

Science and Technology Committee

Oral evidence: [Science Budget and Industrial Strategy](#), HC 496

Tuesday 7 November 2017

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Members present: Norman Lamb (Chair); Stephen Metcalfe; Neil O'Brien; Stephanie Peacock; Graham Stringer; Martin Whitfield.

Questions 1 - 89

Witnesses

[I](#): Rebecca Endean, Strategy Director, UK Research and Innovation; Professor Richard Jones, Professor of Physics, University of Sheffield; Professor Paul Boyle, Chair, Research Policy Network, Universities UK; and Alun Evans, Chief Executive, British Academy.

[II](#): Dr Ruth McKernan, Chief Executive, Innovate UK; David Connell, Senior Research Fellow, Centre for Business Research, University of Cambridge; Tom Thackray, Director for Innovation, CBI; and Tom Morrison-Bell, Head of Public Affairs, techUK.

Examination of witnesses

Witnesses: Rebecca Endean, Professor Jones, Professor Boyle and Alun Evans.

Q1 Chair: Welcome, all of you. Thank you very much indeed for coming in. Can we start by each of you introducing yourselves and saying where you are from? Then we will get into the questions.

Alun Evans: Thank you, Chair. I am Alun Evans, chief executive of the British Academy, which is the national academy for the humanities and the social sciences.

Rebecca Endean: I am Rebecca Endean, strategy director at UK Research and Innovation. I work for Sir Mark Walport, who sends his apologies. He had a prearranged visit to Germany today.

Professor Jones: I am Richard Jones. I am a professor of physics at the University of Sheffield. I am here representing the Royal Society. I should also mention that I was a member of the independent Industrial Strategy Commission, which published its final report last year.

Chair: Last week.

Professor Jones: Yes.

Professor Boyle: I am Paul Boyle, vice-chancellor at the University of Leicester. I am here representing Universities UK. I chair the research policy network and previously I was chief executive at ESRC, the Economic and Social Research Council.

Q2 Chair: Welcome all of you. We are meeting in the run-up to the publication of the industrial strategy White Paper, and indeed the Budget in a fortnight's time. What do you want to see in the Budget, starting with Alun?

Alun Evans: The academy is very committed to the industrial strategy, and one of the things we will certainly want to see is further investment or commitment to the industrial strategy, particularly on the importance of the service sector to the economy, which I might say something more about later, if I may. Sometimes when one looks at the start of the industrial strategy, there is a strong focus on manufacturing and high-tech sectors. If you look at the areas in which Britain has comparative advantage, many of them lie in the service sector, which is 80% of the economy. It would be very helpful if the Government could signal as well their support for the six initial areas supported by the industrial strategy challenge fund, moving into areas that would support the service sector such as areas of cities, the ageing society, the digital economy, tackling pollution and congestion, globalisation and new technologies, but I can say more about that in the future if you would like.



Rebecca Endean: We very much welcome the Government's continued commitment to spending on research and development, building on the £4.7 billion that we received this time last year. We are incredibly grateful for that. We continue to work with Government to look at ways in which we could allocate that funding most efficiently, and we want to work with the Government going forward to provide them with the best possible strategic advice, which, as you know, was a key function of our organisation, as set out in the HER Act.

Q3 **Chair:** The question, just to be clear, is what you are hoping to see in the Budget. Make sure you try to respond to that question, if possible.

Professor Jones: The Royal Society welcomes the commitment to 2.4%. It would like to see that commitment made explicit, and it would like to see more detail of how the Government plan to reach that 2.4% target. That has to involve the whole innovation landscape, the private part of it as much as the public part. We would like to see how that translates into the geographical distribution of R&D. When it comes to initiatives such as the industrial strategy challenge fund, we are very keen to see that they do not always benefit incumbents, and that they leave room for the disruptive innovators we think will be important for driving productivity growth in the future.

Q4 **Chair:** Given that it is quite an audacious target to hit 2.4% in that 10-year period, do you have a view about how much extra the Government will need to commit in order to hit that figure?

Professor Jones: The Royal Society has a briefing document that all the Committee can have—the Clerk has it—which sets out where we are now.¹ The additional money announced in the autumn statement is welcome but is still not quite enough to get to the amount of spending that the public sector would need to put in. Then, of course, there need to be some assumptions about how the private sector responds, because a very necessary increase in private sector R&D would need to be added.

Professor Boyle: Like the other speakers, we certainly welcome the investment in the industrial strategy challenge fund. It is a very wise strategic investment. There are some areas where we would like to see development over time. Following up the first point that was made, not only do we think there is sense in looking at some of the other disciplines not being entirely STEM focused in this, but in particular we are pleased to see that some of the themes that are coming through now look to us to be more multidisciplinary. In some areas, we would welcome slightly more multidisciplinary approaches.

We would like to remind the Committee that we must never forget fundamental research. While we strongly support the money that has gone into Innovate and the industrial challenge areas, we must not forget that fundamental research is a critical part of what we do. Indeed, that is

¹ [Investing in UK Research and Development, November 2017](#).



the bit that it will be very hard ever to get business and others to come to the table for, so we encourage everyone to remember that fundamental research is important. Indirectly related to that, and in the Higher Education and Research Act that went through just recently, we of course strongly support the dual support system. We have seen about a 3% uplift in the research council spend—that half of the investment—and we have seen the QR side pretty much flat cash since 2010. It will be important to think carefully about how those two things come back into balance. It is an extremely valuable source that helps a lot of fundamental work in universities, which does not necessarily get resource from elsewhere.

Finally, there is a lot of interest in place, and how we think about allocating research and innovation spend geographically. We, of course, would support excellence as the primary motive for funding, particularly in research areas, but there is work that could be done particularly around industrial and business collaboration. We would want to promote clusters of universities being brought together, rather than individual universities. We think there is scope for bringing clusters of universities together to help fund and support businesses in a range of different ways.

Q5 Chair: Particularly looking perhaps at lower income regions where there could be a significant return on the investment in terms of economic regeneration as well.

Professor Boyle: There is no question at all but that universities act as significant anchor institutions all across the country. You are right that there are some parts of the country in particular where their expertise could be used to bring together small and medium-sized enterprises. There is no question as well but that we know that that sort of work leads to economic growth.

While we strongly support excellence—we think excellence has to be a driver—there is a lot of work that can be done with businesses at the moment, really bringing businesses up to speed with some of the work we are already doing. A lot of networking could help there.

Q6 Chair: We will return to that issue a little later, but thank you for that. Can I address the question of the balance between public and private? With the increased funding that the Government have already confirmed, going to £2 billion additional, one assumes that it will generate extra private investment. How sure can we be of that linkage? Do we think that the ratio will remain the same in percentage terms? How much do you think we will get from the private sector for the additional £2 billion that we are investing from the public sector?

Professor Jones: As a rule of thumb, you generally expect about twice as much private sector investment as you get public sector. That is based on international comparisons. The ratio is not uniform. Some countries, particularly far eastern countries, have a much greater proportion of



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private sector investment compared with their public sector; roughly 2:1 is the average for OECD countries.

The UK has low business R&D investment in two senses. It is low because the amount of public sector investment is low, so to some extent we get what we deserve. We actually get a little bit less than we deserve. Of course the other very important factor about business R&D in the UK, which makes the UK a real outlier, is that more than half the business R&D in the UK is funded by overseas companies. That is positive, in the sense that it illustrates the importance of the science base in attracting overseas R&D investment; but, on the other hand, one might worry that it makes it more footloose, and with the changes from leaving the EU and suchlike, one cannot really take that for granted.

Q7 **Chair:** Are there any other contributions?

Rebecca Endean: There is a fairly substantial evidence base that public funding leverages in at micro level substantial amounts of business investment and foreign direct investment. That is obviously based on studies that were done in the past and in other countries. We would hope, by carefully designing and implementing policies, to maximise that leverage as far as possible.

Q8 **Chair:** A report commissioned by BEIS, published in October this year, showed that Britain was losing ground internationally: "Britain is losing ground in the global research race and risks being unable to sustain its position as a 'world-leading research nation'." It talks about a reducing share of the total spend on R&D, and the UK share of global academic citations dropping from 11.6% in 2012 to 10.7% in 2014, and China increasing in the other direction. Is the UK's fall in the league table commensurate with other European countries? Is it because of the rise of Asian economies, or are we doing worse than other European countries?

Alun Evans: I do not think it is all to do with what you said, Chair, but we are doing worse than other European countries. If you look at some figures in a briefing document produced by the four academies investing in UK R&D, which I think the Committee has, the chart at figure 2 on page 3 is quite alarming in a way, comparing France, Germany, Finland and other places with the United Kingdom. That highlights, it seems to me, both the absolute low level and the need for an increase towards 2.4% of the minimum. We have also set an aspirational target of 3%, which would be 1% from public and 2% from private, using the 2:1 comparator. It is probably, from my view, a bit too early to say that we are definitely going down compared with China. Those figures are alarming, but in comparison with the rest of Europe we have a lot of catching up to do, which is why it is so important at the moment to get the increase in investment that colleagues have been talking about.

Q9 **Chair:** Do you have confidence, based on the current investment plans, that we could hit the 2.4%, let alone 3% as a longer-term objective in the 10-year period?



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Alun Evans: I have reasonable confidence that we are going in the right direction towards 2.4%. It would need a step change to move towards 3%.

Rebecca Endean: On the Elsevier report that you published, it is partly due to other nations, in particular China and some more developing countries, actually developing their research base and therefore increasing their outputs, and that has to be welcomed. Where we still lead the world is basically in our effectiveness—how many outputs we get per pound we spend. That is still very good, and I think, if not best, second-best across the whole world. That position has not changed. Obviously, you need to keep your inputs, as well as keeping your effectiveness and your efficiency growing. The UK is still a very effective and efficient country.

Professor Boyle: The report demonstrated both points. It is true that some other nations are coming up strongly. In Europe, for example, Italy has done particularly well over the period that has just been looked at, whereas Germany—

Q10 **Chair:** Does that reflect a commitment to increased public spend or is it caused by other things?

Professor Boyle: It is a mixture of things. I do not think it is all down to public spend, but I support Rebecca's point that we are effective as a nation in our spend, but you would not want to be effective for too long, because, effectively, for a long period, we have seen inputs being flat. That is why, of course, we welcome the new investment that is coming along. That would have made an impact on the period. It is inevitable that if we carry on with flat cash while other countries are rising—certainly Germany, the United States and Japan all have close to 3% investment currently—it is no surprise to see some of those countries doing better than us.

Q11 **Chair:** Do you all think that we should be aspiring, in rough terms, to the 3% objective? I appreciate that a percentage is not an end in itself, but, as a reasonable proxy for increased commitment, is it a sensible thing to focus on?

Professor Jones: To go back to the point about whether it is other countries catching up or us declining, China is the big story. The date that is important is 2009, when the research intensity of the Chinese economy overtook the research intensity of the UK. It is very important to recognise that. Ten years ago there was a certain amount of complacency, and people thought China was pouring in huge amounts of money but the quality was not very good. We are now starting to see real quality, particularly as so many expatriates go back to China and build up their research effort. As to whether we are falling back, Professor Boyle's point is exactly right; we have had flat cash pretty much since about 2008-09 while other countries have been increasing their investment, so it is no surprise.



The target is good, but you need to think about the whole innovation system. It is not sufficient to say that we need 2.4% or 3%. You need to think about how it is distributed across the different disciplines, particularly how it is distributed between basic research, translational research and private sector research, and indeed how it is distributed across the country. The target is good, but we need to get beneath it.

- Q12 **Chair:** Obviously, the Brexit negotiation hangs over everything at the moment. Is there any concern, or indeed evidence, that it is having an impact on the private sector's willingness to invest in R&D, or are the trends still in the right direction?

Alun Evans: It is probably too early to tell. I have not seen any evidence, and I do not know whether my colleagues have. It is obviously a risk, but I do not think there is any evidence yet that that is happening.

