as well, though clearly an extremely important and fundamental aspect of research council spend is supporting people answering important scientific questions and discovering things that we do not know about, and we do not quite know what their applications will be until they have been discovered.

Q186 **Chair:** I feel a recommendation for hiding the wiring of Government acronyms coming on.

***Sir Mark Walport***: I am with you.

Q187 **Jim Dowd:** Of course, in these days of advancing wi-fi wiring becomes less and less prevalent. BIS and the Minister told us that the focus on deciding spending priorities in science is on the outputs and benefits that investment in science brings to the economy and society more generally. Do you think they are well placed to make those judgments?

***Sir Mark Walport***: That is where we may come to the Haldane principle, but who are the best scientists and brightest minds to support is an expert decision, which is best done by the process of peer review, which I think has served science very well not only here but around the world.

There are two slightly separate issues. There are some areas of research that declare themselves as important. A very good example of that would be Ebola. It would be a funny system where a disease such as Ebola emerged and there was not the capacity to respond to it with the necessary research. Equally, understanding the fundamental mechanisms of how plants defend themselves against viruses, for example, led to the discovery of small interfering RNAs, which have proved a profoundly important tool across biology. All the gene-editing discovery has come from very fundamental research, but when it comes to the choice of funding scientist a or scientist b, for example in the case of Ebola, that is an expert judgment best done by people who understand how scientists work and the quality of their outputs.

Q188 **Jim Dowd:** You individualised that very much in your response. I was thinking more in terms of general projects that need to be funded, but you are saying that you look at who is doing it.

***Sir Mark Walport***: I think you can divide it into two. There is a strategic question as to how you prioritise one area against another—how much you might spend on plant disease as opposed to animal disease. There are some strategic decisions, and a lot of players are entitled to have a voice there. When it comes to whether you should fund professor x or doctor y to answer a particular question, that requires different expertise.

Q189 **Jim Dowd:** Last week, Research Councils UK suggested to us that a typical time lag for research outputs was anywhere between zero and 20 years. Given the fact that some activities may be so far down the road, how on earth can they know that now when deciding the spending programme?

***Sir Mark Walport***: With respect, it is not research outputs but research impacts.

Q190 **Jim Dowd:** They said "outputs"; that was what they told us in their submission.

***Sir Mark Walport***: I would distinguish between the two. Research outputs usually come in reasonably close proximity to the research itself, although a dataset may be generated that is still giving outputs many years later. It is the impacts that typically take an enormously long time to emerge. For example, the discovery of graphene came quickly, but the impacts of the uses graphene can be put to may take many years to be fully developed.

Q191 **Matt Warman:** Now that capital and resource are ring-fenced together, do you think it was an error for them not to be ring-fenced in the first place? Is it a sign that there is greater understanding that science needs the certainty of funding for the future?

***Sir Mark Walport***: There are many areas where, if you are looking at long-term outputs, you need preferably stability of policy. An important signal that the Government attach to scientific research is that they have been prepared to put a ring fence around it. Of course, the critical question is how much money is in the ring fence, but the very fact that it is ring-fenced has been an important and long-standing signal to the research community that the Government value that fairly fundamental scientific research.

Q192 **Matt Warman:** Do you anticipate that that will continue as well?

***Sir Mark Walport***: Again, you would have to ask Ministers that. I have indicated my preference from my answer, but I am the adviser.

Q193 **Matt Warman:** On a minor point, are there potentially any disadvantages in putting resource and capital into the same ring fence?

***Sir Mark Walport***: I suppose the disadvantage is that what is out of the ring fence is therefore less protected in some ways, but again it is a denominator question. You have to look at what is in and what is out.

Q194 **Chair:** Innovate UK is currently responsible for the catapults, which have an important role in stimulating research at various stages of tech transfer. Evidence we have received is that some of those do not have the necessary resource to be at optimal operational level. Sitting in the position you do, you have a different perspective. Do you think that the resource following the capital is necessary to sweat the assets? Do you think it is at the right level?

***Sir Mark Walport***: Lord Krebs, the previous Chairman of the House of Lords Science and Technology Committee, put it very nicely when he talked about "batteries not included". If any organisation funds capital, it is odd if it then does not fund the revenue that goes to maximise the value of the capital. There is an issue about how long you go on funding the revenue associated with any particular capital investment. Because capital is invested in project x does not necessarily mean that the revenue should go on until time ceases, as it were. The catapults are still at an early phase, and it is clearly important for a good balance to be maintained between the capital and the revenue.

Q195 **Chair:** Are you aware of cases where there is not sufficient resource?

***Sir Mark Walport***: I have not looked into that in detail. I have heard the comments. I think that almost all of the catapults are still at a very early stage of gestation. It is to be hoped that they will be successful. They are a series of new organisations and some are likely to succeed more than others, but I am sure it is a topic that Innovate UK, which has a fair amount of flexibility as to how it chooses to use its own budget, will keep an eye on.

Q196 **Liz McInnes:** Following the triennial review of research councils, we also have ongoing reviews. You have already referred to the Nurse review, and there is also an ongoing review by McKinsey. Can you outline how these three different reviews will interact, and how they will feed into spending review decisions about the science budget?

