

Science and Technology Committee

Oral evidence: [Balance and effectiveness of research and innovation spending](#), HC 1453

Tuesday 20 November 2018

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[Watch the meeting](#)

Members present: Norman Lamb (Chair); Vicky Ford; Bill Grant; Darren Jones; Stephen Metcalfe; Damien Moore; Graham Stringer.

Questions 1 - 137

Witnesses

[I](#): Sir Paul Nurse, Director, Francis Crick Institute; Kirsten Bound, Executive Director of Research, Analysis and Policy, Nesta; Professor James Wilsdon, Professor of Research Policy, University of Sheffield, and Chair, Academy of Social Sciences Policy Working Group; and Dr Sarah Main, Executive Director, Campaign for Science and Engineering.

[II](#): Ernesto Fernández Polcuch, Chief of Section, Science Policy and Partnerships, UNESCO, Paris; Professor Jakob Edler, Executive Director, Fraunhofer Institute for Systems and Innovation Research, Germany; and Dr Jos van den Broek, Senior Researcher, Rathenau Instituut, Netherlands.

[III](#): Professor Paul Nightingale, Professor of Strategy, Science Policy Research Unit, University of Sussex, and (designate) Director of Strategy and Operations, ESRC; and Professor Joanna Chataway, Head of Department, Science, Technology, Engineering and Public Policy, University College London, and Deputy Director of Science Policy Research Unit, University of Sussex.

Written evidence from witnesses:

- [CaSE](#)
- [Professor James Wilsdon and Professor Richard Jones](#)
- [Nesta](#)

Examination of witnesses

Witnesses: Sir Paul Nurse, Kirsten Bound, Professor James Wilsdon and Dr Sarah Main.

Q1 **Chair:** Welcome, all of you. Thank you very much for your time this morning. May we start with very quick introductions?

Sir Paul Nurse: I am director of the Francis Crick Institute in London.

Kirsten Bound: I am executive director of research, analysis and policy at Nesta, which is a foundation that supports innovation for social good.

Professor Wilsdon: I am a professor of research policy at Sheffield. I am also here from the Academy of Social Sciences.

Dr Main: Good morning. I am the executive director of the Campaign for Science and Engineering.

Q2 **Chair:** Is the Government's ambition to hit 2.4% of GDP on R&D by 2027 ambitious enough? Indeed, is it the right approach to take to target a level of spend, rather than look at what is achieved through that spend?

Kirsten Bound: From one perspective, it is monumentally ambitious. It requires a sustained year-on-year increase that we have not seen in a generation. From another perspective, it will take us up to an OECD average intensity spend. No country aspires to be average, so it has to be a step on the way to what we want to see.

It is an input target, and we know that those are imperfect. The ambition that we have to see from UKRI and throughout the rest of the system is for the impacts that we can achieve through this spend, through the best use of data and the best judgment about how we can get the greatest impact from the spend.

Q3 **Chair:** Back in 2004, the Labour Government made a similar commitment, to hit 2.5% by 2014. That did not happen; it was not achieved. How do we make sure that this is achieved?

Kirsten Bound: We know that it is feasible. Several countries have achieved this kind of increase in the past. We also know that input intensity targets are hard to meet. A Portuguese researcher looked at 112 instances of setting those in the past, in 45 countries. I think that they have been met twice, so we know that there is a lot of work to do—it is a tough target. We need to think not only about the impact target but about the impact that we achieve from the spend.

Sir Paul Nurse: I agree with Kirsten. It is a step in the right direction, but you cannot say that it is that ambitious. We have been at the bottom of the G7 for years, at 1.5% or 1.6% of GDP. It is going to 2.4% over an extended period, when other countries are already at 3%. By the time we get to 2.4%, who knows where they will be?



Chair: They will have moved.

Sir Paul Nurse: Secondly, where is the money coming from? Aspiration is not enough. We need to know where the money is coming from. As you rightly said, in 2004 there was a not dissimilar aspiration, which did not get anywhere, because it relied on private industry to produce the money. Of course, Government cannot force that to happen. It needs to put the levers in place—which some here have thought about—to ensure that that money can be forthcoming this time around.

Professor Wilsdon: I agree. The target is very welcome as an ambitious goal to aim for. Paul is right: the scale of what is required, both from the public sector and from the private sector, is considerable. We need to see year-on-year increases towards that goal—certainly from the Government side—in the next spending review. From the business R&D side—remembering, of course, that in the UK system two thirds of R&D spend is from the private sector—there are really big questions about how we incentivise and engender that.

Q4 **Chair:** It is about how you leverage that. Sarah, CaSE has raised a concern about the lack of a vision for that 2.4%—for what we are seeking to achieve by it. What is your vision for that? Have you articulated what the vision should be?

Dr Main: I will take a bit of a step backwards, to start with the ambition point and to add a bit of colour to what has been said. You will know that UK research and innovation spending has been relatively static for some years, with some recent rises. I remember that several years ago—probably in about 2014—a representative of a large multinational said to me, “The problem is that the UK is standing still while everyone is racing ahead.” Here we are now, trying to catch up. That is the international perspective.

One of the purposes and visions of what is a significant aim—to increase research intensity as a proportion of national wealth by approximately one and a half times—is for the UK to be a global partner of choice. Both the Government and the Opposition parties support a vision of the UK where we are a knowledge economy, are strong on research and innovation and are a magnet for talent, as well as a partner of choice in international collaboration. We have thought about some of the issues related to that and how the input goal, as it has been put, of increasing the spend across the economy to this scale can be supported by the packaging of the offer to the outside world, making our ambition clearer and inviting people to participate.

I will make one other point that is particularly pertinent to the Campaign for Science and Engineering, which, as you know, represents a really wide spectrum of research and innovation organisations. The thing that is unusual about the UK is its very rich ecosystem for research and innovation. We have not only the multinational R&D companies, across a range of disciplines, but the full spectrum of academic excellence, SMEs,



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venture capital and really wonderful learned and professional societies and research charities. In the context of the conversation that we are going to have, I would like the Committee to try to bear in mind the implications for this discussion of that rich ecosystem of research and innovation in the UK.

When we submitted evidence to the Committee and made the point that thinking about the strategy to reach this goal is dependent on the purpose you have set, we looked at the purposes set by the Government in the industrial strategy and highlighted some of them in our submission. If you take those as your steer, you will find that they follow on—

Q5 Chair: Do you think that that is a reasonable basis to start from?