Professor Boyle: If you are making a general point, you are right; it is a little difficult to see the evidence, but of course there will be the specific point that businesses may be much less willing to invest in European funding schemes at the current time, because of the uncertainty about whether or not the grants and so on that might be awarded in collaboration with universities and others may or may not continue. Clearly, the Government have set out a very helpful underwrite approach. Of course, that is yet to be ironed out with the Commission, and they are still uncertain about how the underwrite would actually work, hence their recent reminder, a few days ago, that at the end, when we leave, or Brexit, the parts of those grants that are funded for the UK would end. There is obviously a bit of risk there, I think.

- Q13 **Stephen Metcalfe:** I think we all generally welcomed the announcement of an industrial strategy, but it is a strategy, so you have to back it up with something. Do you think that the seven—which I think is the number, although you mentioned eight—projects that have been funded so far as part of the industrial strategy challenge fund actually represent a strategy, or is it a bit scattergun?

Alun Evans: At the moment, it probably is a bit scattergun and it needs to be given more shape. An industrial strategy is not just a list of enthusiasms; it is an integrated whole that picks up various different levers that will help drive growth. One thing I commend to the Committee, if I may, is a document we published yesterday, called "The Most Important Challenges of Our Time," a copy of which has gone to the Select Committee. It is written by myself and my president, Lord Stern, who stood down in the summer, and focuses on what are the drivers of an industrial strategy. We try to bring out three. First are what we call the vertical drivers, which are areas in which the UK has clear comparative advantage, talking about the service sector, which I mentioned earlier. They are things such as the creative industries, the financial sector, professional services and science research in universities themselves.



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Secondly, there are the horizontal drivers, the so-called supply-side stuff, which the Government are very committed to, things such as promoting innovation, promoting open competitive markets, promoting infrastructure spend and, most of all, improving skill levels, which are essential to industrial strategy. We also urge UKRI, as part of its strategy, to develop areas where we can get more integrated cross-disciplinary, or interdisciplinary, work—to pick up the point Professor Boyle mentioned earlier—in areas that clearly will drive growth. The type of areas that we have picked out are cities, the ageing society, health and social services integration, tackling pollution, and the implications of globalisation and new technologies for the world of work.

To give the Committee one example—cities—if one gets various elements working well together in cities, such as good housing and design, good architecture, good use of open spaces, the rights and responsibilities of citizens, tackling pollution, congestion charging, museums, galleries, libraries and places where people want to live, the public investment, it seems to me, is followed by private investment. That then draws in capital and people, and you end up with thriving cities. We see this around the world from San Francisco to Barcelona, or perhaps Cambridge in this country. That really drives growth, so it is a virtuous circle.

Those are the types of areas where we think there should be more investment, and we look forward very much to the second phase of the industrial strategy challenge fund, to see whether it can help invest in those areas. Obviously, all disciplines work together—science, technology, engineering and mathematics—but I would argue, certainly as the British Academy, that in some of the areas I was talking about, the social sciences and the humanities have just as much to add, working together with the other disciplines to give an integrated approach to the challenges of our day, be it cities, ageing societies, health and social services and so on.

Professor Boyle: We are making significant progress in joining up the strategy. You asked whether it was a really coherent strategy, and I think there is progress being made. As I said at the beginning, we certainly support the emphasis on industrial strategy that the Government are now pushing for. Despite that, we still think more can be done. UKRI is going to help a lot with that. We need Innovate and the research councils to be a bit more bonded around some of these issues. It would be better if the research and innovation landscape was a little more joined up. I am a little unclear how the science and innovation audits that were encouraged and requested are being used, and indeed whether there is a strategy for them going forward. We need a little more emphasis on them perhaps.

We need to look outside this country and think about how industrial strategies are developed elsewhere. In the German strategy in particular, they put a lot of emphasis on internationalisation. I do not know that we have quite embedded internationalisation in our industrial thinking as much as we might have done, and I certainly encourage people to look at



the German strategy, which really tries its hardest to embed it in a globalising world. How do we make sure that our innovation and research are both global in what they are doing?

Professor Jones: One theme that our Industrial Strategy Commission was keen to emphasise was the idea of moving away from a wholly supply-led approach to innovation to a more demand-led approach. By that, we mean—similar to what Professor Evans was talking about—that we look for the big issues that Government really need to solve over the next 10 or 20 years, big areas in which the Government spend colossal sums of money anyway and where innovation is needed, otherwise the Government will fail to deliver things they need to deliver.

The two examples that leap out are health and social care. Integrating those two areas is really important, and again, to emphasise the point, this is not a thing that a single discipline solves; it is one where social sciences are just as important as hard sciences. The other is decarbonisation of the energy economy. The climate targets that the UK Government have signed up to—quite correctly, in my view—will be getting very tough to deliver around 2030, certainly in any kind of affordable way. There needs to be a much more focused approach by Government to thinking how they can use the resources they already deploy to drive innovation much harder in those areas, and to bring in the private sector as well to solve the problems. That will be part of the answer to the question of how we get private sector innovation to match, to do its share of the increase to 2.4% or 3%.

Q14 **Chair:** Just to be clear, I understand confronting the big challenges and that the private sector plays a big part, but how do you get the private sector to play its part?

Professor Jones: The private sector are—

Chair: What levers should we be using?

Professor Jones: A very familiar argument: the procurement budget. The Government spend enormous sums of money on health and social care. We have some successful examples; SBRI is an example of how it could work, but it is very small in scale. It is effective when it works, but it is subscale relative to the scale of the challenges involved.

Government spending on energy is not so direct, but, as Professor Helm's report indicated, the Government have, essentially, asserted almost total control over the energy industry, whether on purpose or by accident. They should use that more purposefully to drive the innovation they need to get affordable low-carbon energy.

Q15 **Graham Stringer:** Dieter Helm's report is that the Government are making a complete mess of the energy industry by putting extra costs on it. That is the only interpretation of his report.

Professor Jones: That is certainly a view that is widely held.



Chair: Do you want to ask a supplementary, Graham?

Graham Stringer: It would lead us into a whole line of questions. I won't go there.

Q16 **Stephen Metcalfe:** Rebecca, did you want to answer?

Rebecca Endean: Obviously, the industrial strategy challenge fund is something that UK Research and Innovation thinks is critically important. Of the £4.7 billion that was allocated to R&D at the last Budget, about £2 billion was earmarked for the industrial strategy challenge fund, and there are still considerable further waves to be developed. As we develop them, we are very keen that they are industry led, that they are interdisciplinary, that they have academics and businesses working together and that they help to generate growth. We are working very closely with the community and businesses to develop further challenges, and Ministers should announce them in due course.

Q17 **Stephen Metcalfe:** While they are interesting areas to examine, they do not yet fully present a coherent strategy.

Rebecca Endean: Our role is to develop them, and it is an area where the research councils and Innovate are currently working very closely together, and jointly working with businesses and the community, to do that. In the end, Ministers get to decide the overall strategy and the overall priorities, and they will decide the overall priorities for the next wave.

Q18 **Stephen Metcalfe:** Another aim of the industrial strategy generally was to bridge the productivity gap, and there are priorities in how we might do that. Where do you think the industrial strategy can have an impact on productivity priorities, and is what we have done so far with the industrial strategy challenge fund beginning to address those issues?

Professor Jones: The productivity gap is crucially important and very interesting. It manifests itself both as the overall stagnation of productivity since the financial crisis and the gross disparities of productivity across the country. We are seeing the interesting consensus now that a big part of the productivity problem arises from those disparities. We have leading companies that are highly productive, and then we have a long tail of companies that are less good. We have leading regions that are enormously productive, and then we have a very long tail of regions, essentially everywhere outside London and the south-east, that are not. It is almost an arithmetic thing: we will not fix the productivity problem unless we address those long tails of performance both in firm distribution and in geographical distribution. The industrial strategy challenge fund can help in that.

If I can advertise my own university a little bit, one thing we have found enormously effective in Sheffield, which is one of the least successful core cities in terms of its productivity, has been our translational research activity in the Advanced Manufacturing Research Centre. That works



because it is focused on translational research. It brings together big companies and little companies—Rolls-Royce, Boeing and McLaren at the big end and the SME base—and in that way combines innovation. It involves skills as well. We have several hundred apprentices who are involved in it. That all adds up to something that can lift an underperforming region by spreading the best practice, getting in really high-performing companies from outside, working with leading innovators and spreading that out to small companies. That is one approach in which translational research can be enormously helpful.

Q19 Stephen Metcalfe: Does anyone want to add to that?

Alun Evans: I agree with everything Professor Jones said, but would add that the place agenda is very important. If one gets elements in place working well together, particularly areas such as universities, hospitals in the centres of cities and business working in partnership, it can really drive productivity. In some areas, it is the only thing that can drive productivity. To take as an example Belfast, which I visited recently, the two biggest drivers of productivity are Queen's University and the hospital. Without those, there would not be that function. Where you can get the three working in tandem, there is the most chance of success in raising productivity in the way Professor Jones said, as will—to go back to the point I made earlier—playing to some of the sectors where we have natural comparative advantage, such as financial services, professional services and legal services, which will also probably benefit from Brexit in some ways, if they are lucky.

Professor Boyle: I agree with all the points that have been made. We must not forget that productivity is an exceptionally difficult thing to measure and compare across countries. One outcome of the productivity that we have in this country is related very much to unemployment being exceptionally low. An awful lot of companies may be using people in a way that they would not do if they were disinclined to do that. We also need to bear in mind that there is a range of ways of solving it. Some of the investments made already will have direct effects, things like AI and robotics and those sorts of things. It is also thinking about business practices, how we engage with companies to help them work in better ways. It is not just about technology. It is often about the way they work. Some of that work can be valuable. I think some of the sorts of things that Sheffield has been doing will be in the technological area but will also be about how businesses engage.

Rebecca Endean: I agree with what everyone said. I would remark on the importance of skills. Creating an absorptive capacity in the economy is one key role of the research and innovation base, to help generate the pipeline of people who can work with business and make the best of all the other forms of investment.

Q20 Stephen Metcalfe: I cannot remember who mentioned it, but there was some comment about the balance between incumbent technologies and disruptive technologies. Do you see that balance as correct at the



moment, and bearing in mind that there is still money in the challenge fund for investing, where would you put it—into more incumbent or into more disruptive technologies?

Professor Jones: It is a really important balance. Incumbent companies are important because they provide the capacity that we have already, and they can be important drivers of productivity in regions, but we know that there are some very exciting and important new technologies coming along that give opportunities for new entrants to make a real difference to productivity. I do not have to rehearse what they are. The increasing digitalisation of just about everything—what people call Industry 4.0—is a real thing. It gives opportunities for companies in all kinds of sectors to benefit.

The hard job that UKRI has to do is to get the balance right. In some ways, the incumbents will always be able to make their voice heard, so when you are doing science and innovation strategy, there needs to be a chair at the table that is occupied by the companies that are not here now but will be here in 20 years' time. You need to make sure that that unheard voice is anticipated, if you see what I mean.

Professor Boyle: Following directly on that last point, which I think is very important, universities have quite a role to play in that because often universities are not just themselves spinning out some of these ideas and companies but are also homes. Most universities have some form of incubator space where they try to engage with new and start-up companies, so we have a voice in that.

The critical thing for the research councils, Innovate and others is balance of risk. It is really important to be willing to fail and sometimes to fund things that are brilliant ideas but do not end up with the results you are hoping for. Without that risk, it is very hard for the disruptive technologies, in particular, to come through. It is ever so easy to say that we want to be more risky, but you have to ensure that the governance arrangements around UKRI and elsewhere are supportive of that because, occasionally, it means money looking as if it has been wasted. In fact, without some risk taken, you are going to miss some of the really exciting things.

- Q21 **Neil O'Brien:** Would it be helpful for the Government to set out more clearly the criteria for a good ISCF challenge? In our conversation so far, we have talked about a number of different principles that could make a particular area attractive to select for a future challenge. When I think about the first round of challenges, and things such as the electric battery challenge, there is a clear market demand, a lot of industrial buy-in, a balance of early, medium and industrialising research and a sort of coherent focus around a single technology, whereas some of the things that are for consultation in the second wave, such as an ageing society, seem much broader questions.