***Sir Mark Walport***: As you know, the Nurse review was set up following the science and innovation strategy published by the last Government. Its terms of reference are publicly available. I could read them out, but there is really no point. They are about picking up

some of the points raised in the triennial review; making sure that, for example, there is the most effective co-ordination between the research councils, and that interdisciplinary research is well funded. Sir Paul is looking at that. The Dowling review looked specifically at innovation and how we turn knowledge into money, as opposed to turning money into knowledge.

I think the McKinsey review is rather lateral to all of this. It is a review of operational effectiveness in BIS and all the arm's length bodies that BIS looks at. It is looking at managerial issues rather than how they fund their science. I have not been party to that, but I think it is very different. I do not believe it duplicates Nurse or Dowling in any sense; it is looking at BIS and the arm's length bodies very broadly, so inevitably the research councils are one of those groups of bodies.

Q197 **Liz McInnes:** What impact do you think the McKinsey review will have?

***Sir Mark Walport***: I'm afraid I cannot answer that question. I was not consulted by the McKinsey review. I believe the research councils are a rather small part of it, but I am not the right person to ask that because it is a BIS review. Although we get our pay and rations from BIS, we are not part of BIS.

Q198 **Liz McInnes:** You say you have no input to the McKinsey review.

***Sir Mark Walport***: I am sure it has importance, but in terms of the science budget I do not think that is what the McKinsey review is primarily about. If you want the real chapter and verse, you will have to ask BIS officials.

Q199 **Carol Monaghan:** Universities UK point to the significance of the university-centric nature of the UK science base. To what extent do you feel the health of UK science is linked to the large amount of research funding going to universities?

***Sir Mark Walport***: One of the great strengths of the science system and of our British universities, which as we all know are among the best in the world—they are extraordinary—is that a great deal of research is located in universities. Students in research-intensive universities have the opportunity to be educated in an environment where scientific inquiry is being pursued. In other countries, the balance is different. For example, in Germany the balance is far more towards research institutes, such as the Max Planck Institute and Helmholtz. Frankly, I do not think these things are either/or; we need a mixture of institutes and universities. People can devote different fractions of their time to different activities, depending on whether they are in a pure research institute, whether they are doing their research in business or whether they are doing it in a university. There are some things which are more effectively done in an institute environment than in a university. For example, the sequencing of a third of the human genome, which happened at the Wellcome Trust Sanger Institute, was probably much more effectively done in an institute environment which was essentially running a 24/7 factory. It is not an either/or; it is how we have an appropriate balance between institutes and universities.

I also think that institutes have an extremely important catalytic activity in bringing universities together. The Francis Crick Institute, which will be opening fully for business in the first part of next year, has had a very powerful catalytic effect on enabling King's, Imperial and University College to work together. The new Alan Turing Institute, which

will open in a couple of months' time, has a partnership of five universities behind it, so institutes can be the glue that enables universities to work together. The important thing is that the boundaries between different scientific environments are as permeable as possible—that is one of the challenges—so that ideally academics can move between institutes and universities throughout their training. There should be permeability between the world of business and the world of universities. Indeed, in the Government Office for Science we have interns from universities, typically doing their PhDs, who learn a little about the application of science to Government policy. None of these things are alternatives; they are complementary to one another.

Q200 **Carol Monaghan:** While they are complementary, do you think we should be moving from the majority of research funding going to universities, or should we be looking at these alternative institutes as places where we should put funding?

***Sir Mark Walport***: We have a good balance. The vast majority of research funding is in universities. It would take an enormous shift to change that, and I do not detect any appetite for it to happen. Institutes can be embedded in universities. These things are not quite as distinct as is sometimes portrayed.

Q201 **Jim Dowd:** Can I look briefly at innovation? The Government have the declared intention of making the UK the best place in Europe for innovation. How can we measure their progress towards achieving that goal, or lack of it, as the case may be?

***Sir Mark Walport***: It will ultimately show in the spectrum of businesses that are contributing to the UK economy. We can already see the signs of that in the clusters of knowledge-intensive companies developing in many parts of the country, for example around Dundee in computer games, Tech City in London and the extraordinary cluster around Cambridge. We see this through the evidence of the economic growth that has accompanied it.

Q202 **Jim Dowd:** You mentioned previously the importance of the central role—if I understood you correctly, the dominant role—of universities in research capability in the UK. Do you think the current measurements of how they are doing are adequate?

***Sir Mark Walport***: I was talking primarily about public sector research. One should not neglect the extraordinary power of R and D in business and industry as well. Some of it is of the classical variety that we would recognise in an AstraZeneca or a GSK, the engineering you would see in a Rolls-Royce or the computer engineering that you would see in a company like ARM. We have a very strong SME sector. One of the challenges is to grow SMEs into medium enterprises, which is where patient capital will come from. Research in the private sector is also extraordinarily important. If you look at R and D around the world, in the UK it is about 0.5% of GDP—I am sorry to quote a percentage, but that is the way everyone does it—as opposed to 1.23% in the private sector. Interestingly, if you look at Israel it is 0.48% of GDP in the public sector and 3.5% in the private sector. The R and D question is at least as much a question about business as it is about public sector funding as well. One of the interesting issues in the UK is the shape of the economy, which is dominated by financial services. They tend not to talk about R and D, but they do quite a lot of it, so there is an issue of taxonomy as well.