Dr Main: The Government are entitled to set out their own industrial strategy. It is not for me to dispute that. It is worth looking back at those statements as a guide, if the Government's purpose is indeed to achieve those aims, which are related to wellbeing, prosperity, productivity and good jobs and skills across the country. We have the direct quotes.

Q6 Chair: Paul, it was your review of the research councils that led to the establishment of UKRI, which now controls about 70% of public spend on R&D. When you made the recommendation to establish UKRI, what processes did you have in mind that the organisation should go through to determine how to allocate publicly funded R&D spend?

Sir Paul Nurse: In the previous structures, I felt that there was a failure to have policy for science properly discussed and debated and a lack of decision making. With UKRI, we have an opportunity to take on strategy discussions, which I think are both exceptionally important and quite difficult to do well. You have identified some of the issues, and some of the submissions have identified the issues that need to be dealt with.

Talking about strategy, I do not want to underestimate this issue. I have thought about it for many, many years, and I cannot say that I know exactly how to do it, because I do not. What I do know is that you need to have a broad approach. People talk about bottom-up and top-down approaches, for example. You need to use different ways of trying to get a strategy, which requires consulting those who do science, of course, and consulting social scientists, who think about these processes, as well as consulting the public in some way.

You need to know a number of things. You need to know how science is done. That was rather lacking in the submissions, but it makes a big difference. If you are interested in this issue, which I talked about in my review, we can get into a discussion of the philosopher Karl Popper, in particular. That might not be what the Committee wants to do, but I am happy to have a go at it if you have a spare five minutes at the end.

Q7 Chair: We have certain time constraints.



Sir Paul Nurse: The point is that science is a spectrum, ranging from discovery research, through translation, to application. The different parts of that spectrum share many values and ways of doing things, but making decisions differs in those different parts. When you are close to application, you have to have a more top-down approach, identifying big challenges, societal needs, economic needs and the like. You cannot operate in the same way with discovery science, because you will snuff out discovery. It has to be recognised that there is a breadth and a different way of doing things.

Strategic discussions of issues such as the issue of place—where it is located, which George Osborne used to talk about a lot—are very important, but you cannot be trite about it, because it is complex. In addition to thinking about place, you have to think about quality.

That is part of the golden triangle issue. My view on that as regards strategy is that, if you are close to application, place can be very important. If you are in Bradford, for example, local industry engaging with the university is a critical issue. If you are trying to understand how something works, I would simply go for quality across the country.

Q8 **Chair:** It can be a reinforcing process, can't it? The more you invest in existing excellence, the more dominant you make that.

Sir Paul Nurse: It is a problem. Unfortunately, quality attracts quality. We see it in the US, where I used to work. You have powerful places on the east coast—Boston and New York—and on the west coast. What is important is to realise that the powerful places can be conventional. You need to have places that are free from the barons of science and can allow new things to prosper. One of the strengths of the US is that you have all the other decent universities in the middle of the country, which do things in different sorts of ways. We have to think about that.

The real way forward here is for UKRI to put in place a strategic committee that will look at all these issues. That is one of the main things it has to do.

Q9 **Chair:** Should it have done that already?

Sir Paul Nurse: It has, but it has to make it really work. I think that it is the most important thing that UKRI has to do.

Q10 **Chair:** Presumably, there should be an openness about that, so that there is a public understanding of how these decisions are being made.

Sir Paul Nurse: The public are really critical here. There was this phrase that came from a House of Lords report 15 years ago, which was that we scientists have to earn our licence to operate. You earn your licence by engaging the public and getting them on board. If we do that properly, they will trust us, but we need to earn that trust. UKRI has an important role there.



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- Q11 **Chair:** I am conscious of the fact that time is really tight and that others need to get in. Have any of you been asked yet to advise UKRI on the critical issue of whether there is a case for altering the balance of funding between the different research councils within UKRI?

Dr Main: No, I have not been requested to do that.

Professor Wilsdon: No, I have not. With a colleague, I have done it without being requested, but that is a different matter.

Chair: I see. You did not wait to be asked.

- Q12 **Darren Jones:** Kirsten, in Nesta's submission, you say, "there is limited evidence on the effectiveness of innovation and growth policy." Can you elaborate on that a bit this morning? Is it because it is hard to correlate, or is it because we are not collecting the right data to be able to evaluate it properly?

Kirsten Bound: Innovation policy is not really very innovative. One of the problems is that it is really tough to try new things, because the evidence base for what works is so poor. Recently the What Works Centre for Local Economic Growth looked at around 700 innovation schemes across the OECD. It found that only 4% of them have any credible evidence of causality, so there is a very low base to work with. Where there is a better evidence base—for example, on R&D tax credits—there are still questions about whether there could be better ways of achieving radical increases in innovation in the private sector.

We at Nesta are working to try to improve that evidence base, not by getting the perfect evidence catalogue or database but by building a culture of constant experimentation in designing and delivering innovation and growth policies. That involves constantly tweaking and optimising them, but also creating the space and risk capital route for trying new things.

- Q13 **Darren Jones:** If we were to ask UKRI better to evaluate the effectiveness of innovation policy, what should we ask it to measure?

Kirsten Bound: Certainly, we need to look beyond the traditional statistics that we have been measuring for R&D expenditure—patents and things like that. One thing we are particularly interested in is how you capture the power and possibility of big data, so that you capture, visualise and see innovation in the economy in real time and in a more granular way. Rather than just relying on patents and publications, we should look at scraping millions of job ads, to see which technologies people are hiring for. We should look at the information in thousands of websites and millions of open datasets, draw it together and visualise it in new ways, so that policy makers can have much more granular and real-time access to data for decision making.

- Q14 **Chair:** Are we doing that at all yet?



Kirsten Bound: In very limited ways. We are experimenting at the moment. We are creating a dashboard for the Welsh Government to help them to access these new possibilities, but we are still at the early stages of unlocking this. For UKRI, it has to be an aspiration to use these incredible new powers of data-driven decision making.

Q15 **Darren Jones:** What data should we be collecting? What should be on our innovation dashboard?

Dr Main: Would you mind if I added a separate cross-Government point, which is not quite the specific answer to your question? I wanted to say earlier—and I think it is relevant here—that this question is not pertinent only to UKRI. We know that UKRI is responsible for about 70% of public R&D spend. Other Government Departments are responsible for the other 30%. Defence and the NHS are significant players in that, but many Departments are responsible.

This is a key part of the conversation. You have mentioned public dialogue and public acceptance, which is absolutely vital. If we are trying to increase research and innovation intensity in this country by 50%, you need the public behind you to support you, as politicians, to support the policies that are needed to enact that.