Do the panel think it would be useful to set out some clearer criteria? If



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you had to pick one or two criteria, what would they be? Would it be closing the science and innovation gap, addressing clear market failure, focusing on the productivity of the UK or stimulating private investment, or would it be going after the most important challenges facing our society? What would be the balance? I am interested in your different views on that.

Alun Evans: It would be useful, to answer your question directly, if Government were to set that out. As to the areas I would go for, you will find that in "The Most Important Challenges of Our Time"; I have listed about five, but we could probably get a list of 10. I would particularly focus on the cross-cutting and interdisciplinary aspects. If you look at the first wave—not that there is anything wrong with the subjects in the first wave—they tended to be, first, more on the manufacturing base, high-tech side, and, secondly, more single areas, such as batteries, robotics and space technology. Some of the cross-cutting challenges, such as the ageing society, are probably inherently more complex probably to work on. They speak very much to the productivity agenda, because if you got an ageing society working well you could save a lot of investment on the health service and get productivity from older workers. They speak very much to the challenges of today. I very much welcome the direction of your question.

Q22 **Chair:** Is it also where Government perhaps can give the greatest value added?

Alun Evans: Without a doubt. We are back to the age-old structure, having worked in Government for 30 years, of the problem of departmentalitis and silo-based working in departments. The hardest issues are not single department ones; they are cross-cutting ones where Whitehall has to work better together, where the Cabinet Committee structure has to work better and you cannot go back to saying everything has to be run by the centre, because that way you would put everything to the Prime Minister or Cabinet Office. The challenge of the governance of these cross-cutting challenges is one that needs to be faced. I think, Chair, you are absolutely spot on.

Rebecca Endean: The Government have been quite clear, and we have criteria we are looking at, which are that there needs to be a potential market that could be created, disrupted or improved by new technologies, research and innovation. There must be evidence that the advances can generate economic benefit. There needs to be capability within the research, innovation and business communities, and there needs to be evidence of clear business commitment to work with Government in this area. We need partners working with us.

Neil is quite right that some of the ideas are quite broad. One challenge is to narrow them down so that they focus on a specific challenge rather than just talking about ageing and social care more generally. For example, what technologies could help people stay in their home for



longer? That is a specific challenge that addresses all those four questions. It is part of the work we are doing at the moment.

Professor Jones: It is a great question. If am positive, I think productivity would be a very good overarching theme. If I can be negative, market failure has been something we have talked about for a long time. The time has come to recognise that that is probably not enough and one needs to go beyond talking about market failure to how the Government can make markets. Rebecca has already alluded to that.

The Government are in a position to shape new markets and to create opportunities for the private sector to benefit from that. That is going to be really important. It is about whether one can plausibly see that a market will be created from which the private sector can benefit. That involves understanding national landscape capabilities. It is also important to take a quite hard-nosed international view about how the UK fits into the broader landscape. There are very fast-moving developments in technology in many other countries, and one needs to be realistic about the niche where the UK can find and add value. It is a great question but difficult to answer. It is UKRI's core business to do that, and Rebecca has outlined some of the ways they are thinking about it.

Professor Boyle: I agree with everything that has been said. It is a very useful question, except that I probably would argue that, as you gave a very good and sensible list of things we would want to try to deliver, I am not sure you would necessarily want to narrow it down to one or two of those. It will depend on the particular body of work you are trying to fund, but the things you listed were sensible.

I will reiterate the point I made earlier, just to remind everyone—it is not a direct answer to your question, but it is close—that for us to succeed, a lot of the disruption will come from some of the very fundamental research. Let's not forget that while it is sensible, I think, to be more mission focused in trying to deliver answers, in some of our funding, we are also going to get answers to those questions from the fundamental work we do, but we would not know that when we set out on the trail.

Q23 **Neil O'Brien:** Universities UK have told us that they want the Government to require that ISCF bids in the future have to include consultation with universities. Would that be helpful or unhelpful to the programme, or is it irrelevant?

Professor Boyle: Should I start on that? You know what I am going to say. Perhaps I could explain by elaborating slightly. I said at the beginning that I genuinely believe that universities are very key anchor institutions in communities. That is not just in places where they have developed very large science parks and so on, which is one part of the story. It is also the relationships they have with very small businesses locally, and the very deep relationships they have with their local LEPs and indeed with the CBI and others. Universities have a role to play on



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this. As we are going forward, it is almost inevitable, in my view, that UKRI would want to listen to that, as part of the voice.

Professor Jones: UKRI has a really important role as a broker of information. There is a real need for analytical capacity. I do not believe that all the analytical capacity in the world is in Whitehall. Universities are full of people who have both local knowledge about their regions, as Paul discussed, and hard-core technical knowledge about what the likely innovations in the future are going to be.

UKRI has a really important role in absorbing that information from the research base, from the university base, and transmitting it to Government. UKRI receives strategic priorities from Government and responds to them, but it also needs to be a voice that is very strongly heard within Government, so that those insights, both about place and the new technologies, get heard and influence strategy discussions in Government.

Q24 **Martin Whitfield:** We have heard a lot of positive discussion about the industrial strategy, which is one element, but we also have the sector deals that are coming through. As an opener, would you like to comment on the relationship between the two and how they work, before possibly exploring it in a bit more detail?

Chair: Between the challenge fund—

Martin Whitfield: Yes, between the challenge fund and the sector deals themselves.

Rebecca Endean: We have talked quite a lot about the challenge fund, and obviously the challenge fund has been going since we got the autumn statement money last year. The way to think about the sector strategies are as aligned but slightly different. The sector strategies were announced in the industrial strategy Green Paper. They are basically an open-door challenge to various sector leaders to come up with ways of working with businesses, and with Government, to produce a strategy that helps reform the whole sector. Four have been published so far—life sciences, AI, creative and Juergen Maier's "Made Smarter." The strategies are meant to be much more broad-ranging than just R&D, but we are very pleased that all of them have a really big research and development component. As we work up our next wave of challenges, we are talking to Sir John Bell, Juergen Maier and everyone to make sure that the R&D element is captured in the industrial strategy challenge fund.

Q25 **Chair:** Are you happy that the response to the challenge to sectors has been good? Do you think there will be a continuing stream of sector deals coming through, or do you want to see a bit more urgency there?

Rebecca Endean: If you read the life sciences one, the AI one and Peter Bazalgette's creative one and what they all propose in terms of R&D—obviously not everything can be funded, because there is a limited



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amount of money—they are thoughtful and interesting, and we have had some very good engagement with all of them.

Q26 **Chair:** What about others? What is in the pipeline?

Rebecca Endean: I think there is a pipeline, but it is for Ministers to decide whether they want to encourage more sector strategies to be produced.

Q27 **Martin Whitfield:** Do you think the sector strategy is the more holistic approach, or will they allow the cross-disciplinary approach that you have talked about? A lot of people have referenced that point.

Rebecca Endean: The sector strategies cover things that are outwith R&D, so they cover the broader landscape, regulation and everything like that, and that would not always be something that is a responsibility for UK Research and Innovation.

Alun Evans: The potential for some of the sector deals to play more to what I was describing as an interdisciplinary approach is there, and again it has the potential of playing to some areas that are very good in productivity and have great potential. The creative industries are something that, historically and at the moment, the UK economy thrives on. They do well, they bring in talent and they bring in wealth, particularly around different parts of the country. That is a type of example of something where the industrial strategy, delivered well and cutting across the manufacturing and service sectors, really has the potential to deliver. I am optimistic and I would like to see more delivered by Ministers in whatever announcements they make.

Q28 **Martin Whitfield:** The sector deals, in essence, are bottom up. It is a collective idea that is then passed up. Do you think strategically that is more valuable than a top-down approach, or do you think there should be an interrelationship between those two waves?

Alun Evans: It is clearly an interrelationship. Which is the more important, I do not know. I would stress, coming back to an answer I gave Mr Metcalfe earlier, that it needs to be a complete holistic, or whatever you call it, strategy that brings all the elements together rather than just picking and choosing separate one-off sections. It has to be horizontal and vertical drivers, and then investing in the areas where we have most potential to influence UK growth and productivity.

Q29 **Martin Whitfield:** The budget is a single pot, and there is obviously competition between the industrial strategy and the sector. Do you have any comments about the sharing of that pot or indeed, if there is anything left in the pot, where it should go?

Alun Evans: I would come back to the things I was saying in the paper I commended to you. I think it is right; it is not really for me to judge, but the balance is not too bad. It is not vastly out of kilter. Obviously, one



would like more money, but £4.7 billion is a pretty large starting pot to begin with.

Professor Jones: In the Industrial Strategy Commission, we thought a lot about sectors and ended up with quite an ambivalent view. It is important to look back at successes, and if we look at the auto industry, a central approach to the auto industry since 2007-08 has been remarkably successful, and Innovate UK—or TSB, as it was then—ought to take some credit for that. We ought to look back and ask what we did right to boost that sector. We can beat ourselves up a lot, but sometimes we do things right and it is worth looking at that.

The downside of sectors is, of course, that they reflect the world as it is, or as it was. Certainly Professor Diane Coyle, on our commission, who as an economist very much focused on statistics and measurement, was very critical—not really critical; it is just inevitable—of the way that we cut up the world to do statistics, because it reflects the economy as it was, not the economy as it is going to be in the future. The lesson of things like Industry 4.0 is that those boundaries get blurred.

Manufacturing now is very different, particularly the line between manufacturing and services, which is enormously blurred. There are things such as design and the kind of pre-manufacturing stages of design, listening to users and user-centred design on the one hand, and the post-manufacturing sector, using the famous example of Rolls-Royce and all the information it gets from its engines in use—the complete picture—and it is difficult to say whether these companies are manufacturing companies or service companies. It is about where they can get the maximum value and how they can get more of that value chain. Those are the questions we should be asking. To some extent, you start with sectors because you have to, but it is important to recognise that the economy will look different in the future, and we ought to be looking at the world through that kind of future-orientated lens, not the backwards-pointing one.

Q30 **Martin Whitfield:** To be open to the change that is coming.

Professor Jones: Yes.

Alun Evans: If you look back over the history of industrial strategies—which Lord Hennessy recently published a paper on for the Foundation of Science and Technology—it is more sectorally based and runs the risk of suffering the danger that Professor Jones alluded to, that you invest in the areas that are strong at the time and not necessarily ones that will be strong for the future. I think that was part of the problem of previous industrial strategies ending up sometimes being the Government picking winners, and, in the end, losers picked Governments.

Professor Boyle: I have two quick points following up on those. One, it is really important that as much as possible—it is a challenge—the various bits of evidence are joined up in a very holistic way. To take one



area that happens to be important in my university—the space industry—we have a national space strategy, and there is investment now, to a degree, in some of the industrial challenge, but we need to make sure that we listen to the various parts of Government that are talking about this, going back to Alun's point earlier.

Reflecting on the point about top down versus bottom up, I have never been persuaded that either truly exists. In a sense, top down always has to listen to the voice of the researchers. We made the point earlier. In a sense, of course there are some things that are stimulated from the top, and some are perhaps dominant, but in the end they have to be a proper conversation that involves bringing as many people to the table as you can.

Chair: Martin, are you going on to your other question?

Martin Whitfield: Yes.

Chair: I am conscious that time is tight.

Q31 **Martin Whitfield:** Next April, the research councils and Innovate UK fall under UKRI. Is this going to change the balance of research and innovation funding, or is it going to develop it? What is going to happen in April?

Rebecca Endean: The reason why we are setting up UKRI is to consider that question—to think about the right balance between research and innovation, and do it in a proper evidence-based way. We are delighted that we have just appointed a very strong board for UK Research and Innovation. They met for the first time a couple of weeks ago. If you look at the balance of research and innovation over time, quite often people say that it has been relatively constant, especially within the research councils and the different disciplines. Previously, Ministers would always make the decision about the allocation of funds. What we are trying to do is provide advice to Ministers on how best, if they wanted to change, they would do that in order to create maximum effect. As we develop new instruments such as the industrial strategy challenge fund, which looks at ways in which research and innovation can come together to work on a particular challenge, and the global challenges research fund, which is Overseas Development Assistance funded, and looks at specific international development challenges, and as the research councils and Innovate collaborate with each other, it will change boundaries at the margins, but we see it as a fundamental job of UK Research and Innovation to look at the question properly.