Q203 **Jim Dowd:** There is an apparent growing focus on impacts—a term you used earlier—helpfully measuring this. Are there any other metrics we need to improve on that?

***Sir Mark Walport***: Impact is a bucket measurement; it aims to encompass all the measures of what has happened as a result of science and innovation. Impact could be improvement in health care or the better operation of a facility. There are all sorts of ways in which impact can be had—everything from aesthetic impact through to commercial impact.

Q204 **Derek Thomas:** My question relates to the Haldane principle. The previous panel were very generous in their replies, so hopefully you will be too. Who knows best—researchers or politicians? In terms of the Haldane principle, when it comes to the new agenda for promoting regional growth and how politicians get behind that, does that concern you? Is that threatening the Haldane principle?

***Sir Mark Walport***: No. I would strongly commend the Haldane report on the machinery of government. With respect, I would recommend that you all read it. It is a wonderful report on the whole machinery of government from the Ministry of Reconstruction in 1918. Haldane had six principles, and there is too much focus on one of them. These were set out in the science and innovation strategy. His first principle was that research and evidence was important to the development of Government policy. I say amen to that. The second one is that each Government Department should provide funds to answer specific policy questions. The third one is that there should be a department of Government charged with funding general research questions. The fourth—the one to which you are referring—is that the choice of how and by whom that research is conducted should be left to the decision of experts, but, fifth, that the questions and topics to be tackled should be considered as a result of close collaboration between what he called the administrative and the general departments. Finally, there should be a department that supports research applied to trade and industry.

In his report Haldane talked about the nascent Medical Research Council and commended it—this was at the end of the first world war—on the work that had been done looking at problems of national significance during the war, such as trench foot. Haldane was absolutely clear that the research agenda and the sorts of questions to be answered should, at least in part, be dictated by discussions between Government and those in receipt of Government funds.

On the issue of a place-based policy, it is a mistake to think that excellence is limited to just one or two parts of the country. There is excellence around the country, but the important thing—where Haldane comes in—is that excellence needs to be a priority. But there is excellence everywhere; therefore, it is entirely open to Ministers to take a view that taxpayers' money should be spent in a geographically dispersed fashion. The opportunity is to identify the strengths in different parts of the country and make sure that where money is regionally applied, it is building on strength and not funding the second rate. I see no sign of any appetite to fund anything other than excellence.

Q205 **Derek Thomas:** That is good. In terms of industrial strategies and the great eight technologies, given what you have just said, would you say there is no real tension in Ministers getting involved in what we would see as picking winners?

***Sir Mark Walport***: I think that is an unfortunate term, because it is a bit toxic. It is like "green shoots". A different way of looking at it is making choices; choices have to be made, and this is about making sure that the choices are good. It comes back to a question I was asked right at the beginning about the importance of understanding the research landscape, recognising that there is great academic strength throughout the country. We have to build on that. It does not make any sense to put all the money into a tiny fraction of the country; indeed, that has not happened for a very long time.

**Chair:** Sir Mark, thank you very much for your answers today; they are very helpful to us. As I have said to other witnesses, we may write to you and follow up some of the points. Next time you appear before us I may ask you to provide us with a glossary in advance to interpret your acronyms.

***Sir Mark Walport***: I am sorry. I'll try not to use them.

**Chair:** Other than that, you have been very generous with your time. I hope we will see you often.

## Examination of Witness

*Witness:* **Professor Brian Cox,** Physicist, gave evidence.

Q206 **Chair:** Professor Cox, welcome. As I have said to other witnesses, this is the third session of our science budget inquiry. It is kind of you to appear before us to give evidence on the issue. You have previously been very outspoken when there have been proposed cuts to the science budget, but as we have been discussing throughout this session—I know you have heard the evidence—BIS is an unprotected Department and it is going to have to find 25% to 40% cuts in this spending review. My first question to you is, given your role essentially as an ambassador for science, what do you think is the level of public support among taxpayers for funding science at a time when we are having to make choices between welfare, education and all sorts of other top priorities?

***Professor Cox***: Thank you, Madam Chairman, and thank you, Committee, for inviting me to give evidence. I would echo what has been said in this session and in previous sessions. I suppose the question is what the optimum level of R and D expenditure in the economy is that gives you the optimum level of return. We are talking about investment in growth and, therefore, investment in future productivity, among other things. I note that everybody agrees on the numbers. That is not because everybody has got together and decided to come up with a Machiavellian-type plan, but because, as far everyone can see, those numbers are facts. It seems that this level, of the order of 2.5%, of which about a third is public expenditure and two thirds is private, is agreed upon and backed up by all the research I have seen over many years. It also seems to be the level that is converged upon in our competitor nations, not only the OECD average but countries like Germany, the USA and so on. It is exceeded in some. As has been pointed out, it is significantly lower in the UK. For me it is surprising and remarkable that we are certainly the most efficient scientific nation in the world, and arguably one of the most effective. You will have seen the figures from the Royal Society—15% of the highest cited papers and 3% of the investment. It seems to me the correct answer is the level the data tell you gives you the biggest return and, therefore, the largest possible growth in the economy.