On the question of innovation, looking at SMEs and high-growth companies and their interaction with Government is an example of an area where you can get other Government Departments involved. The Connell review made a number of recommendations on SBRI. That is an example of something that is outside the remit of UKRI, but that can have a significant effect on innovation adoption, procurement across Government and the health of the SME high-growth system in the UK.

I will give one example that I hope will make you smile. We spent about two hours in the office looking at what an entrepreneur or innovator who wanted to look for public sources of support for research and innovation would find. In two hours, we found 28 different websites offering Government support for research and innovation that are unconnected to one another and have no central linking point backwards.

Q16 **Chair:** You would say that it is all very welcome, but crap.

Dr Main: It is terrifically complicated—and no doubt it was before. We have spent time—as I am sure Nesta has—gathering SMEs and high-growth companies, to talk with them and with officials in BEIS and UKRI. There seems to be a real vibrancy of people and organisations that want to come to the UK to do innovative activity. We need to be really careful to encourage that, rather than to hinder it in any way.

Q17 **Darren Jones:** We have talked about Government co-ordination—I think you are right about that, Sarah—and about data dashboards and how we measure that. If we need to innovate in our innovation policy—as you have just said, Kirsten—what does that innovation look like? What would you like to see from Government?



Dr Main: Kirsten has set out some ideas. For us as an organisation, basing strategies and policy on evidence of what has worked and on consultation is really valuable. There is a good deal of that going on, but we must make sure that it is in line with the purpose that is set and what people are saying works. That is what this iterative process speaks to.

Professor Wilsdon: I agree with Kirsten. One of the biggest advantages of UKRI as a structure, in line with Paul's ambitions in his original review, is that it allows us to take a much more holistic strategic look at which aspects of the system are working well and which are not. Given that we are only six months into the creation of the organisation, this Committee's inquiry is very important in establishing what the baselines will be, as well as what the specific indicators will be.

If we look internationally, we are at a point where there is a great surge of analytical capacity, involving the use of big data and new techniques both to understand, to measure and to analyse innovation systems and to do the same for research. There is a big growth in so-called research on research—science of science—which has been attracting a lot of attention in the US, Japan and elsewhere.

My hope is that UKRI will approach all that with greater ambition and, in the next 12 months, will put in place the systems, mechanisms and capacities to measure what is and is not working well and to keep track of the multiple vectors of balance. The commitment to balance is there in the original Act and in UKRI's own strategies, but, as we know, there are multiple vectors of balance—balance across different disciplines, as represented by the research councils, balance between QR and non-QR streams of funding, balance between challenge-directed funding and other sources, and balance between more applied and more—

Q18 **Chair:** It is quite a nebulous term that needs a bit more definition.

Professor Wilsdon: Exactly. In a sense, you need to underpin that with indicators that allow us to say, "Three, five or 10 years in, to what extent has UKRI improved or altered the picture against all these vectors of balance? How has that translated into real outcomes in the UK economy, such as productivity?" It is a big and challenging task, but I think that UKRI has the ambition to do it. It is important that we encourage it to do it.

Q19 **Darren Jones:** What I am hearing is that, before we get to the question of how we innovate in our innovation policy, we really need to understand and evaluate what we are doing and how we measure that. I have timed out today, so we will have to do the classic "Will you write to me?" question, but what I am not quite clear on from your answers is what we are asking Government to measure—what is on the dashboard—and how we get that across different Government Departments. I agree with everything that you have said, but we want to make recommendations to the Government on how to be better at this. We need to be quite specific about what we are asking them to do. If you have any thoughts on that



and want to write in with them, that will be very helpful.

Chair: Do you have a quick answer to that question? Please write in if you have additional thoughts.

Dr Main: The measures are really important. The Industrial Strategy Council has only just been set up, about a year on from the industrial strategy. One of its specific roles is to establish measures for the success of the industrial strategy. I would say that there is a Venn diagram. The industrial strategy is not all of research and innovation—there will be innovation that is pulled in—but it is extremely important. I would certainly press on progress in the council's consideration of what those measures are. It will be measuring to fulfil the aims of the industrial strategy as set out, which are—I will find this quote if it kills me—"to improve living standards and economic growth across the country." That is set as the central objective of the industrial strategy, so presumably the council's measures will be much more tightly linked to that.

Kirsten Bound: I will follow up with exact measures, but it is important to innovate at the same time as we are getting better at measuring innovation policy. Innovation policy is made in situations of extreme uncertainty. It is supporting industries that may not have been imagined yet. We are looking into new techniques such as anticipatory regulation that can bring together firms, Governments and civil society in new ways, to try to anticipate and exploit new technologies such as artificial intelligence in a way that moves them along as fast as possible, while protecting consumers. That ongoing, anticipatory approach to creating policy is what we need to see in the system.

Sir Paul Nurse: One could imagine metrics rather straightforwardly. I am sure that we can write in about that. We also need to capture the softer stuff—the pre-competitive relationships between universities and the commercial side. That is more difficult to do, but it is often where things start. We should look at tech transfer companies in the universities. I am not entirely certain that they are fit for purpose in the way they operate.

Q20 **Vicky Ford:** As Darren said, we would like you to follow up on your comment that we need to set the baseline and then the indicators. In your written follow-ups, will you say whether there are any countries that are doing that well? What are the key indicators we should be looking at? Will you bring in all those points? Is there best practice that we can follow in order to make sure that we can give that steering?

Damien Moore: You mentioned balance a few moments ago. Is the current balance of expenditure on R&D wrong in some sense? Is there a specific problem for UKRI to fix, or does it need to do more of the same to secure our position as a leader in science?

Dr Main: In our submission, we attempted to do some analysis to address these questions. I would put the caveat up front that we are using publicly available data. I recognise that Government Departments



and UKRI itself may have much more detailed data, but the fact that we have used publicly available data speaks to Parliament's scrutiny role and the involvement of the public. I think that it is reasonable.

One can delve into and look at relatively crude differentiators between basic and applied R&D, as defined by the Frascati definition. We have tried to do that, with the intention not of stating what it should be, but of illustrating the fact that it has changed over time, although we have been in a relatively static period in which the envelope for spending has been relatively fixed and, therefore, substantial changes have not really been on the table.