Q32 **Chair:** But you haven't reached a view yet.

Rebecca Endean: They have only had their first board meeting, so it might be a bit—

Chair: Premature.



Rebecca Endean: We will give them a bit of time to think about it.

Q33 **Martin Whitfield:** You made reference to what is understood as the Haldane principle, the protection. Do you think there is enough protection or are we at risk?

Rebecca Endean: The Haldane principle has now been put on the face of the Bill in the HER Act, which is actually a very neat way of summarising what David Willetts said in 2010 about what the Haldane principle meant. It is actually quite neat. If you think about effectiveness and value for money, everyone in the community would suggest that choices about who should be funded for each individual project are best made on the basis of expert views. That way you will fund the best projects, and you will not have people who do not really know what they are talking about choosing them. That does not mean that Ministers will not decide overall strategic objectives. It does not mean they will not fund overseas challenges. It just means that, in principle, when you are looking at competitively funding particular projects, it is best, in terms of value for money, that that is made through peer review. If it is on the face of the Bill, we will take it very seriously.

Q34 **Stephanie Peacock:** There is a raft of Government-funded initiatives to support businesses to invest in R&D or to encourage universities to link up with businesses. Do you have any thoughts on them, and whether they are effective and value for money?

Professor Jones: That is an interesting question, and perhaps Dr Connell will talk more about it in the next session. It is very interesting to compare the direct instruments, such as grants and contracts, with the indirect instruments, such as the R&D tax credit. There is not enough appreciation in policy circles about how large some of those sums of money are. R&D tax credits constitute a lot of money. It may be for others to decide whether they think that is money well spent or whether you could spend that money more effectively directly.

Q35 **Chair:** Do you have a view?

Professor Jones: I am not sure about R&D tax credits. It is complex. The consensus from the economists I was talking to was that the patent box was a truly terrible piece of public policy that was enormously distorting. That is one view. The economists seem to be less clear about whether R&D tax credits matter. Anecdotally, when I talk to our technology transfer partners at the university IP group that does our technology transfer, they are very keen to stress that R&D tax credits are an important part of the business plans of small companies, spin-outs, and R&D-intensive companies. It matters to them a lot. If you think of it as part of the support for innovative young companies, it clearly is important.

It needs to be taken into consideration with an appreciation of how much other Government support is going to young, innovative companies. Again, the sums are very large. People perhaps do not appreciate how



much Government money goes into venture capital—how much Government money goes into venture capital allowance schemes. There is an interesting regional dimension to that, because a very large amount of Government money ends up very regionally focused in areas where venture capital is strong. If you are considering the innovation landscape across the whole country, that is something one ought to think about.

I am not really answering the question about whether I think this is good or not, but those are questions that do not get talked about enough. There needs to be more discussion of them, more evidence and more thought, and a more holistic view of how the R&D tax credits add up with Innovate UK direct funding, and demand-led schemes such as SBRI. Those are really important questions that we ought to think about.

Alun Evans: It is not entirely answering your question, but there is ample evidence that universities, business and research and development working well together is in itself a virtuous circle, because R&D invested either publicly or privately will bring in more R&D. It works, and the places that work have proven that it works. With capital and ideas being mobile, they will gravitate towards centres of excellence where the relationship is working well. If you get that virtuous circle working well between university, business and R&D investment, in itself it brings in more and more, and there is ample evidence from around the world that shows that it works. That is what we should be aiming for. We are achieving it in some universities and cities, and we are not achieving it in others. The disparity in performance is quite marked in the UK.

Q36 **Stephanie Peacock:** I have some specific questions for Professor Jones. I know we have touched on the place agenda already today, but I have read your article entitled, "What has science policy ever done for Barnsley?" You might be aware that I am the MP for Barnsley East, so I think your broad conclusion, "Not enough," is a conclusion I would agree with. Has your opinion changed since you wrote that article last year?

Professor Jones: No. My opinion has not changed. To elaborate on that, in my previous job I was PVC for research and innovation at the University of Sheffield. We worked very hard to develop links with businesses nationally and locally. We are very proud of the Advanced Manufacturing Research Centre and of our work with skills and apprentices.

The question arose because that direct question was asked of me by Steve Houghton. Barnsley is a very poor part of the country. It is quite typical, unfortunately. There are many Barnsleys in the UK. We could be talking about Merthyr Tydfil, Dudley or Burnley. Many formerly industrialised places have intractable combinations of low investment, poor skills and poor infrastructure. My personal view—this is a personal political view rather than a view as a professor of physics—is that it is intolerable that we live in a country that has such gross disparities in prosperity, so for that reason I was challenged. The force behind it was that if we focus too much on elite science, and if we get to a situation



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where we think that elite science is something that we do because we are prosperous and we can afford it, it is the wrong way around. We need to think very hard about how the research we do can drive prosperity in places like Barnsley, and that may take some changes in perspective. I wrote that article and I still stand by it.

Q37 Stephanie Peacock: What do you think the Government should or could be doing to make sure that areas such as Barnsley are not left behind?

Professor Jones: That is a much broader question than just science and innovation. There is a very important issue about infrastructure. Our commission—Diane Coyle in particular—was very keen on the idea of a universal basic infrastructure, and there are some quite technical questions about how we assess investment decisions in infrastructure. It seems fair enough to me that all parts of the country ought to have basic infrastructure, in terms of hard infrastructure, transport, and the modern bits of infrastructure, access to broadband and mobile telephony, and softer infrastructure, the quality of schools and education.

Another very shocking piece of data that has come out in the last couple of weeks is from HEFCE about higher education participation rates. There are really shocking differences in participation rates between Barnsley, east Sheffield and west Sheffield. We are talking of a few miles: in Fulwood, it is about 90%, and in Manor it is about 10%. How can that be right? These are really important questions. The science and innovation part of it is important, too. We have a very imbalanced distribution of research funding across the country. No one has done that on purpose. It is the result of an accumulation of decisions.

Q38 Chair: The key question is what we should be doing now to correct that.

Professor Jones: We need to recognise that those imbalances are there, and we need to think about systemic interventions.

Q39 Chair: Give us the interventions you recommend.

Professor Jones: You cannot just dump some kind of institute of advanced something in any place. You need to build on what is there and on the capacity that is already there. The science and innovation audits were a way of thinking about how you could work with the grain of a local economy and find some area where it made sense to boost the innovation capacity of that area.

Q40 Chair: Together with addressing the infrastructure weaknesses.

Professor Jones: Yes.

Q41 Chair: It was fascinating to hear the report from South Korea on the “Today” programme this morning about how they are going for one gigabyte speed across the country. Should we be far more audacious, particularly in some of the areas that are falling so far behind?



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Professor Jones: Yes. This is getting outside science and innovation, but we should be looking at those differences in infrastructure and correcting them, and thinking about the investment and appraisal methods we use that currently reinforce those divisions rather than alleviating them.

Q42 **Stephanie Peacock:** In your article, you outline regional disparity between areas such as the obvious London and Cambridge, but if you drill down and take, for example, the northern powerhouse, what do we do to ensure that towns do not get left behind—areas such as Barnsley compared with, for example, Sheffield and Leeds? Do you have any suggestions on that?

Professor Jones: Again, you are asking away from science and innovation, but one development that is important is local accountability. For example, the peripheral regions of Manchester, now that there is a mayor, will get more voice. Strengthening local accountability will help.

Q43 **Chair:** And greater devolution of powers.

Professor Jones: Yes.

Q44 **Chair:** And funding—finance.

Professor Jones: The LEPs were helpful in the sense that they coincided with natural economic areas. The things that LEPs would need to make them work are democratic accountability, analytical capacity, because they currently do not have a lot of analytical capacity, and actual resource, things they could do. Devolution needs to be accompanied by those things. Analytical capacity, of course, is where universities can be particularly helpful. Certainly in the south Yorkshire science and innovation audit—I led the writing of that—we were able to bring in the kind of analytical capacity that the universities have, to be able to support that process.

Alun Evans: Can I make a very quick point, which reiterates something I said earlier? If we are talking about industrial strategy playing to the whole economy, we have to look at the service sector, which is 80% of the economy and where growth will really come. I am not an expert on Barnsley, but if you take health and social services, for example, to which I referred before, and get growth in productivity and investment there, coupled with investment from Government, whether in infrastructure or innovation and skills, you can develop aspects of the service sector even in areas where the manufacturing sector is now much weaker than it used to be in the past, or non-existent. We need a more nuanced approach where we look at what aspects of the service sector in some parts of the country could be developed, and where there is scope for growth and productivity in those areas.

Q45 **Graham Stringer:** You have answered a lot of the questions I was going to ask. Following on from Stephanie's question, isn't the real answer that we should change the imbalance of science funding? About 90% of science funding that doesn't go to universities is in the golden triangle of



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the south-east, and even when you look at the funding of universities, the London universities, Cambridge and Oxford get a disproportionate amount. Shouldn't there be a real attack on that, so that when there is an excellent institution, such as the Crick centre, it is not automatically plumped in the middle of the most expensive real estate in Europe and is put elsewhere in the country, or you don't transfer the Diamond Light Source from Daresbury to Oxford? Isn't that the real answer?

Professor Jones: Those are decisions that have been made.

Q46 **Graham Stringer:** It is how we stop similar decisions being made in the funding programmes.

Professor Jones: The research councils have had a very correct focus on excellence, and we have lots of individual decisions. For example, there was a recent decision to site a dementia centre in UCL. I looked at that decision and part of me thought, "Gosh, it's a pity it's in London again," but then, if you look at the quality of the science and of the people, you can see why that decision is made. That is why we need to look at really systemic interventions, which would have been leaving Diamond Light Source in Daresbury. I agree with you. That was a bad and wrong decision.

When we talk about excellence—and it is important to talk about excellence—it is also important to remember that places are not intrinsically excellent. The things that are excellent are the people who work in places. If you make lots of incremental decisions based on what is already in place, you will get concentration, so to undo that you need to make systemic interventions that, in a sense, move the excellent people to the place of need.

Q47 **Graham Stringer:** My guess is that, if we were to double your physics budget in the University of Sheffield, you would be able to attract some of the best minds in the world, and Sheffield would improve. It is cart and horses, isn't it? If you change the funding, you will change the excellence.

Professor Jones: Yes. I think that is fair.

Q48 **Graham Stringer:** What will be the role of the United Kingdom Research and Innovation body in changing this? The Council for Science and Technology has written to the Prime Minister and suggested that you should have a lead role in changing the balance between the regions.

Rebecca Endean: Our functions, as specified in the Act, are about efficiency and effectiveness of science, leading to economic growth. It is something we should carefully consider. You throw away the principle of funding on the basis of excellence at your peril, and that is a mistake that lots of other countries have made. That said, there must be scope to look at where there are pockets of emerging excellence outside the golden triangle, and to think about imaginative ways in which funding could be made available, using all the information in the science and innovation



audits to consider whether you could try to grow pockets of excellence. But they should be pockets of excellence. It would be a mistake to fund non-excellent science just because it is in a particular area of the country, but a more analytical, intelligent approach to how we go about these decisions would be a good idea.

Q49 Chair: Is there a case for some financial support for taking good to great?

Rebecca Endean: There is definitely a strong case to be made. Making these decisions is always harder when it is a zero-sum game and you are talking about taking money away from one bit of the country and putting it somewhere else. With additional funding—

Q50 Graham Stringer: That is not what has happened, is it? There has been an increasing amount. The Crick centre, which was a brand new centre, could have been placed near Manchester University or between Leeds and Sheffield Universities, and it would still have been an excellent centre because it is extremely well funded and is starting from scratch.

Rebecca Endean: Yes. We need to make these decisions based on evidence, and taking into account all the relevant factors. Big capital investments will probably always be a decision for Ministers to make. Our role should be to make sure that they have the best set of information in front of them when they make those choices.

Professor Boyle: It is absolutely clear that emerging areas of excellence do exist outside the golden triangle. If you look at life sciences in Dundee and at my own institution in the space industry, we have—

Graham Stringer: Or Newcastle.