Q207 **Chair:** We heard from the Minister in our first session. He said that we were looking at this backwards and we are going to focus on outputs, and that if we looked just at inputs we were misdiagnosing the problem. If we obsess about the ring fence we have missed the point. Do you think that because we have such a productive science base in this country we do not need to fund it as much as we need to worry about education or something else?

***Professor Cox***: You can turn that around and say that the fact that we get such tremendous output from a small input means that a slightly larger input gives you even more tremendous output. That is the way I would read it. It is also true to say that the level of output at the moment, our excellence at the moment—all the evidence backs this up—surely is based on previous investments. It is true that there is a big lag time. If you look at the outputs from CERN, for example, the decisions to build the large hadron collider were made in the 1980s. The same goes for the big space missions that are providing our outputs now. If you go back in time and look at the possibility for generating those outputs, and the strength and health of the universities and research labs themselves, we are reaping the rewards of decisions made decades ago. If you are focusing on outputs, the correct question has to be: what do we have to invest now to make sure those outputs at least stay constant and world leading, but become more valuable as time goes on, as we would wish? We are looking at 10 and 20-year time scales.

Q208 **Chair:** The Government and this Committee are very concerned about the shortage in STEM skills. There is a concerted effort from Ministers and MPs in their own constituencies for representatives like you to attract young people, particularly girls, into STEM careers. An important plank of that campaign is science communication, but when we look at the BBC budget from the licence fee, it is £1 billion more than the science budget. When we are going into a spending review, would you say we are spending too much on the BBC or not too much on science?

***Professor Cox***: I do not think they are linked, but it is a good question. Putting the BBC to one side—I will comment on it in a moment—it is interesting that you link the science budget and the research outputs, linked to GDP, growth and so on, with communication. That is very important. To give you one small piece of evidence, I am involved in St Paul's Way school in Tower Hamlets. I am now a patron of the school. Back in 2007-08 it was a failing school. Through many interventions and ideas, the idea was to focus the school on science. Because I knew I was coming here I asked for the outputs from that focus. They are quite remarkable. Here is a school which focuses on science. It also, very importantly, collaborates with universities. A very important point is that the value of our universities, our great research-based universities, is untapped in some senses, and they can make a huge impact by collaborating with schools and the community. The figures are quite remarkable. The cohort going on to study STEM subjects at university increased by 88% since the regeneration of the sixth form in 2012; 100% of those students are from ethnic minorities. Forty per cent of the 2015 cohort are studying engineering courses, compared with 20% in 2012; 50% of the 2014 cohort studying STEM degrees are women—half of them. If you look at the numbers taking STEM subjects, for biology AS there is a 500% increase since 2012; for chemistry, it is a 700% increase; for physics, it is 150%; and for mathematics it is 233%. I could go on. They are quite remarkable figures, but the point is that we are seeing 50% of women going into STEM subjects and 100% of those students are from ethnic minorities in a deprived area like Tower Hamlets. It is

transforming that area. The reason is that research-active universities in the area, particularly Queen Mary in this case and also UCL, are collaborating with the school.

The impact of a healthy research sector—a university sector—can be massive. I see that as a pilot project. We have capacity in our research ecosystem in the universities which has not been taken up because of restricted funding. Once you start to increase that funding a little, the gearing of that extra freedom—sweating our assets, if you like—can be absolutely massive.

The same is true when you talk about the BBC. The BBC obviously does more than support the science ecosystem. You may have seen that I was involved in an announcement with Tony Hall last week about what the BBC wishes to do. I think it has taken its responsibility as a public institution more seriously than it has ever done since I have been involved with it over the last 10 years or so. It recognises that as a bridge to 97% of the British public every week it can make a difference; it can get these messages across and inspire young people as part of its remit. That is extremely important.

My suggestion to the BBC, which is also part of my involvement with St Paul's Way school and others, is very simple. We have world-leading institutions in this country. We have heard about the universities and research institutions, the BBC as a public sector broadcaster and also the schools. If those institutions can work together, in this case in the interests of science, the amplifying effect is tremendous. It seems to me that the question we should be asking is how we can focus and, I think, increase these budgets, slightly if necessary, to give us the freedom to do things like that. If you replicate that throughout the country, we transform the economy, we transform the prospects of young people and we transform our research base. That is the language we need to be using. We are using quite technical language about relatively small amounts of money as a percentage of GDP. As we have seen, they are extremely small by international standards, but they make a terrific impact.

Q209 **Chair:** If that would be the impact of increasing it, what do you think would be the impact of reducing the science budget?

***Professor Cox***: When I heard that I would be called to give evidence I looked through all the evidence that had been submitted. I have been in research for 20 years roughly speaking, most of it not on television but mostly involved with STFC and, before that, PPARC, and it seems to me that now we are at a crossroads. It is a frightening but potentially exciting crossroads. If you look at STFC's evidence to the Committee, it is frightening because I have never seen a stronger and more fearful submission to a spending review from a research council. I was involved very heavily in the problems just after STFC was formed after CSR07. The last time I gave evidence to this Committee was in 2010. We called it a physics funding crisis then because of the way the merger between PPARC and CCLRC and STFC's budget was handled, which essentially had been flat cash since 2007. We predicted that there would be a 25% reduction in PhD students, very large reductions in early career researchers, postdocs and so on. All of that has happened. Now it looks like STFC is in a position where, unless there is an increase in its budget of something like 10%, essentially it will either pull out of major areas of research or we will see a collapse in the funding of younger researchers. That is extremely important and very serious. I get the sense that the same problems exist across all research councils. I know you have had lots of evidence about why that is. In STFC's case it is because we are

paying for large facilities and not staffing them with enough researchers. It is an obvious thing. The fixed costs are very large and the flexible costs, which pay for the researchers who are going to be the future and who will drive increases in productivity in the economy, are just not there.