When you look at the spectrum of what is now in UKRI, plus the other Government Departments, you can see some trends. There are some trends in defence spending, for example, where later-stage experimental development spending has come down. You can also see rises in some later-stage spending in civil departments. What was noticeable for me is that there are distinctions, albeit by these relatively crude measures, between the type of research—in very loose terms, basic or applied—that is funded both by different research councils and by research councils as opposed to Government Departments. On the whole, Government Departments spend much more on applied R&D.

Moving towards the next spending review, to meet the 2.4% target, the envelope must expand and increase. In that scenario, it is reasonable for the Government, Parliament, UKRI and all the stakeholders to look at this and to accept that there are now choices, in an increasing envelope, about the balance of funding. In setting up the industrial strategy challenge fund, the Government have already made a significant step. They have put substantial money into that challenge-led approach. In the Higher Education and Research Act, there was also a commitment to balance of funding and a recognition of the value of the different streams of unhypothecated QR, response-mode research council funding and other funding outside the UKRI domain.

We have provided some data that I think can be informative when we are thinking about how to move forward. There are some noticeable gaps. From the data that are available to us, the increase in unhypothecated QR in announced funding has been relatively small to date, compared with other increases that have already been announced. We have calculated a rise of about 4%, which is small compared with the multibillions that have been put into the industrial strategy challenge fund.

Chair: We have an awful lot to get through today, with three different panels. Will you try to keep your answers as succinct as possible?

Q21 **Damien Moore:** One of the advantages of setting up UKRI is the scope to alter strategically the distribution of funding between the different research councils? Do you think that will happen?



Professor Wilsdon: To build on Sarah's point, given that we hope to have this extra money flowing through the system, I think that it is possible to have that debate in a more creative and open way than has been in the case in recent years, particularly during the period of flat-cash budgets. There is a good passage in David Willetts's recent book in which he talks about peering under the lid of this question and shutting it back down, because you have so many established incumbent interests in the research system that it is very hard to alter the budget in a flat-cash environment. With more money coming in, we should be able to ask those questions. As we said earlier, UKRI brings the system-wide potential to look at these things in a more open-minded and, hopefully, evidence-informed way.

To underline what Sarah was saying, from my perspective—speaking from the university side, as I am the only university person at the table—we have real concerns about the balance between QR and other modes of funding. We rely so heavily on the QR line to be able to do all sorts of things institutionally, which is becoming harder as the pressures on that budget increase. We are grateful for and welcome the move towards an industrial strategy and global challenges—the big challenge-directed funding streams—but we observe that they are coming at a time when the core, mainstream research council budgets remain largely static, give or take a bit of flux. That is another issue of potential concern over a five or 10-year period.

If I can speak from Sheffield's perspective, as an adopted resident of Sheffield, we look at the balance of public spending in R&D across the country and see 41% being spent in three cities: London, Oxford and Cambridge. It is 54% if you look at health-related research. Is that the right balance? Should UKRI take a look at that? Certainly, those of us in the north of England would suggest that the time is ripe to open up that question in a much more full-blooded way than has been the case in recent years.

Q22 **Damien Moore:** I will link the next two questions together. What is the best way to phase in public investment so that private investment follows that? Even if we had 2.4% to spend, would we be able to spend it?

Dr Main: Responsible stewardship of public money is an extremely important point. It is right that Parliament scrutinises this in detail. Although we started with the question of ambition, let us not forget that spending is rising—I will look at my numbers here—from approximately £33 billion to £62 billion across the economy.

Q23 **Chair:** This is combining public and private spending.

Dr Main: It is across the whole economy. We are adding 50% to national wealth. The public purse position is £11.3 billion per year on top of what is currently spent. If you include the existing commitments, that is £9 billion when we get to 2021. Therefore, there must be an element of responsible stewardship of public money. That is essential.



Your question was about the interface between public and private spending. We, as well as other organisations, have spent time trying to ask companies what might incentivise them to increase their R&D investment. We have put a number of suggestions in the submission, but the one that I will highlight is that it is a long-term plan. Our core message today is that this is a 10-year programme of work to attract increased research intensity and activity in this country on that scale. The organisations that will be doing that need to have a long-term framework to work to. I have heard from a range of different organisations across the sector that they would like to see the Government put down a 10-year framework, including the budget for the public proportion of this R&D target.

Q24 Chair: Do you mean how the increases are phased over that 10-year period, so that there is certainty?

Dr Main: Yes. It is true that we have announcements up to 2021, but this is a plan to 2027 and 2028.

Sir Paul Nurse: I will make a very quick comment. As has already been mentioned, with an expansion of spending, we have an opportunity to shift the research council spend in an effective way. We have to maintain the core funding—which, incidentally, have been unchanged. It is now 48 years since the Dainton report. I remember talking to Fred Dainton at the time.

Chair: You do not look that old, Paul.

Sir Paul Nurse: At that time, we spent 20.4% on the MRC. In 2016, it was 19.5%. NERC, which is the only other council unchanged from that time, we spent 14% 48 years ago and spend 12.5% now. It is hardly shifting. That tells us that history is determining what is happening. That cannot be right.

My suggestion is that, as we expand the money, we should not just allocate it to research councils. There should be some cross-research council bidding, so that we can move on to new things.

Secondly, one way in which we should look at application and what I prefer to call discovery research is to get much closer working between the private sector and the public sector, so that the risk can be shared. Companies do not like to take such long-term approaches, because it is a risk. By having a public-private relationship, you can share that risk. A topic like antibiotic resistance is not of interest to the commercial companies. It could be, if there were a proper private-public relationship. I suggest that the Committee might want to look at that more closely in research close to application.

Q25 Vicky Ford: This question is for Professor Wilsdon. In “The Biomedical Bubble,” the report you wrote for Nesta, you suggest that it would be ineffective to continue to increase public spending on biomedical



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research. Where do you think it should go instead?

Professor Wilsdon: I am slightly hesitant to make this argument with a Nobel prize-winning biomedical scientist—and my former boss, to boot—to my right.

Sir Paul Nurse: Go for it, James.

Vicky Ford: Go on.

Professor Wilsdon: I wrote “The Biomedical Bubble” with Richard Jones, who is a physicist. Essentially, we wrote it to pick up the gauntlet that has been thrown down both by Paul’s review and by UKRI’s emergent strategy to have a more textured and, possibly, more argumentative discussion about balance across the system. I share Paul’s scepticism about the scale of static budget lines within the system. It feels instinctively wrong, given the enormous pace of change in the research base and in the application of research in all sorts of different domains.