Professor Boyle: We have absolutely clear strengths. It is quite clear, and I think you are right that to a degree that has happened through investment. In particular institutions, there has been recognition of strength and they have built on that excellence, so I am sure that one of the strategies that UKRI will think hard about will be how we identify and build on those areas of strength. I support that.

It is not dissimilar in some ways to the funding that the Government have put into the Newton Fund. The Newton Fund encourages collaboration with countries that we perhaps would not otherwise collaborate so much with, and there is a very clear strategy to try to identify areas of strength we may have been unaware of, and to build those relationships, so that gradually over time, as they become better and better, we will be the partner of choice. There are some similarities in that strategy that we could think about regionally in the UK in how we fund different opportunities.

Q51 Neil O'Brien: I have a quick question on the same theme, with more or less a yes or no answer. Is it not the case that, if we seriously want to spread our science spending around the country, we need a new,



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bespoke funding stream that is explicitly aimed at that purpose? If we just put more money into the same funding streams, we will have the same outcomes and we will continue spending nearly half the science budget in just three cities. Does anybody disagree with that proposition?

Alun Evans: The challenge for UKRI is whether they are able and willing to rebalance the split between the seven research councils, which I think over the last 40 years has just about stayed the same share. The trouble is that people say they would like to see their research council get more money—I would be just as bad as anyone; I would like it to be the ESRC and the AHRC—but that would be at the expense of someone else. The alternative is what you suggested, Mr O'Brien—a separate funding stream.

Q52 **Chair:** Do you support the concept that Neil puts forward?

Alun Evans: Up to a point, and then there is the fact of whether there is more money going in, which is Mr Stringer's point; there is a chance to rebalance because there is additional money going in. If it is a zero-sum game, by definition you cannot do that. There are winners and losers.

Professor Boyle: There are also other political things that can be done. In the allocations through the local growth fund last time round, in the east midlands in particular, where I happen to be based, it was quite clear that there were political reasons why there was a very small outcome for that part of the region. That has had a direct impact, given that the major investment they wanted to make was in collaboration with universities and science and innovation in that region. There are other areas you can think about. To answer your question a bit more directly, in a sense the industrial strategy challenge fund is what you are talking about, but it is now in the hands of UKRI to think very carefully about how it is used in the most appropriate way.

Q53 **Neil O'Brien:** You would be against a place-specific rebalancing type of plan.

Professor Boyle: I would certainly welcome the conversation about how that might best be achieved, but there is a range of ways in which you can do it. If you set up a single fund, there is a risk that there would be a single approach to it. I have faith that UKRI is going to take this seriously in the challenge fund.

Q54 **Chair:** The Council for Science and Technology specifically proposed an innovation and growth place fund. What response do any of you have to that? It seems to me aligned to what Neil is suggesting.

Professor Jones: I would support it. In principle, it is a good idea. I can think of many ways in which you could implement it badly. I would charge UKRI with the responsibility of doing it well, and that needs data. This is a seemingly trivial point, but these things need to be underpinned by good data. We do not have particularly good general economic data, let alone specific innovation data at the place level, so it needs some



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thought, supported by data and a lot of effort, to do the thing well, which I think UKRI will be in a good position to do.

Alun Evans: There has to be some type of place-based approach, and it could be the way you have suggested, or I hope by, as I said earlier, UKRI setting up a special scheme for cities, city regions and growths in place, which I think will be welcome.

Q55 **Chair:** Rebecca Endean, are you up for this? Do you welcome the suggestion?

Rebecca Endean: I think Neil is very cheeky. Ultimately, this will be for a Minister to decide. The CST's ideas are very interesting. The absolute critical factor is the one Richard gave; if you were going to go down this path, the design and the implementation of the scheme is absolutely critical. That is the way you ensure the efficiency and effectiveness of the spend. With a well-designed scheme, which balanced the importance of excellence with local economic growth, I think—

Chair: It is a very attractive proposition.

Rebecca Endean: It would be astonishing if we were not thinking about something like that.

Chair: That is encouraging.

Q56 **Martin Whitfield:** I suppose it would be wrong not to mention Brexit this morning. Interestingly, there are BEIS questions going on in the House, and the Government again confirmed their commitment to the continuation of the Horizon 2020 programme. When Jo Johnson gave evidence a few weeks ago, he said that the £2 billion a year science budget uplift would not be raided to pay for our continued membership association with that, and there will be a lump sum, a fee, negotiated. How much do you think it is worth paying to stay in? How valuable is it?

Professor Jones: There is very wide consensus in the Royal Society that it is very valuable indeed. In a sense, it is too easy to talk about money, and we do talk about money because we have done particularly well out of those funds. Membership of the EU has been a good deal for us in that respect. That will change, which is a pity, but that is another issue.

It is important to stress why it is valuable. It is invaluable because it gives us money, but it is more valuable because it gives us connectivity and competition. The ERC is an agency that is much loved in the UK science community because it is so competitive. It raises our standards to be constantly judged against the best scientists of the whole continent. We have done enormously well at that, which I believe has been a driver to raise the quality of the whole of the UK science base. That competition is really important. The connectivity is really important. Science research is a collaborative activity. The UK is a small but significant country, and in the scale of things we can benefit enormously by collaboration with other researchers across Europe.



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Collaboration also extends into the private sector. Colleagues in Cambridge remind me that they have access to networks of high-tech SMEs in their sectors, particularly in Germany, that they would not have. The innovation landscape we live in is an international one. There is connectivity on the academic side of it and connectivity on the commercial side, and that plays into our increasing integration into European-wide supply chains. We have supply chains in innovation as much as in the actual gismos and gadgets that these industries make. How much it is worth is a political question. It is worth more than we currently pay, because we do so well out of it.

Q57 Chair: Is there urgency also about sorting this out and reaching a conclusion about whether we are part of the successor programme?

Alun Evans: There is urgency in getting a decision on what we do. Like Professor Jones, I think there is an absolute case for staying in because of the benefits we get from the ERC and Horizon 2020. The other issue is mobility of researchers, and whether or not in future researchers will want to join UK universities and are welcome there. LSE is probably the best example, with some 50% of academics there being EU based. Are they going to be welcomed after Brexit? One aspect is that good people coming from Europe to join the research groups in LSE, in that example, could be lost. That is something the jury is still out on.

Professor Boyle: I strongly support that. There is absolute consensus in the sector that we should stay part of the European funding system if we can. It is about whether people will be attracted to the UK. We attract very many people who bring their European grants to come and be based here, and if we are not part of the system that would end.

There is urgency around the transition period. As I said earlier, the Commission has been very clear that, when Brexit is enacted, at that stage there will be no system in place, despite our promises of an underwrite, to accommodate that, because it sees the underwrite as part of the overall divorce bill. There is a sticky issue where the Government clearly want to support us to the end of the Horizon 2020 programme, and the Commission and the European member states want us to be in until the end of that programme. We really need momentum to make sure that is guaranteed.

Q58 Chair: Is it also the case that people are working on the shaping of bids for the successor programme and that they need some certainty pretty quickly?

Professor Boyle: Not just now. The December call for ERC bids will go in. It is quite feasible that a good number of those bids will not start until after March 2019, in which case there is a lot of uncertainty about whether even bids that might be accepted relatively soon but will not have actually started will be able to start. Of course, as I said, the Commission is not clear about how the underwrite that the Government have put forward would work in practice, whether that is administered



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here or is money that is passed to the Commission. There is none of that detail, as far as I am aware. I spoke a couple of weeks ago to some of the article 50 negotiation team, and at that stage they had no understanding of how our Government expect it to be used.

- Q59 **Martin Whitfield:** The industrial strategy White Paper is on its way. Is it not a bit early, until we have a decision about Horizon 2020 and the influence that Europe will play, and unless we know the outcome of discussions and negotiations and what the format looks like in the future? That will surely have a huge influence on our industrial strategy coming down the line. Do you have any thoughts on that?

Professor Boyle: Do you mean the negotiations about FP9?

Martin Whitfield: I mean how the industrial landscape will change with the consequence of Brexit.

- Q60 **Chair:** We are developing an industrial strategy before we have the conclusion on Brexit.

Martin Whitfield: Is the cart before the horse or the horse before the cart?

Professor Boyle: The timing is unfortunate. We are at a tricky place. There is absolute consensus that we should do our best to stay in the system. I am personally optimistic that we will get there. What I am most worried about is that we will get there but with a gap, and that we will somehow fall out for a period of time and have to re-enter. That, for both sides, would be a great disaster. You are right; in a perfect world you want all these strategies to come together at the same time so that you have clear sight of what needs to be delivered. If we end up leaving Europe, if Brexit means that we end up having to leave that system, we would obviously be very keen that the funds we currently put into Europe, plus some, were rethought, because it is not just the money we put in but what we win out, and are used to having in our system. UKRI would be the obvious place, and perhaps one or two other places as well, including maybe the QR system.

Chair: Thank you very much indeed. We have got there. We appreciate your time. Thank you.

Examination of witnesses

Witnesses: Dr McKernan, David Connell, Tom Thackray and Tom Morrison-Bell.

- Q61 **Chair:** Good afternoon, all of you. Thank you very much indeed for attending. Could you introduce yourselves quickly?

Tom Morrison-Bell: I am Tom Morrison-Bell, head of public affairs at techUK.

Dr McKernan: I am Ruth McKernan, chief executive at Innovate UK.



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David Connell: I am David Connell. I am a senior research fellow at Cambridge Judge Business School and I specialise in innovation policy and science and technology-based companies, particularly new ones. I have spent most of my working life in the technology sector, including co-founding an early stage venture capital fund and a manufacturing technology start-up. I should add that about this time last year I was asked by 10 Downing Street and BEIS to carry out an independent review of SBRI.

Chair: Which I suspect we might come to in due course.

Tom Thackray: I am Tom Thackray, director for innovation policy at the CBI. We represent businesses, large, medium and small across the UK.

Q62 **Chair:** Some of the questions we will ask you will be questions that we asked of the first panel as well, but could I start by asking about whether you see any impact of uncertainty with regard to the Brexit process in the private sector's willingness to commit resource to investing in R&D?

Tom Thackray: We run surveys all the time to track investment intentions across the piece. We did one a couple of months ago looking specifically at the impact of Brexit, and that estimated that around 30% of companies had noticed some impact or put some investment on hold as a result of the Brexit decision. We expect that number to increase over time, particularly as we failed to move on from phase 1 of the negotiations to phase 2, and given the priority for businesses to start talking about a transition period once we leave the European Union in 2019. We cannot dissociate the types of investment within the figure we highlighted, but R&D, we imagine, is a substantial part. Anecdotally from members as well, we have heard about investment decisions being put on hold.

Q63 **Chair:** Are there any other contributions?

Tom Morrison-Bell: Anecdotally, techUK, among the membership, would share exactly the same position. What is interesting with the forthcoming Budget is opportunity. R&D is an area where the Government could give some certainty. We know that there is a target of 2.4% within the next 10 years. One thing that techUK would be supportive of, and has put in its Budget submission, would be for the Government to set out a road map for those 10 years to get to the 2.4%, so that, as there is increased uncertainty around what will come out of the Brexit process and the transition period, the Government could make quite a clear statement, show leadership and give some certainty for the next decade, which would encourage businesses. They would understand that the UK remains competitive in R&D at this time and would be very supportive of that.

Q64 **Chair:** Are there any other contributions?

Dr McKernan: I would add only that we should not forget the SMEs. The SME instrument in Horizon 2020 has been particularly valuable. Last



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year, SMEs won as much funding from that instrument as they did from us, so it is not all about research; it is also very much about SMEs. I hear from small businesses that they are concerned about two things: the ability to hire people and the ability to make connections, which I think we heard in the last session too.

Q65 Chair: The other question I want to ask at this stage is, do any of you have concerns about the fact that we are producing the industrial strategy White Paper before we have certainty over what the future looks like in the Brexit negotiation?

Tom Thackray: From where our members sit, it is useful to publish the White Paper as soon as possible, to give a direction of travel. The White Paper could have contingencies built in, depending on what the future relationship with Europe will look like, particularly when it comes to access to programmes like Horizon 2020 and FP9, but, for business's perspective, we need to get on and start focusing on where we can invest, so publication of the White Paper is a useful thing to do as soon as possible.