The reason it is exciting as well is that we are in the position that we are still, just about, the world's leading research base. We still have the infrastructure and we still have universities that are world leading. We have the possibility, with small increases, of generating terrific gearing in return. Imagine that we have the Diamond light source sitting there and we cannot afford to pay anybody to work at it. Obviously, we can pay people to work at it, but there is excess capacity, and that is going to grow if STFC gets flat cash or even not a large increase. By small increases you are funding scientists to go into already existing and paid-for viable infrastructure facilities and generating much more knowledge for small inputs. That is exciting.

Another exciting thing is the change in public attitudes to science, which goes back to your initial question. When we fought the battles back in 2007 for STFC, one thing we all noticed was that there did not seem to be strong public awareness of science or strong public support for it. Many of us felt we needed to address that and pay much more attention to outreach, both in schools and to the public in general. That was one of the reasons I got involved in television for the first time. That has worked. There is no doubt. If you look at the surveys done now, an overwhelming majority of people think that investment in science is positive for them, their children and the future of the country. That is different from what it was 10 years ago. That means we are in a position where increases in funding will, I think, be geared very highly to increases in productivity and economic growth very quickly, because we have the capacity. We also have unprecedented support and demand from young people and from the population in general. That is why I am excited as well as concerned.

Q210 **Derek Thomas:** We are talking about public awareness and enthusiasm for science, and I want to thank you for the contribution you have made. I have sat in front of the TV with my eight-year-old son and it has cost me money, so I do not know how grateful I should be for having to go out to buy science kits and various bits and pieces. Clearly, the awareness of science has increased, which is fantastic, and more can be done, but does that translate into a commitment by the public to fund it, in the way that there has been public support for money for the armed forces and to help refugees? Do you think we have done enough to get similar support and enthusiasm for taxpayers' money to be put in and behind science?

***Professor Cox***: Yes is the answer. I am just looking for the Ipsos MORI survey figures for 2014 in the Royal Society's report. I think you have those. If I remember rightly, about 75% of the public agreed with the suggestion that the funding of science was something the Government should do. I will find the figures for you; eight in 10 agree that, even if it brings no immediate benefit, scientific research which advances knowledge should be funded by Government, and two thirds disagree that this funding should be cut because the money could be better spent elsewhere. That was an Ipsos MORI survey in 2014.

Q211 **Derek Thomas:** In a difficult funding environment do you think that the public would support a freeze or even an increase in science funding?

***Professor Cox***: Yes, if it is framed correctly. As I tried to say when I was talking about the particular school I was involved in, we can demonstrate it evidentially but we can also point to the political rhetoric. George Osborne has said, "We want to make Britain the best place in the world to do science." Why do we want to do that? Not only do we want to grow the economy but we want opportunities in the knowledge-intensive services and industries for our children. We often focus too narrowly on the science budget. The investment we are talking about forms the basis of future prosperity and, therefore, opportunities for all the students who are at school at the moment, or a large percentage of them. We want them to be in high-skilled industries. We cannot have that without a healthy science base.

Q212 **Victoria Borwick:** I have been energised about how you have raised the profile, understanding, attractiveness and impact of science as a subject. I commend that. I think everyone around this table is very motivated by that. In general, are you optimistic or pessimistic about the future of science? Do you think it is going to get better?

***Professor Cox***: If there is another flat cash settlement, realistically it is dire. That is not my opinion; it seems to be the unanimous opinion of the research councils. Certainly in my area, for the STFC, it is an absolute disaster. I would be extremely pessimistic if that happened. I spend a lot of time going to schools, talking to students and telling them that putting their energies into STEM is the way they can secure a better future and have a very enjoyable time while they are doing it. That is true at the moment, but it will not be true if we become a second-class scientific nation. Where will those jobs be? In the STFC high-profile areas—particle physics, astronomy and nuclear physics—we have seen a 25% decrease in the number of PhD studentships, so what message does that send out? We are talking about budgets in single-figure millions, because the young researchers are the cheapest ones, but we cannot afford to pay them. Because of the capacity that is still there from previous investment it is clear that for every extra £1 we spend we can leverage large amounts, and increase not only productivity and GDP but excitement. It is about messages when you go into schools. Are these areas prosperous and successful? Is it possible for me to go and work for the European Space Agency as an engineer, or whatever it is? These questions are asked by students, and I have to answer them honestly. With a poor settlement under CSR, how do I answer honestly? I say that it will be increasingly difficult.

Q213 **Victoria Borwick:** Have you seen any positive trends?