Traditionally, the biomedical part of the UK system has benefited more substantially than other bits of the system. Our argument is not that we should stop funding health research but that we need to take a hard look at where we are prioritising spend with respect to health outcomes and with respect to the balance between the biomedical part and the rest of the system.

There are a few arguments linked to that. A big part of it is to do with what is going on in the pharmaceutical industry, which, of course, has traditionally been a great strength. It is still a very important R&D strength of the UK economy, but, in relative terms, it is suffering from an R&D productivity crisis of its own. There are all sorts of uncertainties attached to the sector.

Q26 **Vicky Ford:** Do you want to name some sectors that you think could benefit?

Professor Wilsdon: In health terms, we have said, “Put more money into preventive social, behavioural, environmental and big data aspects of the health system.” It is not an argument against health research or against money going to the Medical Research Council.

Q27 **Vicky Ford:** What about other non-health sectors?

Professor Wilsdon: As a social scientist, I think that, in relative terms, we do not fully exploit the potential of social science, both for the economy and in the social sciences research base.

Q28 **Vicky Ford:** In your report, you suggest that the pharmaceutical industry will not be able to put up as much of the private sector money and investment as it has put up before.

Professor Wilsdon: Indeed.



Q29 **Vicky Ford:** Are there other areas of the private sector that you think we could be looking to for greater investment?

Professor Wilsdon: We say that there has been a decoupling. There was a positive multiplier effect for pharmaceutical industry investment on top of public investment, but that has stopped being the case since 2012. It is very clear in the data. That is an issue. Where else it goes is the big industrial strategy challenge. The investment areas that we are seeing through the ISCF are welcome. Clearly, a lot of thought is going into which sectors are ripe for greater investment.

Q30 **Vicky Ford:** Which other parts of the private sector do you think are best placed to help to put more private sector investment into R&D?

Professor Wilsdon: Advanced manufacturing is one area we are very involved with in Sheffield. The short answer is that I do not know. If I did, I probably would not be in a university—I would be in the City, making lots of money. Again, this comes back to what the process will be through which UKRI will develop these strategies and priorities—what range of inputs is going in, as others have said. Clearly, there needs to be a very strong private sector voice, to ensure that we get the £2 for every additional £1 that the state will put in to meet the 2.4% target.

Q31 **Chair:** Paul, presumably you welcome this challenge, given what you said about sticking to historical trends not being satisfactory.

Sir Paul Nurse: I absolutely think that we need to have this discussion. There is evidence that it has remained unchanged. By the way, social science has gone up from 2% to 5% over the same period.

Chair: So take that.

Sir Paul Nurse: They added economics on the way, so you could say that it was due to that.

I welcome the challenge and think that we need to discuss it. As I keep saying, it is complex. It is sectorial. There is a different balance in, for example, the biological sciences, where we do not understand how organisms work. The so-called tech industry is pretty simple and straightforward. You hear people talking about moon shots and stuff, but that does not apply in the biological sciences in the same way as it applies in the physical sciences. Going to the moon required Newtonian physics from 1705 and big rockets. It was simple. Trying to solve cancer is immensely difficult, because we do not understand it. Making iPhones work is relatively simple science. You need to have good ways of marketing and thinking about what you want to do. Reality-wise, the physical sciences are where you probably need to invest if you want to get more immediate gain. However, if you want to protect society and health and want long-term gain, you need the biological sciences.

Q32 **Vicky Ford:** You also need to balance that with your phrase, "We have to earn our licence to operate," because health research tends to have



popular support.

Sir Paul Nurse: You must make sure that the money that you spend is spent effectively. Don't ever forget that. You have to produce good-quality outcomes.

- Q33 **Vicky Ford:** What I am really pushing on, before we move on, is whether there are other sectors where you think that that public-private interaction is untapped and more could be coming from the private sector, and—given your comment that you have to earn your licence to operate—where there is a greater public willingness to invest more and to provide support.

Sir Paul Nurse: I think that the public are interested in health. Because it is long-term and difficult, you need public-private partnerships as part of it. In the tech industry, they will make their money anyway. It is simpler.

- Q34 **Chair:** I will take comments from Kirsten and Sarah. Could you both be very brief, please, because we are tight for time?

Kirsten Bound: I will add a small point, focusing on R&D. Investment in R&D represents only around 12% of investment in innovation as a whole. To unlock that investment and to realise the benefit, we have to invest in all kinds of intangible things, such as design and branding—things the UK is fantastic at. Therefore, I would encourage a look at broader investment in innovation, beyond R&D. Some of our current definitions miss out some of our key strengths, such as the creative industries.

Dr Main: I have two separate points. First, I want to question something, since we are in a challenging mood. I am not sure that it is right to think that the pharmaceutical and biomedical sector is saturated and that the tap has run dry. I think that because—going back to the point that I made earlier about other Government Departments—what we hear over and over again is that there is huge potential that can be unlocked by the NHS and research working together more effectively, particular on adoption of innovation. The UK has an NHS number for every person, which is a hugely powerful tool. I think that that could unlock further innovation.

Vicky Ford asked a question about other industries. It is worth having a map of the UK in your mind, to remember where our strengths are. In aerospace engineering, in particular, there are areas of great strength that bring together industrial and research strength—in the south of Wales, with the semiconductor industry, in Bristol and the south-west, in aerospace, and in Northern Ireland. Across the UK, there are strengths. The question that I want to leave with the Committee is whether the concept of Strength in Places is about building on substantial strengths where they already exist—as is the case around the UK—or is it a question of trying to build up strength where there is very little? Both have benefits for society, but they are two quite different things.



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Q35 Graham Stringer: Sir Paul, may I take you back to the point you made about the conservative funding of different areas of science and the fact that it has not changed? Are particle physics and astronomy an exception to that? They have had a reduction over a period, haven't they?

Sir Paul Nurse: We have to think that science is not entirely utilitarian and that it actually contributes to our culture and civilisation. Particle physics and astronomy get us a better understanding of the world and ourselves. We should not forget that. When Fermilab, which is a particle accelerator, was built, the director was asked by the Senate Committee, "What is the use of this to defend our country?" His reply was, "It is nothing to do with defending our country. It is to do with making it worth defending." We should not forget that part when we are thinking about subjects like particle physics and astronomy.

Q36 Graham Stringer: I agree. I am asking a factual question, really. Has the funding of particle physics and astronomy dropped since the funding council for them disappeared a decade or so ago? I am just trying to find out whether that area of science has had its funding diminished, so that we can put it into the report.