Q66 Chair: Is that view broadly shared across the panel?

Dr McKernan: I would say yes. Coming from a commercial background, you can always wait for the next bit of information or the next whatever, but when you are trying to develop a product or a service and you want to be able to sell that across the world, your competitors are not holding on and waiting for another piece of information. To be competitive, producing the industrial strategy, the sooner the better for businesses.

Chair: I am going to do some rejigging of the order and bring in Graham next.

Q67 Graham Stringer: I think you were all present for the previous discussion about the golden triangle. The centre of that debate was around whether pursuing excellence actually opposed spending more science research money in the regions. How do you think we get over that, or do you think excellence is the enemy of redistributing science investment?

Dr McKernan: I would like to start on that, because our data do not say that funding to business goes to the golden triangle. We very carefully measure and map, and, as you will have seen, Neil, in your previous role, we take lot of account of where our funding goes to businesses. Per business, the most successful is the north-east. We do not find that our funding predominantly goes to the golden triangle. When it comes to business partnership and investment, they are putting in half the funds—remember this is match funding—and it is not the same picture as we see with research funding.

Q68 Graham Stringer: That is interesting, but it is in terms of the basic grants to universities and—



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Dr McKernan: The picture looks different from the basic research perspective than from the industrial partnership and business perspective.

David Connell: We can learn a lot from the early days of the Cambridge cluster, even though most cities have nothing like the same research or investor base. One of the key events in the creation of the Cambridge cluster was the formation in 1960 of a company called Cambridge Consultants by three new engineering graduates. Over the years, it has turned into a sub-cluster of technology consultancies employing over 2,000 of the country's best scientists and engineers. The core business of those businesses is developing new technologies and products for their customers, mainly overseas corporations, but along the way they have developed many proprietary technologies and spun off a series of successful businesses, including two of Cambridge's five largest. They have also effectively provided a finishing school for engineers, many going on to found and manage other businesses.

In many ways, they are a sort of private sector version of Germany's 60 or more Fraunhofer institutes, on which our own Catapult centres are based, although the Cambridge consultancies are far more successful at spin-outs. The German Fraunhofers tend to pump their technology into the existing industrial base and, of course, ours is much weaker, so that is another issue.

Another catalyst of Cambridge's growth was the Commuter Aided Design Centre, or CADCentre, originally set up in the 1970s. It was not an academic institute but was, effectively, an early Catapult. Some of the young software engineers it attracted went on to start a series of very successful companies. In the meantime, the CADCentre itself morphed into AVEVA, not the insurance company but the city's largest software company, with 1,700 employees and 90% of its turnover from overseas.

Acorn Computers, founded by Hermann Hauser, also led to a sub-cluster of companies, the transformational point in its development being winning a BBC contract to supply computers for the computer literacy project. Then, of course, Acorn went on to spawn ARM, which is well known, again funded not with venture capital but with customer funding, first from its parent and then from Apple.

In my view, those examples indicate that one of the best ways of developing other clusters is by establishing Catapult centres with world-class teams doing specialised R&D for their customers, linked to some kind of inherent strength within the area—it could be a university, it could be past industries—at the same time as having policies such as SBRI, to increase the demand for innovation through contracts and help breed Catapult spin-off companies. There is already a good example of this in Sedgefield; a company called PolyPhotonix, which has been funded by SBRI to develop a new therapy and is very closely linked to the town's



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Centre for Process Innovation, part of the High Value Manufacturing Catapult.

This could be a very useful way forward to develop new regional clusters, but there are pitfalls.

At about the same time as the CADCentre was set up in Cambridge, the National Engineering Laboratory was set up in East Kilbride. That turned out to be less of a success. It is important to ensure that these centres really do have some of the best people in their field doing development work and, if they can, that they have some of the best companies in the world as customers as a basis for them to develop the expertise and technologies from which spin-outs and further local economic growth can flow.

Tom Thackray: I have four quick points. I think the first was mentioned in the last panel. There is excellence in every single region, so it is a slightly false argument to talk about going for excellence or going for capacity building. They are two different objectives and we should be pursuing both in every region. That would be my sense, whether that be the semiconductor industry in south Wales or creative industries in Manchester. We all know where examples of excellence exist across the country.

We could use the capacity of institutions such as Innovate UK and universities to give support to local institutions to understand where that excellence resides. I think it is true to say that Innovate UK has more applicants that meet the bar—their quality threshold—than they are able to fund, so is there an opportunity for them to work with local institutions to get that money to businesses across the country who could benefit?

Q69 **Chair:** Do you see the sort of work you are describing as a key priority for UKRI? Ought it to build capacity and support work in locations?

Tom Thackray: There are two separate things. You need to be quite careful about whether you are pursuing excellence or capacity building. We are right to pursue an excellence agenda from a lot of these institutions, but my point is that that excellence exists across the country. We cannot be blind to the impact on place and we should, at the very least, be measuring where our investments are made.

On capacity building, a slightly overlooked factor that we need to address is that it is not always about cutting-edge innovation. If you look at the impact on productivity gains, often it is about the adoption of technologies and management practices that already exist. It is about what support is available to businesses across the country for the diffusion of innovation as well as the creation of innovation. Since the disbandment of the manufacturing advisory service and the business growth service, there is a bit of a vacuum in terms of that type of business support, so is there scope through the industrial strategy to look at how that is replaced, perhaps through the shared prosperity fund?



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The third point is what happens to places that are not well served by political infighting between local authorities or if they do not have their asks of central Government very well defined at the moment. There are difficulties around the Sheffield city region at the moment. Is that area going to be under-served when it comes to science and innovation through the industrial strategy, and will businesses will be at a disadvantage because of that? That is probably something we need to look at.

Finally, the science and innovation audits were a really useful exercise in identifying where excellence is across the country, but I do not think that we have fully used all the data and information that we obtained through that process. Hopefully, the industrial strategy is a way of doing that, and for having a place-based agenda prevalent in science and innovation work.

Q70 Graham Stringer: This is my final question, given the time. How important is infrastructure for both spreading out the golden triangle and innovation in the golden triangle? Basically, how important is it for innovation and investment?

Tom Morrison-Bell: I have one thing to add to what Tom said around the place-based agenda and the golden triangle. The Tech Nation Report, which the Government support each year through Tech City, showed in 2017 lots of growth in the tech sector, twice as fast as the rest of the economy, with nearly three times as much job creation. What was most interesting about the report was that digital jobs are being created around the country. It is still much stronger in the south-east, but it is more diffuse than other sectors. When it comes to industrial strategy, what we think is interesting is that innovation often happens at the intersection of different sectors, and the fact that tech has, effectively, become a suffix to all sorts of other sectors—edtech, govtech and healthtech—is evidence of where technology and digital technologies begin to interplay with existing areas, and you are able to spawn that type of innovation.

When looking at place, one thing that techUK and our members are quite supportive of is trying to understand how in the specific context of digital it can be tacked on to specific areas of existing excellence. If you were to take the desire for driverless cars, let's say, in the north-east, we know that they are going to need to be cyber-secure, so how do you make sure that you build the capacity for cyber-security in an area where there is existing excellence and drive for that?

Infrastructure is absolutely critical. It was mentioned in the previous section—on moving from good to great—that on the whole the UK's digital infrastructure, which I am speaking about specifically, is good. There are definitely improvements to be made, and we know there are not spots and black spots where it is difficult to get, and successive Governments have worked on that. In the context of the industrial strategy, there has been quite a lot of focus in digital infrastructure on



what consumers need—how you stream things in your home and what the download rates are. Businesses need different types of connectivity; there would, for example, be more emphasis on uploads and upload rates. It would be interesting to see how that can come into planning. For example, in Hong Kong they have a rating, such as we have for energy ratings for buildings, for their connectivity and business connectivity. It is much more built into the planning process. We have it here but not to the same extent. That could be an interesting way to look at how the UK could meet those kinds of connectivity challenges.

Q71 Stephen Metcalfe: With the industrial strategy challenge fund, there are some very interesting projects that are being funded, but, looking at them as a whole, do they yet create a strategy? Is there an overall strategy or are there gaps, and what are those gaps?

Dr McKernan: I think the industrial strategy challenge fund is one for me. If I could, I will take a couple of minutes to take you through everything that has happened since the funding was announced, because that will help to understand why we have launched the ones we have launched and what we are doing with the next ones. Bear in mind that we are getting some valuable insight from the industrial strategies from different sectors. As we have been doing this work—we have had John Bell's review, and Juergen Maier's, Peter Bazalgette's and Wendy Hall's—we are seeing a lot more data and evidence on which to work.

When the industrial strategy was first announced, the first thing we did was to go out and do a lot of engagement events around the UK. We spoke to 900 people at different events. All the nations and regions were represented; 50% of the people there were businesses, 35% were university people and the other 15% did not want to self-assert as either, so I am not entirely sure what they were. Out of that, we did some great workshops about what business thought the growing areas were, what the opportunities were and what challenges could be solved that would lead to economic growth and improved productivity in the UK. There were some that were very obvious and clear and where work was already ongoing. Batteries came out of that. Advanced therapies in the healthcare sector, and improved manufacturing for them, and then robots came out of that. There were also some additional pathfinder and smaller investments that were made in what you will now know as wave 1.

We ended up with a lot of other ideas from those engagement events, and then we had the information from the Green Paper to look at. We got to see anything that was to do with innovation or ideas for challenges, so that was great, and we went back to some of the businesses that had put in proposals and invited them in at the next stage. One thing I would say is that, if anybody sends something to a Green Paper, please put your name and your company's name on it. There were many ideas where I would have liked to go back to the person who put it in, but they had put it in anonymously. That is just a bit of help and advice.



From that long list, the information in the Green Paper and the work we did with the research councils and Government Departments, we had another set of workshops and we ended up with 41 ideas. Then the programme board, which I chair, looked at those 41 and compared them with the original requirements in the autumn statement, which Rebecca went through in the previous session so I will not repeat them. From that, we came up with a list of 11, where our job was to create evidence and understanding. To do that, we held another round of engagements throughout the summer, with the subject matter experts, the business experts and the SMEs that could be involved, to the point that we were able to describe the benefit of the challenge and collect some evidence on growth, and where and how it could be implemented. We have provided the evidence. We have also given some ideas about how you could do a balanced portfolio, but it will be for Ministers to decide which of those will get taken forward. I think we have put together the best case we can, with the best advice and input, in the time.

Your point is whether that creates a coherent plan. What I have observed in doing this, and seeing what businesses regard as the future that they could create, is that digital and data underpin absolutely everything. There is no proposal that does not say, "We could use digital information, we could use data in a better way or we could use machine learning." Everybody says that. Then there are verticals that cover some of the areas that you heard about in the previous evidence session, things such as how we can make the NHS more productive by, for example, focusing on some of the things that came from John Bell's review—improving how we manage pathology, radiology imaging or managing the elderly population or those with mental health problems. There is a digital and a vertical subject matter part to that. The same is true with Peter Bazalgette's review, and with Juergen Maier there is the idea of using digital to upgrade manufacturing.

The proposals that we have now, were we in a position to fund all of them, which we are not, would give quite a well-rounded set. There is still more that can be done. Obviously, there are sectors that have not reported, and in some areas they have an industrial strategy where actually the work we do may not have much to contribute to it. For a year's work, we are in a very good place, but creating the economies of the future and improving productivity is a multi-year, multi-wave endeavour.

Q72 Stephen Metcalfe: Does anyone want to add to that?

Tom Thackray: I have a small point. Businesses welcome the opportunity to engage, but the announcement of the first wave of challenges had to be made quite quickly, and I think the type of challenges that were settled upon were a bit of a reflection of that—areas that you might expect to be funded through the industrial strategy challenge fund. One of the challenges we collectively face in meeting a target of getting to 2.4% of GDP in R&D is how we broaden the base of



businesses that are engaged with this, and particularly how we ensure that the services sector is engaged in the programmes that are set up to support businesses in their R&D activity.