***Professor Cox***: Absolutely; I gave the figures earlier. I give you one other example. I brought with me a piece of evidence. I am involved in the Jon Egging Trust; I ran the Great North Run for them on Sunday, so I am still recovering from that. We focus on children who are having real difficulties for many reasons. They are selected by schools and put forward for these programmes because their attendance is low or they are disruptive—many reasons. Last week I was at an RAF base near Lincoln talking to 14 and 15-year-olds and I was sent the feedback. I talked to them about science. One 14-year-old said, "After today's talk I want to achieve my ambitions by thinking more deeply about the universe." Another 14-year-old said, "I'm inspired to become a better scientist." Another said, "I'm motivated to learn more about scientific discoveries and find something I am passionate about." These were 14 and 15-year-olds sent into the programmes in the trust because they were disruptive and going absolutely nowhere. It is

about collaboration as well. What we have there are institutions, in that case the military, the Royal Air Force, helping out with leadership programmes. The science budget feeds into that, with universities coming in, and companies like BAe Systems looking at giving those people apprenticeships.

If you join up the assets we have in this country by not putting so much financial pressure on them that they cannot operate and become narrowly focused, the effect is amplified terrifically. The examples I have given you are not anecdotal; there is some evidence there, but it speaks volumes about what we could do with the capacity and capability we have.

**Victoria Borwick:** That is really encouraging.

Q214 **Matt Warman:** When it comes to where we are spending the money, do you think we are spending it in the right place? There is always the fear that the big sexy topics get a disproportionate amount of cash and some of the less exciting but potentially more lucrative stuff does not get what it deserves. Is that fair? What would you change if you could?

***Professor Cox***: I know that the Nurse review is looking at this to some extent. For me, the answer is: how was it we became the most efficient scientific nation in the world? We got there over many decades by having a system that works terrifically well. By the way, one of the reasons it works is that there is intense competition, as has already been mentioned. The reason for the intense competition is that we have a throughput of young researchers who are hungry and displace the old guys. There is a good answer about the way funding is allocated. One of the great success stories is about Sir Andre Geim and Konstantin Novoselov at my university, Manchester, who won a Nobel prize. Graphene has been mentioned already. There is a big investment opportunity at Manchester. If you look at Andre Geim's speech in 2010 it is illuminating. Here is someone who came into the country from Russia initially, via Holland. He said, "My greatest thanks are reserved specifically for the responsive mode of EPSRC." That is what he thanks in his Nobel speech. "The funding system is democratic and non-xenophobic. Your position in an academic hierarchy or an old boys' network counts for little. Also, visionary ideas and grand promises to address social and economic needs play little role when it comes to peer review. In truth, responsive mode distributes its money on the basis of a recent track record." He goes on to say, paraphrasing Churchill, "The UK has the worst funding system except for all the others that I am aware of." That is important, because here is someone who won a Nobel prize. I was vaguely involved when he was appointed at Manchester. I was working there then. He came to Britain because of the freedom at a time when our science budget was expanding. It was during the time of Lord Sainsbury as Science Minister, when there was a large increase in funding. That brought people like him into the country. Through the responsive mode of EPSRC, as he said, and backing winners, in the sense that you back people with a recent track record who are hungry, young and want to do research, you get things like graphene. I could carry on quoting. I think Bill Gates got it right when he said, "I believe in innovation, and the way you get innovation is you fund research." These people are worth listening to; it is not just a series of quotes. I think it matters. There you see a tremendous success story for Britain, with a multi-billion-dollar, if not trillion-dollar, industry generated by funding great researchers in a field that did not even exist. He invented the field.

Q215 **Chair:** The point in that quote is that the research councils were responsive and they engaged well with the researcher. One piece of evidence we have received is about the complexity of the innovation and research landscape, and the difficulty some researchers and businesses have in accessing the funding, and knowing where to go with their idea—their eureka moment. What has been your experience of that? Do you think it is an indication that we have lots of different points of access and it is a positive thing, as we have heard in evidence from some people, or is it a problem that is blocking researchers and businesses from finding the right pot for them, because it is just too complicated to find the money?

***Professor Cox***: I have worked in particle physics, and I have limited experience of my own research being immediately of interest to local businesses. What tends to happen in particle physics is that things like medical imaging come out of it, or famously the worldwide web, which was a big collaborative thing. We have done a lot of work, certainly at the University of Manchester, in making individual researchers aware of their social responsibility in the sense that, if they do a piece of research that they think could be useful for whatever reason, they should be aware of the mechanisms and where they should go. They do not just sit there, publish it and leave it. What can they do?

I am not an expert in that area, but I think there is now an awareness among researchers. Curiosity-driven research has always been the foundation for great ideas that transform economies. That is obviously true; it has always been true, and it always will be true. What is important is that when you have an idea and make a discovery like graphene you make sure, first, that the patents are there; and, secondly, that the UK leads the translation of that knowledge into economic development, and so on.