Sir Paul Nurse: I cannot answer the question, as I do not have the figures. I know that the rearrangement with STFC made this very confusing. I think that it is worth looking at it. I do not know whether any of my colleagues know, but I do not.

Dr Main: I do not have the figures.

Q37 Graham Stringer: Can you drop us a note to clarify the issue?

Sir Paul Nurse: It could easily be found. You could just ask the Royal Society.

Dr Main: Potentially, you could ask UKRI.

Chair: We will find it out.

Sir Paul Nurse: I do not know the answer. I am sorry.

Q38 Graham Stringer: May we go back to the golden triangle? You have helped the Committee with that issue before, Sir Paul. Has the imbalance between the golden triangle and the rest of the United Kingdom got worse over the last decade?

Sir Paul Nurse: I do not know whether it has got worse. I am not sure whether "worse" is quite the right word. As I said, for discovery research, quality attracts quality. The problem that we have with it—which is why places like Sheffield are interesting and important—is that it is not a place where new things necessarily grow as effectively, because it is controlled by those who are in power at the moment. Do you understand the point that I am making?

Graham Stringer: I do.



Sir Paul Nurse: I think that there are opportunities in other places—personally, I have worked in quite a few other places outside the golden triangle—that can be effective. However, we should try to be really careful about this discussion, rather than simply saying, “It is good if it is outside the golden triangle.” It is good if the research is good and there is a good opportunity. Focus on goodness and quality all the time in these discussions. That is all that I can add to the debate.

Q39 **Graham Stringer:** May I ask you a couple of specific questions about that? When Andre Geim and his assistant won the Nobel prize for graphene in Manchester, George Osborne put money into the graphene centre. Do you think that enough was done in that specific case to use the excellence of those two absolutely top-rate scientists to generate a better centre of excellence in Manchester?

Sir Paul Nurse: May I give my view, which is a bit anecdotal? Others may give you a more informed view. I do not think that either of them, great scientists as they are, was in the slightest bit interested in this initiative. That is my view. It simply looked good, because you had the Nobel prize for graphene and people said, “Excellent. Let’s now invest in graphene.” I do not think that they wanted to take it to the next stages. They just want to fiddle around in their laboratories.

It is not a bad thing to do, but the decision to do it should take a much wider perspective than simply having a couple of really excellent scientists. You have to think about all the surroundings. Maybe that is there in Manchester, but it needs to be factored into the decision making—not just the fact that you have a couple of Nobel laureates there.

Q40 **Chair:** Do others have a contribution to make on that?

Professor Wilsdon: Not on the specifics of Geim.

Dr Main: People have got in touch with us at the Campaign for Science and Engineering when, over the last few years, the Government have put substantial investments into new centres of excellence in different parts of the country. The theme that I take away from that, which includes both the graphene example and a number of others, is that what the researchers are interested in is that the Government’s function brings together the expertise that is already there and the infrastructure that they need. It does not always have to be in a physical centre—it can be through a network of collaboration. Those models work well. In some instances, there has been a certain amount of frustration with putting physical buildings in places where the researchers would tell you that the expertise is not there.

I would add another point to your thinking about this issue. You raised the issue of the golden triangle. Again, I would ask you to think about the R and the D. You will find that the later-stage, potentially more



engineering-focused, more applied research is very widely dispersed across the UK, but in pockets of real strength.

- Q41 **Graham Stringer:** May I come back to you, Sir Paul? When we discussed this last time with respect to the Francis Crick Institute, which you have shown us around and which is an excellent institute, with top-rate scientists, we were concerned that it was another focus in London. You said that, from the hub, you would have spokes going out to the regions from the Francis Crick Institute. How has that developed?

Sir Paul Nurse: We have been open for only 18 months, so it is very early days. As I told the Committee last time, this was not new money. It was actually all old money in London—in fact, rather less than there was before. Sometimes you read that we have just sucked up all the money. That is utterly untrue. We did not do that.

The point that you are making is this. We see the Crick as a centre of excellence to attract the best people from around the world, because quality attracts quality. We have 100 applicants for every faculty position and 30 applicants for every graduate student position. We can attract the best from around the world. Then, after a period of time, we export them elsewhere in the country. This is an interesting model. They are of an age where they may fall in love with somebody locally, which is an added possibility in trying to get them to settle. I am serious about it. Attract around the world, get good quality and then help them to move to other places, such as Sheffield.

- Q42 **Chair:** In 2013, in an *FT* article, you said that the Crick “would automatically become local if it was in Birmingham or Edinburgh or Manchester, say. In London it can serve the national agenda much more straightforwardly.” Is that inevitably the case? Why does it have to become local? Why isn’t it possible to have a national-serving institute somewhere else in the country?

Sir Paul Nurse: What I wanted to point out is that it is more difficult, if you are in Birmingham or, in particular, Cambridge or Oxford, not to serve Birmingham, Cambridge or Oxford. In London, you have the advantage that it is seen as somewhere where you can support the rest of the country, if you are prepared to do it—as we have at the Crick. I am not saying that it is impossible; I am saying only that it is more difficult. Once you have a model in London, you could have models elsewhere. I do think that.

- Q43 **Graham Stringer:** Is the Strength in Places Fund sufficient to tackle this problem—if, indeed, it is a problem? How should we measure the success of the fund?

Professor Wilsdon: The Strength in Places Fund is very welcome. It is not sufficient to tackle the scale of the regional imbalances in R&D spending. I totally agree with Paul that this is a debate that needs to be approached with nuance and subtlety. It is not simply a matter of “out of the golden triangle good, inside bad.” However, there are observable



trends towards greater concentration over the last 20 years. They are very clearly visible in the data. There are also all of the dynamics we have already touched on within the system that will further concentrate R&D spending in areas that are already successful. That is partly what Paul describes—excellence breeding excellence. It is also other Matthew effects, as Merton and others have described them, in the funding systems. It is very hard to disentangle the positives from the negatives of all of that.

You will not tackle the balance issue at a regional level without very determined public policy interventions and more ambitious funding than we are seeing through Strength in Places as it is currently constituted. This needs to be larger by an order of magnitude to make a significant difference to the overall patterns of investment.

The final point that I would make goes back to where we began. If we as a nation are going to increase our investment in R&D from 1.7% to 2.4%, and then beyond to 3%, surely it makes sense to try to ensure that more of the benefits of that additional investment are spread around and not simply located in three cities or three regions of the country. Brexit reinforces all those dynamics with regard to inequality, but I think that there is a very strong argument from basic first principles that this needs more attention than it has had.