Q73 Stephen Metcalfe: We also have the issue of sector deals. Could you clarify the relationship between the industrial strategy challenge fund, and the awards it is making, and the bids for sector deals, and whether or not the links and the differential between them is clear, for the community to know where they should be focusing their energies?

Dr McKernan: Is that me again? The sector deals—this is rather a generalisation—are proposals put together largely by incumbents who are able to ask for and contribute something. Where the industrial strategy challenge fund work has been able to align with that, we have tried to do so. With John Bell's proposal we tried to do that, although I would say he expects the sector deal in healthcare technologies to be more a one on one company than a group of businesses together, as was done with automotive, which was very successful. Where we have had sight of it, we have tried to align with it, but the challenge is very much a forward-looking way of creating economic growth, bringing together, obviously, some big businesses but very largely SMEs and elements from the research and science base to help diffuse new technology to businesses, to allow them to accelerate their growth. The industrial strategy challenge fund is an aligned element, where possible, of sector deals.

Tom Morrison-Bell: For the digital and the technology sector, it is an interesting one, in that we are so heterogeneous that, in many cases, it makes more sense to think of the tech sector as the underpinner in the industrial strategy. When we had a previous iteration under the coalition, there was the Information Economy Council, but, relative to sectors with highly integrated supply chains and big OEMs that are able work closely with them, that kind of sector council was less effective than others. In the context of the sector deals and the challenge fund, the thinking beginning among our members is that the deals might do well in tech when they are focused on where there might be market failures, or the market is not there yet.

One area we are beginning to look at with a subset of our members is a cyber sector deal specifically to target potential vulnerabilities around the internet of things, and uptake in infrastructure and construction. It would be good to see the ISCF, once it is ready, perhaps attached to those where possible. A broad tech sector deal does not look like it is going to be very feasible, but you might have something around digitisation. The diffusion of digital technologies is probably in the short term one of the main things you can do to drive up productivity: what are the possible demand-side stimuli that could make that a reality? That would be an interesting angle.

Q74 Stephen Metcalfe: As an aside, you do not think that the sector deals are very good at supporting cross-cutting enabling technology. They want



specifics to support.

Tom Morrison-Bell: It is difficult to say, because it has been very much handed over to industry—"Come to us and ask what you want"—which is fine, but none of the discussions that we have had seemed to suggest that there was a particular model for horizontals. That is not to say that, if you thought of one that was going to work, you could do it. In that sense, we would probably look at cutting a sector such as ours into sections, but it means that for an organisation such as techUK—compared with, say, the SMMT, which can make it more homogenous because that works well for automotive—the work would require huge amounts more resource, because it is going to touch every sector of the economy.

Q75 **Stephen Metcalfe:** Do you think it is the right approach from Government to ask you to come up with the deals and then for them to either accept or reject, or would you like a more strategic top-down approach?

Tom Morrison-Bell: Speaking purely from digital and tech, it would be good, as the strategy develops, to understand how digital is going to underpin all the others. Maybe there is a special case to be made for tech, because it is increasingly the case that that is what is happening; in all the conversations I have been in, either with BEIS or often at the CBI with our other trade association bodies, everybody is talking about digital. Ruth said exactly that. Everybody says digital and data underpin everything; everybody says digital skills underpin everything. Our members are uniquely placed either to provide those services and products or to do a lot of that training. They are different, in that they support everybody else to be able to do that in that sector.

Q76 **Stephen Metcalfe:** Does anyone want to add to that?

Tom Thackray: I have one point on the architecture. It is absolutely right that there is openness to say to industry, "You come up with the ideas and we will listen," but the frustration that comes from some areas of industry is that they do not know what the framework for engaging with Government might be, what are the parameters, who they speak to—the general architecture. Hopefully, that is something the White Paper will be able to address.

Chair: Neil, if you do not have a supplementary, do you want to go on to your main question?

Q77 **Neil O'Brien:** We will come on to David Connell's review of the SBRI specifically in a moment, but could I ask you about the different schemes that exist that are intended to promote a business's investment in R&D? Obviously, there are things such as the HEIFs, SMART grants, the R&D tax credits, the SBRI itself and knowledge transfer partnerships—all those different things. Are there schemes that you think would be particularly attractive to expand? If you had your choice of one or two, which do you think are the best of those schemes?



Tom Thackray: At a broad level, we should look at the balance of the schemes and make sure that we support elements along with TRL schemes, at TRLs that really matter to businesses. If you look at the balance of funding on research and innovation at the moment, there is about a 10:1 split on research and innovation. I am not by any stretch of the imagination saying that should be 50:50, but we should consider whether it is the right split, and whether there are nearer to market interventions that are more effective, particularly given the target that we have set ourselves to increase investment in R&D, both from public and private sources. Elements that have the best impact in leveraging private sector investment—collaborative R&D is a big element of that—are areas that we should look at.

Q78 **Neil O'Brien:** You have answered a question I nearly asked: which are the best schemes for the overall balance of our spend between primary and closer to market? You said a 10:1 ratio. Do the panellists think that balance is right at the moment, or would you prefer to see more close to market?

Tom Morrison-Bell: There is a general point that I would make from the digital sector, particularly in the context of Brexit. An overall ambition should be that R&D budgets are spent in the UK where possible. At a time when there is a potential diminishing in competitiveness, although we hope not, as a result of Brexit, anything the UK can do to make itself internationally competitive, and remain internationally competitive, is important. Digital businesses are particularly footloose.

Q79 **Neil O'Brien:** Is there a particular thing that you think we should be doing—that would be attractive to them?

Tom Morrison-Bell: The tax credits are valuable; our members say that— R&D tax credits.

Q80 **Chair:** Does the evidence also support it, other than your members just saying it?

Tom Morrison-Bell: An interesting stat is that in the total pie for R&D spend by business, higher education and Government research, looked at in its totality, the UK, as a proportion of GDP, is middling. We are just underneath the EU average. When you look at the amount proportionately spent by business, we are almost on a par with the USA, which puts us in the top five or six countries in the world. From that, I would take it that the way the system is working at the moment is clearly encouraging private investment in R&D. We are doing well globally in that part of the pie. Along with collaborative efforts, it is going to be interesting to look at what comes from the other parts to ensure, one, that that either continues or increases, and, two, what are the further bits that are going to help us get to 2.4% when we look at the pie in total.

Q81 **Chair:** There seems to be some head shaking going on.



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David Connell: In answer to Neil's question, clearly we need a mix of policies that address the needs of different sectors of the business community—the inward investors, the established large companies, the small companies and so on. The challenge we have is that these policies are, effectively, directed by different parts of Government, the Treasury, BEIS and, to an extent, through procurement and other departments. I do not see a lot of joined-up thinking, or even presentation of data and analysis.

I believe one of the most important areas is in policies to grow significant new UK companies to diversify our industrial base and replace those in the sectors in which we are currently strong if and when the global competitive situation changes.

One of the things I have done in my own work is to try to study the histories of the most economically significant UK STEM-based companies that have been started in recent decades. By successful, I mean in terms of employment, long-term growth, R&D, exports etc. It is companies such as ARM and other flagship companies in Cambridge, Dyson and Renishaw in Gloucestershire, Oxford Instruments and those sorts of businesses, which are in effect the nearest equivalents we have to the German Mittelstand companies. We need to grow more of those sorts of businesses.

If you look at their early histories, you find that a key feature of those companies was that they tended to avoid venture capital, or at least delayed it until their technology was proven through customer-funded R&D contracts. I can give the Committee detailed histories of these businesses. That has enabled founding entrepreneurs to remain in control, rather than being encouraged by their investors to sell out early, which is typically what happens to successful businesses that have been VC-backed from the start. Those disposals are usually to overseas-based corporations, which usually results in the loss of key entrepreneurial founders and often in the truncation of further growth in the UK.

Very few of those successful companies are based on academic research, contrary to widespread opinion. Instead, their technology has been developed against a specific customer need, either with individual customers or sometimes partners, themselves funding a good deal of the R&D. Furthermore, many of these companies started in fields that were of little or no interest to venture capitalists at the time, and I would include, for example, Autonomy, which you will probably have heard of, and Cambridge Antibody Technology, which was the UK's most successful biotech company ever. They were unable to attract the interest of venture capital investors and they did not figure on any Government's list of priority technologies or sectors. Their success has been rather gradual, starting in specialised markets in which they have been able to build a strong position, as applications have become broader and more significant.



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By the way, that is a significant success strategy everywhere. Other examples include Microsoft and Intel. Vodafone, which is the UK's most successful start-up since the second world war, was essentially a spin-out from Racal, which started as a two-man engineering consultancy business developing radios for the military.

Q82 Neil O'Brien: Can I jump in, David? This is very good, and is giving us a sense of the non-linear nature of innovation and the way that innovation really works in the private sector, but just to sharpen the question and to get to the end of it, other than the SBRI, about which we will talk in a second, are there particular schemes, given the history you have researched extensively, that you think the Government should be focusing on if they want to encourage private sector innovative businesses and private sector investment in innovation?

David Connell: Can I answer that by first addressing where the balance is? I am arguing for demand-led programmes; SBRI is one. Demand-led innovation is what has grown these success stories. In contrast, existing UK innovation policies have been traditionally, and probably are continuing to be, mainly to do with increasing the supply of R&D. One key assumption is that, if you make R&D cheaper, companies will do more of it, and that of course is the rationale behind R&D tax credits.

Let me say a bit about R&D tax credits, if I may. R&D tax credits now cost around £3 billion a year. That is about 10 to 15 times what Innovate UK has been spending in funding business R&D directly through grants. Most people are not aware of that. The statistics so far suggest that R&D tax credits have had no significant impact on aggregate UK business R&D spending as a percentage of GDP, except that an increasing proportion has been funded through R&D tax credits.

Q83 Chair: You actually suggest, do you not, that net business R&D spending has gone down?

David Connell: It is net if you take off the R&D tax credit, yes. The data up to about two or three years ago suggest that R&D expenditure paid for by companies from their own funds, as a percentage of GDP, appears to have declined. We do not know what would have happened without R&D tax credits, but that suggests to me that R&D tax credits are not the solution, or, at least, are not the complete solution. My own view is that we should be re-thinking the R&D tax credit model and trying to find a way of using some of that money—all companies get it and appreciate it—to fund R&D activities that bring greater benefits to UK industry: for example, through a voucher system to encourage established companies to make more use of Catapult centres or university research.

Most importantly, R&D tax credits mainly help companies with significant revenues or VC investments to provide the remainder of the funding. For companies at the beginning of their journey, who have neither raised venture capital nor have significant revenues or profits, R&D tax credits



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are a bit like the unexpected legacy from the aunty in Australia, welcome but not transformative.

The second key assumption underpinning traditional UK policies, which we touched on just now, is that academic research is the key driver of innovation, so we see a lot of emphasis in terms of policy drivers, on doing more translational research, collaborative projects between industry and university researchers and encouraging university research spin-offs. But that thinking, although it is important and I am sure we could do better, does not entirely align with the evolution of many of our most successful companies—new companies as I have described earlier.

When it comes down to answering your specific question, Neil, first, we need to revisit the balance of funding between supply-side programmes and demand-side programmes, of which there are very few in the UK. The only one really is SBRI, which is about public sector demand. We could do more, in the context of the challenge fund probably and the sector deals, to encourage innovation within the supply chain. Take, for example, the automotive sector, which is very important. Automotive companies, car companies, have very tight financial pressures. They tend not to spend a lot of money on contracting other companies to develop technologies for them. By and large, they expect their existing supply base to do that and fund it themselves. One thing we could do is to assist them to fund R&D in innovative UK suppliers as lead customers, using the collaborative grant mechanism, thereby ensuring that UK businesses, especially newer businesses, have a growing part to play in the supply chain.

Neil O'Brien: That is really helpful. Ruth, just to complete the round.

Dr McKernan: I have three quick examples. The intervention you use depends on what you are trying to solve, what you are trying to deliver. If we are trying to deliver demand-led programmes that will produce productivity and do something for economic growth in the UK at the same time as improving regional disparity—the work that Richard Jones was talking about—the challenge fund is a good way of doing that. It encourages the whole supply chain—a group of researchers and businesses—to work together. You cannot put a man on the moon by making a large fund available for rocket parts. There has to be a strategy, a structure and a set of organising companies and businesses around it.