One other thing that seems to be broadly agreed upon is one of the arguments for a broad research base, of which graphene is a good example. The argument for funding a broad research base goes back to your question about how we prioritise between areas. All the research tells you that you need excellence, if you can, across the whole spectrum. The reason for that is that you do not know where the next ideas will come from. They do not have to come from the UK, but in order for the UK to have any chance of translating ideas from anywhere in the world into economic activity—jobs and so on—you need researchers, PhDs and postdocs, trained in those areas. They are the engines of innovation; they are the bridge between ideas and industry. What we do know is that one of the key jobs of universities and of the science budget is to train that cohort of bridges, if you like, so that when the new knowledge comes in we can make it work in our economy. That is a necessary but not sufficient part of the innovation process.

Q216 **Chris Green:** Many fantastic fundamental research projects capture the public imagination; they are on television and in the media a great deal, but over a period of time naturally interest fades away. What benefits, practical or otherwise, can the taxpayer expect from fundamental scientific research?

***Professor Cox***: You have to look at the past in order to understand what the benefit is. It is impossible to predict. For example, I get asked a lot, "What's the Higgs boson going to do for me?" The answer is that I do not know, but I can point back not only to spin-offs. The spin-offs of particle physics are well known: medical imaging and of course the worldwide web. It almost seems rather unfair when you talk to economists. If you ask, "How much was that worth?" it is a lot, but it is worth pointing out that Tim Berners-Lee said he did not feel it could have been done anywhere else but at CERN, because of the specific

challenges we had there, or we have, with international collaboration, large amounts of data and so on. That is one of the reasons why CERN drives innovation.

Looking back through history, the compact disc player, for example, generated huge revenues for the music industry, but it comes from two pieces of basic research. One famously is the laser, which essentially you can trace back to Einstein. Quantum mechanics comes out of the attempt to understand the structure of atoms. There is a very famous quote. When Rutherford discovered the nucleus in Manchester someone asked him what use it would be. He said, "Well, it certainly will not be an energy source; you're talking moonshine if you think that." Within 30 years we had not only atomic weapons but the first nuclear reactors. You cannot tell, other than that it seems to me self-evident that the more you learn about the way nature works, the more opportunities there are to develop technologies that will increase life expectancy and so on.

There is another very famous quote by Fleming, which is worth noting. He said, "When I woke up just after dawn on 28 September 1928 I certainly didn't plan to revolutionise medicine by discovering the first antibiotic." It is a very important point. It seems abstract, but I know from my 10 or so years of dealing with politicians and funding questions that we could give many concrete examples of research leading to a train of innovation and economic benefit. It is worth pointing out that the things we take for granted now, such as modern electronics, modern health care and all those things, came from fundamental curiosity-driven research not long ago, and it has not gone away. Graphene is a good example. That was curiosity-driven research. It is very important that we do not lose that lead in Britain.

Q217 **Chris Green:** It may be quite a while until we see great innovations from these research projects, but we have a whole catalogue of research projects we can look to and say, "This is a pointer for the future."

***Professor Cox***: You have to. I emphasise that. It is virtually impossible, as far as I can see, to pick the next field that will lead to increased economic growth, by whichever metric you like to measure its worth. I cannot see how you can do it. The history of science tells you that it is a random branching tree a lot of the time. I do not envy people who have to—I was going to say—focus the money. It seems to me the evidence is there that, if you have a broad and strong research base, you take advantage of those discoveries wherever they come from.

**Chair:** I think we could trade appropriate quotes all day. One of my favourites is from Lord Porter, Nobel laureate: "There are two kinds of research: applied research and not yet applied research; it's just about time scales."

Q218 **Carol Monaghan:** It is an honour to have you here today, Professor Cox. I know that many of my former physics students are watching today and are excited about this as well. At the weekend I actually managed to have a conversation with my 16-year-old son, simply because you were going to be here, so thanks very much for that.

We have talked a lot about science funding. I am not one you have to convince about that, but within it do you think that there are other specific things that we could look at? I would like to know your thoughts on how we should be funding women in science and engineering—STEM—and how we could make science more attractive to them.

***Professor Cox***: It is a terrifically complicated question. I am asked this a lot. You may know that some of the work that has been done suggests what it is that puts off young women. It seems that before the age of about 10, 11 or 12 there is a completely democratic distribution of people being excited about everything at school, and somewhere we lose in physics and engineering. There is some evidence of parental and teacher influence or bias, not necessarily conscious, in the reaction to girls and boys saying different things about what they want to do. It is interesting to look at the experience at St Paul's Way school where that is not there. Fifty per cent of students who went into STEM subjects in 2014 were young women. What has been done right there? It is a case study to look at. I do not know. I know it is a complicated issue. It is easy to refer to role models and so on. That is important.

If we go back to the comments on the BBC, one of the things the BBC has taken very seriously, and will continue to take seriously, is the fact that it can put academics on television, and it thinks very carefully about the spectrum of those academics. You have people like Alice Roberts, Helen Czerski and Maggie Aderin-Pocock. There is a gender balance and a balance of people from different backgrounds, but all academics presenting science programmes. I think that is important.

As an aside, the power of those people who get into the public eye is not just in the period they spend on television; it is the work they do afterwards and the fact that they lecture in universities and go into schools. By making people like Alice Roberts, for example, national figures, the BBC has a multiplier effect. She does not go away when she is not filming TV; she is working in schools and universities. I think she lectures at Birmingham.

Q219 **Carol Monaghan:** But that role would require a financial input.