Q44 Graham Stringer: Is there a compromise, or a dilution of the commitment to excellence, with the Strength in Places Fund, even if only for a short period?

Sir Paul Nurse: Not necessarily. Alec Jeffreys, a great human geneticist, spent his entire life in Leicester. In my view, he thrived there because he was outside the golden triangle.

Q45 Chair: To pick up Sarah's point, can you both search out and invest in excellence elsewhere and seek to build excellence? It is a different point, but is that a legitimate exercise as well?

Sir Paul Nurse: I think that it is, if undertaken with great care. It is not adequate to say simply, "We will put a bucket of money here and expect it to work." It requires real care to recruit at the highest level—and recruiting at the highest level is really difficult. If we get the Crick to work in London, a model could be Crick-like institutions that can act as a magnet from across the seas and then seed new things. We have not yet shown that it works, so you could not use this as a model, but it would be different from a university model. I do not want to push it too hard, because it may not be right to do that, but it is a new way of thinking about things. If you have real centres of excellence and get people attracted to Manchester, they may settle. It is a possibility.

Q46 Graham Stringer: This is my final point. We have been talking about the golden triangle. Are the stats on this reliable?



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Professor Wilsdon: I think that they are, on the regional aspect. There are good data on that, as far as I am aware.

Dr Main: The tension that we are talking about here is between the input and the output of the goal. The input is to get to 1.5 times greater research intensity. The output, as stated in the industrial strategy, is “to improve living standards and economic growth.” The tension we are talking about here is around those two things.

With two thirds of research and development spending coming from the private sector, you have to think about what the contribution of private sector R&D to that 2.4% goal will be. The large-scale multinationals that have a big budget and might contribute a substantial amount of that uplift say very similar things when you ask them what their attractors are for different location decisions in the world. The first will be the quality and creativity of the research that is going on in that place. The No. 1 point that they make is that they want to be near the good research, because they want to derive their own benefit from that and to plough their furrow through the creativity coming out of the research environment. The next will be skills. They need to be able to recruit skills in a reasonably tight geographical location around the centre of their business.

Q47 **Chair:** But we are recruiting skills all over the world. We are not looking just at the local economy in the recruitment of skills.

Dr Main: That is true. The policy environment for recruitment of international skills into the location country is important, but so is the talent pool that they can attract. I have spoken to companies that are located a half-hour train ride outside London, for example. That is an important issue for them, because, on a global scale, they can attract people on the basis that, broadly, this is an attractive place to locate in the UK. The physical environment of the country and things like R&D tax credits—the fiscal environment—are also important. Therefore, when we are thinking about the input of this target, research quality—which we hear is really underpinned by unhypothecated funding, such as QR, as well as challenges—is vitally important.

The output point, which is to improve living standards and economic growth, is a seriously challenging question. How do you connect increased investment in research and development to genuine uplift of skills, wellbeing and quality of life in different parts of the country? I agree with the point that Sir Paul made earlier—that it is not necessarily solved by just putting a new institute in a place. Unless the walls of that institute are porous and the benefits of having high-level jobs, opportunities and learning in that place are connected to that environment, you can end up with an institute that is entirely unconnected to quality of life in the area around it.

Chair: Thank you. That was an excellent discussion.



Examination of witnesses

Witnesses: Ernesto Fernández Polcuch, Professor Jakob Edler and Dr Jos van den Broek.

Q48 **Chair:** Welcome, all of you. Thank you so much for coming to give evidence to our Committee today; it is enormously appreciated. I know that all of you have travelled. May we start with brief introductions, please?

Dr van den Broek: I work at the Rathenau Instituut in the Netherlands. We are an independent institute with a mission to inform the public and parliamentary debate on science, technology and innovation policy.

Professor Edler: I am a professor of innovation policy and strategy, and I am executive director of the Fraunhofer Institute for Systems and Innovation Research in Germany. I also hold a 20% position in the Alliance Business School at the Manchester Institute of Innovation and Research. I was working in the UK for 12 years and two months ago I moved back for the new position, so I think I know both systems a little bit.

Chair: Welcome back.

Ernesto Fernández Polcuch: I am the chief of science policy and partnerships with UNESCO, where I deal with global science policy, innovation, technology and policy programmes. For many years I have been at the UNESCO centre for statistics and basically put in place the global R&D statistics survey.

Q49 **Chair:** Thank you. You will have seen from the first panel that we have a lot to get through. If you kept your answers as succinct as possible that would be helpful.

Ernesto, the UK has committed to hitting 2.4% of GDP by 2027. How does that ambition compare with that of other countries?

Ernesto Fernández Polcuch: Within the framework of Europe the Lisbon agreement was to make it 3%, so in a sense it is in the framework of the global discussion. We have been looking at different targets. China is at 2.5% in 2020.

Q50 **Chair:** What is it at the moment?

Ernesto Fernández Polcuch: It is at 2.2%. The interesting thing is that China is one of the few countries that might actually get to its target. That is the other question about targets: are they to get you there or to drive you there? For instance, Africa is globally setting a 1% goal, which drives other countries towards the goal. Only three might arrive there. One can see very clearly how China moves its policies towards that goal, and it might get there.



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Professor Edler: There are countries in Europe that have done it. I talked last week to one very important person in the German Ministry of Education and Research. He said, "We are very surprised that we reached the goal," because it reached the goal of 3% coming from a much lower level. Austria has reached its goal and it is now far beyond 3%, so a couple of countries have done it.

Q51 **Chair:** What about Finland?

Professor Edler: Finland dropped enormously after the crisis. Sweden has gone up, but Finland has dropped enormously. They are two different political models.

It can be done, but in Germany there is a discussion, which could relate to your discussion, about going to 3.5%. They all have their models and analysis done in my institute. There is some scepticism about whether there are enough personnel to absorb that and the structures allow that, so there is a decreasing return on R&D investment at some point.

Q52 **Chair:** What we are really saying is that many countries are all doing the same—seeking to increase the share of GDP spent on R&D. Is that right?

Professor Edler: That is right.

Q53 **Chair:** If we succeed in getting to that ambition of 2.4% in 2027, will we discover that it is no longer the average for the OECD and that it is well below it?

Ernesto Fernández Polcuch: The global average is 1.7%.

Q54 **Chair:** We are at the global average at the moment.

Ernesto Fernández Polcuch: Exactly. This is the global average; 1.7% of GDP globally is spent on R&D, so if you move towards 2.4% you will necessarily be under the OECD average in 2027.