A second challenge we have is in how we scale businesses quickly enough. We have introduced our investor accelerators, which means that Innovate UK funding goes in alongside the private sector, so we now have private sector investors who do the diligence on the company while we do the diligence on the technology. Then they get their funding together, and they have reserved funding from the investors for the next round of investment. That will probably save them a year, which is very important in a highly competitive environment.



To help companies get their products launched—because what they really want is customers, not grants—we are introducing our loans programme, which has been some time in the working and understanding with BEIS. We now have our group set up; we have our chief investment officer, we have partnered with the British Business Bank, who are on our advisory board, and we are just about to start providing loans for businesses who are ready to start making their products, to help them get over that last phase that gets them customers and helps them grow. That is non-diluted. We are using all the tools at our disposal to solve the problems that companies have at different stages of growth.

Tom Morrison-Bell: Could I make one point from the perspective of some of techUK's members? On the distinction between demand and supply side, the really blue skies forward-looking innovation, where there is no market and the product may not exist yet, is by definition always going to be supported by supply-side incentives, because there is no demand yet. The demand-side incentives are useful, as I think Tom mentioned previously, for the diffusion of either tried and tested technologies, which would be successful, or a new product coming to market. They need to be balanced. Equally, which is where the international context is important again, the UK is not offering its incentives in a vacuum. If they change, they will have to be understood relative to what particularly Ireland, in the case of Brexit, might be offering, or France or Spain, so it is important within that context.

On the demand side, we would agree with David Connell. One area in the context of the industrial strategy that techUK has been examining, and would urge, is that, on the productivity question, you will need short-term, medium-term and long-term bets. It is going to take skills and PhD funding, and that is 20 or 30 years down the road. In the short term, it looks like there is general agreement that digitisation is going to be one of the core areas that could help drive productivity. It is clear, and the Eurostat figures show, that the UK, while being the most mature and strongest digital economy in Europe, fares quite poorly in the digitisation of our businesses across the board.

On the demand side, we certainly believe that there would be grounds for the Treasury, perhaps in the forthcoming Budget, to look at research on what actually are the most productivity-enhancing digital products that small businesses, SMEs, can use. I think it has been done for the energy technologies list. We know globally that digital products work, but there is a gap in the research as to what the actual products are. It is probably going to be around cloud, data analytics—a range of things. Once that list is determined, perhaps a small pilot could be run to see which are more successful, and so on and so forth, to determine whether there is a demand-side stimulus that can be done. While I think companies probably recognise that there is an existing economic incentive to do digitisation, for whatever reason it is not happening at the moment in the UK.



Q84 Neil O'Brien: That is very helpful. Could I come on to a specific question, if we have time, to talk about the SBRI specifically? This is mainly a question for David Connell. Your review was announced roughly this time last year. Could you give us a flavour of what conclusions you are coming to, and specifically could I ask your view on two things? First is the question of whether you think it would be helpful for SBRI to have its own budgets rather than be carved out of the Department's budgets and, secondly, whether you think it needs some sort of strategic centre in Government that owns it to push it forward.

David Connell: I will give you a couple of bits of background data. SBRI is running at about £75 million a year. It has no separate budget. It has been operating in different forms to an extent since 2001 but did not really get going until 2010 after several different attempts. One of the reasons it has been successful is the very active promotion of the Innovate UK team in drawing it to the attention of spending Departments, and some very strong top-down encouragement—maybe even pressure—from No. 10 and No. 11 during the course of 2013-14. For those who may not know, it is about enabling spending Departments and agencies to fund the development of technologies that they will need in the future, either to improve their own performance or for policy reasons. It covers a whole variety of different Departments and areas.

The success of SBRI has been a bit of a mixed bag. Companies love it. They love it because it is a customer, and a customer gives you endorsement to go to other customers, partners and investors, so it is very important from that point of view. They also like it because it is 100% funded, rather than grants, which are typically maximum 70% funded. It is in two phases, initial phase 1, which is typically £100,000, and phase 2, which is typically £250,000 to £1 million—it probably should be at the top end of that scale—spent over two years. As I indicated earlier, for many start-up and early stage companies, grants and tax credits do not enable them to do the job. They need 100% funding. That is their business model and that is what they need. It is very popular among businesses. For many, it has been transformative. It can be a transformative programme.

From the point of view of Departments, there are some very active users. NHS England is the role model by far. It has been going for about six years now. It has a stable team—the same team—and recent studies commissioned by NHS England and by the Department of Health have given it a very strong stamp of approval in terms of what has been delivered. Innovate UK uses it for some of its own programmes and there are some other Departments that have used it pretty well, but for many Departments it is not something that they are used to doing or want to do.

Q85 Chair: But they could.

David Connell: They could, but at the end of the day it is largely about money. Many Departments regard it as BEIS's job to fund businesses,



and where many Departments have run an SBRI it has not been consistent with the guidelines for the programme. A lot of the contracts have been too small ever to have a chance of delivering a procurable product. A lot of the competitions have been a bit ad hoc in response to senior official's suggestions for programmes. Many do not have stable teams. Essentially, there are three problems that we have to fix to get SBRI working effectively.

First, it needs a long-term funding solution that overcomes the short-term pressures on Departments and gives them an incentive to run it. From the perspective of a spending Department, it is a tiny amount of money. Permanent secretaries and boards have little visibility of it, but when it comes to addressing financial pressures, it is easy to chop. My view is that the answer is a central fund into which Departments can bid, and that is the recommendation I made. I have looked at other approaches. Many other approaches have been in the past—three or four different approaches. I believe a central fund is the right one.

The second thing we have to fix is to devise a governance process that will ensure that departmental or agency SBRI programmes are designed and run effectively. I believe the way to do that is to ensure that the central fund has the power to evaluate proposals to ensure they are consistent with best practice, and indeed to spread that best practice. And to monitor progress.

The third thing that is needed is to enable SBRI to play a continuing strategic role in improving the cost-effectiveness of Government Departments, which we all want—that is one of the benefits. To do that SBRI needs to be embedded within them in the same way as any good private sector organisation would do, through the kind of open innovation processes that they use. There is a lot more detail in the report obviously.

Neil O'Brien: That is very helpful.

Q86 **Chair:** I want to ask a final question on something else. The recent Treasury consultation on financing growth in innovative firms identified defined benefit and defined contribution pension schemes and insurance businesses as potential sources of funding for patient capital. Indeed, Sir John Bell last week talked about the experience from the States, where an adjustment to what was deemed prudent investment back in, I think, 1979 appeared to unleash a significant increase in capital available for R&D. What do you think is needed here? Do you think it has potential if we could do something similar in this country? What is your advice to us on that?

David Connell: I am not familiar with that particular piece of legislation, but I have looked in some detail at the US Government funding programmes for innovation. First—I probably do not need to repeat it—procurement is a very important non-dilutive source. Secondly, we need to realise that financial returns to venture capital in the US are quite a lot



larger than the UK. In the UK, the long run financial returns to venture capital, especially early stage venture capital, have for 30 years, more or less, been significantly below those of other asset classes regarded as lower risk. You would not want your pension fund in a basket of UK venture capital funds. There are exceptions in areas such as the internet and so on where growth is very quick, but the geography, the fact the US is a larger market, so growth can be faster, effectively makes it much more difficult to make really good returns in the UK.

One of the things that the Small Business Administration did in the US was to establish Small Business Innovation Company (SBIC) programme, under which private sector funding, both for venture capital and for venture debt, is leveraged with public sector capital. One of the most important areas there is in mezzanine capital, or venture debt, which is funding for scaling up businesses that have had some venture capital and then the risk declines. That is very weak in the UK. We could learn quite a few lessons from looking at how the US have used the SBIC model to encourage the growth of that area.

The final area is Government loans. The SBA has a whole range of different small business loans, and they are made available through a very wide network of small banks and so on. These loans provide a range of different sources of loan capital appropriate to different levels of risk and return, through to very high-risk lending, where obviously the return is greater.

Tom Morrison-Bell: As David Connell mentioned, for the tech sector and start-ups, venture capital is really important. I am glad that you note that its growth is different from other areas. There may well be an increasing trend, particularly in the tech sector, but what is important for a digital product is how quickly it can be scaled, so that once you are online and it is an internet-based product you can have a global audience. From quite a small starting point based in the UK, your audience is the world. The ability to scale is attractive to VCs. That is one of the things they will look at. That may also be a reason why it is more successful or more important in the tech sector.

Going back to something Neil mentioned, we have touched on Brexit, and in regard to the tech sector—it is not a scheme as such—the European Investment Fund has been critically important for venture capital in the UK, particularly in tech. Between 2009 and, I think, 2015, it accounted for about 33%, around a third, of the funding that VCs channelled into start-ups in the UK. That was European Investment Fund backed or money that came from them. While we are likely to have to leave the European Investment Bank, not being a member state, the European Investment Fund is open to non-member states. Indeed, there are private companies, banks, which are part of it, so retaining a stake in that is certainly something that the tech sector would be keen to see. I appreciate that is not directly about your question on means of inward investment.



Q87 Chair: No, but it is helpful. I will have one final go. The defined benefit pension funds at the moment hold £1.3 trillion of assets in this country. Insurance holds £1.9 trillion in assets. In the States, the US Department of Labor ruled that allocating a small part of a portfolio to venture capital funds would not be seen as imprudent. It was not legislation. It was just an interpretation ruling. If, as a country, we have this ambition to get to 2.4%, and indeed to 3%, in a time of massive constraints over public funds, I am interested to know whether there may be ways of unlocking some of those enormous assets for the benefit of research and development in this country.

Tom Thackray: My question would be, why does that not happen already? Are there regulatory barriers to that happening, or are there skills deficiencies within institutional investors?

Q88 Chair: The argument is that in the States that tweak to what was regarded as prudent unlocked it, and Sir John Bell was arguing that doing something similar here might unlock assets in this country. That was his argument.

David Connell: The devil is in the detail—the legal detail. The reality has been, historically, that UK pension funds have been rather unwilling to invest, certainly in early stage venture capital. Later stage and private equity is not an issue, but they have been reluctant to invest in earlier stage venture capital. That is probably true across Europe, and for very good reasons.²

² Note by witness: I would also like to add a comment in relation to the Chairman's last questions (87/88/89). I interpreted this as being about the narrow point of making a rule change to allow pension funds to invest more in higher risk venture capital. As indicated I do not believe this would have much impact as it would not change the IIR on UK VC funds which is the problem.

However I do of course agree with the desirability of increasing institutional investment investment in VC funds. To do this we have to increase the IRR such funds deliver. There are two main ways to do this:

(i) To increase the amount and effectiveness of non-equity funding early in the life of companies thereby taking them to the point where they are "investment ready". Lead customer programmes, like SBRI, provide a very effective way of doing this, not by "picking winners", but by "using customers to help identify potential competitors" and using a phased competitive process to focus funding on the best. The £73m of NHS SBRI funding since April 2012 has so far resulted in an additional £104m in private sector investment in contract winners.

(ii) By developing public/private sector investment fund structures in which the government bears a higher proportion of losses by individual funds, but has a "catch up" clause allowing it to take a higher share of those making exceptional returns. The US SBIC model allows this kind of approach, with government spreading its investment risk over many funds and years. The UK ECF model offers a higher upside to private investors compared with the British Business Bank's co-investment, but does not cushion private investors from losses. Given the poor historic returns on early stage venture capital, a different formula to the ECF model would be required to significantly increase



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Q89 **Chair:** You do not see this as the holy grail.

David Connell: I am afraid not.

Dr McKernan: I would be a bit more positive. We are funding a lot of small businesses, scaling businesses, and in order to recoup that investment, which is public funding, we need a way to ensure that the private sector invests thereafter. This may be one way of doing it, but we certainly need to approach the problem.

Chair: Good. Have we any other final questions? No. We got there, so thank you very much indeed for your time. It is really appreciated.

private sector interest.

We need also to increase the time horizon of VC funds, ideally by encouraging an evergreen rather than 10 year LP model.