***Professor Cox***: Absolutely. I have spoken to colleagues about the potential problems at STFC if there is not a significant—something like 10%—increase in the budget; otherwise, it is a very rapid decline in the capability of that research council. One of the things it does is immediately hold the throughput of young researchers. You do not get rid of the old professors; they tend to stay where they are. We have seen this demographic cliff before. When I came through as a young researcher, my age group was relatively isolated. There was a big gap up to the old guys, because of funding problems in the previous 10 or 20 years. We will halt the ability to take those young researchers and use them as role models; they will not be there. For me, the key message is that the whole thing is joined up. We are discussing a much bigger thing; it is not just the science budget but the whole thing. It is inspiring children at school, the basis of a knowledge-intensive economy and so on.

When looked at in those terms, the numbers become tiny. When we look at the crisis at STFC back in 2007 and the one we are facing now, we are talking about single-figure millions, or tens of millions, a year; it is not billions. The aspiration of the Royal Society is an increase of 0.69% or 0.67% of GDP. That is what they are hoping for over the next CSR, just about catching up with our competitors. All the evidence suggests that we are talking about single-figure billions which have a gearing effect of tens of billions; they are multiple percentage points on GDP.

Q220 **Liz McInnes:** I want to ask about the contribution made by overseas students to UK science. It has been quite a political issue recently. What are your thoughts on what funding

arrangements and visa regulations would best encourage overseas students to make a contribution to UK science?

***Professor Cox***: It is a tremendous contribution. You will know the figures; it is about £13 billion a year. As far as I can see, everybody who is sensible suggests that the student numbers from overseas should not be involved in immigration targets. It is completely indefensible and daft. I think everybody knows that. It seems to me that the political argument has to be made. This is not what the controversy about immigration, such as it is, is about. The economic and social benefits are clear, and the benefits to our soft power are clear. We are talking about the best and brightest people from around the world who will come to the UK and be educated at UK universities. Some will stay and contribute to the UK economy; some will go back and become powerful and influential people across the world. That soft power is probably more valuable than the immediate economic impact of the fees those students pay. We should strive to encourage that immigration.

I was in India relatively recently filming for the BBC. There were big headlines in the papers about how the UK was clamping down on Indian medical students and doctors coming into the NHS. There were extremely negative headlines in the Indian press. The impact of clamping down on student numbers and postgrads and postdocs and so on would be horrendous. It is beyond the financial.

Q221 **Liz McInnes:** Do you think the whole issue of overseas students coming here at the moment is having a potentially detrimental effect on British science?

***Professor Cox***: Yes, of course. The fewer overseas students we have, in economic terms the less well-funded our universities will be, because the less we will get in fees, but it goes way beyond that; it is about UK soft power as well.

Q222 **Matt Warman:** This is a question that came from the public that chimes with my own experience. If I look back to the PhD my wife did, which she finished in 2006, not a single one of her cohort is now working in academic science. That seems to be the story across the piece. What do we need to do to fix career prospects, in terms of what people can do when they are going into their first academic job, and give them a sense of where they are going to end up?

***Professor Cox***: We all know there is a shortage of trained STEM graduates in the economy. I was at an oil industry conference in Aberdeen last week. Even though the economics of the oil industry are problematic at the moment, the conference was focused on getting young engineers and young people into oil and gas exploration. They understood that you cannot have those demographic cliffs and big valleys of talent; you invest in the downturn so you can take advantage of the upturn.

The reason we have a shortage of STEM graduates going into engineering is that they are so valuable to the economy, and so well trained, that they tend to go into other jobs. That just tells you we do not have enough of them. How do you get more STEM places and more people going into PhDs and postdocs? You fund them. It seems very simple to me. I read a lot of complex jumping through hoops about this, but it is rather simple. If you pay for those places, more people will do it and you will have a higher-skilled workforce. I do not think there is anything more to say about it.

Q223 **Matt Warman:** But there is an issue about keeping people in academia and working with industry as well, and there is the sense that we are losing some of our brightest graduates very early on. What can we do, other than just paying them as much as they earn in industry?

***Professor Cox***: I do not necessarily mean you pay them well; you make sure the jobs are available. I keep mentioning STFC because I know about it. The problem if there is a bad settlement under the CSR is that there would not be enough money to fund postdocs. In fact, there will not be enough money to fund PhD studentships, so we will not have those people. At Manchester, I have not seen a lack of demand among the students I teach. I teach physics to 280 students in their first year at Manchester. Many of them come to me and I will say, "What would you like to do?" They say, "I want to do a PhD in something or other." The problem is that, although it is good that there is a high level of competition for PhD places, we could fill many more. PhD students and postdocs are extremely valuable to researchers. They mean that we do better research because the academics have more intellectual support. We could fill twice as many places. It is simply a question of funding at that relatively small level.

**Chair:** Professor Cox, thank you for your time today. I do not think there is anyone in this room who would question the fact that we urgently need the case for science to be made as loudly as possible. You are someone who is particularly good at making the case for science in a way that can be understood by all sections of society. On behalf of the Committee, I would like to thank you for the work you do in making sure that happens. We have heard your concerns about the possible outcome of the spending review. We will take note of those and also of your views about the way in which science spending could amplify the impacts on the UK economy. Thank you for your time. That brings this session to a close.