Q55 **Chair:** But, if we look at developed countries, which is the OECD approach, it is a very different picture.

Ernesto Fernández Polcuch: Yes.

Q56 **Chair:** Are you agreeing with me that by 2027 the average is bound to have gone up from 2.4%?

Ernesto Fernández Polcuch: That is most likely, but I also agree with Professor Edler that you have to bind the targeted expenditure with the need for people to conduct that R&D.

Q57 **Chair:** On that point, I think UNESCO collects data on the number of researchers per 1,000 of the population. Do you know how the UK compares on that measure with other countries?

Professor Edler: I think it is 12 per 1,000, and for Germany it is 15. That is the only comparison I have.



Q58 **Chair:** Are you aware of any other comparisons?

Ernesto Fernández Polcuch: It is parallel to where you are with expenditure, but I am happy to get more information later.

Q59 **Chair:** How are the data on R&D spending collected? I think UNESCO and OECD publish information on R&D spend. Do they both use the same methodology, or is there a variety of approaches?

Ernesto Fernández Polcuch: The methodology is commonly agreed; it is based on the Frascati manual, which is globally accepted; it is an OECD manual, but it has also been adopted by UNESCO to make sure there is only one figure for every country and that the data are comparable globally. The data are produced by the countries through their national statistical offices and national statistical systems—in other words, part of the national statistical systems. The highest quality ones rely on surveys of all the institutions that carry out the research. They declare how much they have spent and where that money has come from. That is integrated into the national figures.

Q60 **Stephen Metcalfe:** Regardless of which nation it is, what are the best measures for how effective R&D expenditure is? I do not know whether you have examples from your own countries or around the world, but are there any effective measures?

Dr van den Broek: There is an example from the Netherlands. We have what we call WBSO, which is tax relief on R&D personnel. It has been in place for 30 years. A lot of evaluations have been done, and it is stated that €1 invested leads to between €1.5 and €1.9 of benefits.

Q61 **Chair:** That is the return on investment.

Dr van den Broek: Yes. That is quite an effective one, and now in the Netherlands we have 88% of innovation spending in tax cuts. The question is whether that is going to help you direct innovation, because it is very non-directional. That is now being debated.

Q62 **Chair:** Is that similar to our R&D tax credits?

Dr van den Broek: Yes; they are different tax credits.

Ernesto Fernández Polcuch: The effectiveness depends a lot on the objectives that you set yourself. It is very difficult to establish it. The systemic nature of it makes it extremely difficult. You were asking earlier about the scoreboard. The systemic nature of the innovation system makes it very difficult to capture it in a few figures. That is the challenge we handle every day, so this is our bread-and-butter discussion. There is a whole community researching this.

For us, the framework is the sustainable development goals. We are now looking not only at the industrialisation part but how R&D expenditure contributes to other sustainable development goals, including the fact that you need scientific knowledge to inform other types of policies. How



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do you evaluate the effectiveness of that scientific advice on other policies? It is getting more complex by the hour.

Professor Edler: I totally agree that it depends on what you actually understand by “effectiveness,” and for what. If you look at the overall economy, it might be that the importance of R&D is different for different industrial structures. R&D in the UK is pretty much flatlined and rather poor compared with many other countries, but the annual growth rate since 1995 is not worse than many countries with much higher R&D expenditure. What does it tell us about R&D? It might tell us something about the industrial structure and the relative importance of R&D, and the way we measure it for the economy. The economic strengths of the UK may be slightly different from the German structure, where traditional R&D measures may mean something different. I am not saying R&D is not important. Do not get me wrong.

Q63 **Chair:** There is no clear relationship between R&D spend and economic performance.

Professor Edler: Across all countries there is a clear relationship, but, if you look at how different countries plot it, it means something different from what you have in the UK. In the UK you have less R&D but you still have a pretty decent annual growth of GDP. Therefore, in terms of that measure, R&D might mean different things for different countries. That is the point I am making.

Q64 **Stephen Metcalfe:** That is useful. I suppose that all Governments around the world that are effectively spending billions of public money on research want to have some way of measuring that it is a good use of money, as opposed to doing something else with it. If you have any further thoughts on that, please feel free to share them.

You touched upon the difference among individual economies. What are the best examples of economies that turn R&D spending into economic growth?

Professor Edler: Are you interested in economic growth?

Q65 **Stephen Metcalfe:** Yes. You have talked about the UK. Perhaps because we have a large financial sector, we have that growth, but I want to know about countries that translate R&D spending into direct economic growth. Is there a correlation between the two?

Ernesto Fernández Polcuch: We have to think about this in terms of innovation rather than R&D, where R&D is part of the innovation system and R&D expenditure fits into the innovation system, which is composed not only of the R&D function but of the framework conditions, policies and skillsets and people you have, as discussed earlier. In the traditional linear model, if you feed more money into R&D naturally you will have economic growth, as in the report of Bernard Baruch in the US in 1946. We know now that we cannot make that assumption. However, when you look at the big figures, as Professor Edler said, it actually works, but it is



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not an automatic process where you feed in R&D and get economic growth.

Professor Edler: Korea is a good example, because it invested when there was a crisis. It made the decision, "We will get out of this by innovation and R&D." I think they link it with an interesting mix of instruments, so it is not only about R&D but thinking about the markets you want to create, and what industries you want to be strong. I have not really studied Korea, but from the evidence it is an example of a real turn-round where a country has said, "Let's focus on certain things based on R&D and innovation."

Q66 **Stephen Metcalfe:** It is also a big spender on R&D.

Professor Edler: An enormous spender.

Q67 **Stephen Metcalfe:** Is that an efficient use of money, or is it that it has just thrown a lot of money at this?

Professor Edler: The proof of that will be seen in years to come because we are all a bit impatient. If I may say so, this country is more impatient than many other countries in wanting to see a return on investment. I think the Koreans have taken a bet. I am sure there are people who say, "Why don't we spend it on the health system or more traditional things?" I am sure they have had these discussions, but it has made the bet, and, as far as I can see, it seems to work.

Q68 **Stephen Metcalfe:** Its growth is higher than it might otherwise have been.

Professor Edler: Yes.

Ernesto Fernández Polcuch: That is certainly the case. If you compare Argentina and Korea in 1960 and today, you will see the effect of the innovation policies. There is no doubt about that.

Q69 **Chair:** There may be other factors.

Ernesto Fernández Polcuch: Yes. Those are the societal factors that make that innovation policy possible, but the growth in patents is completely off the scale.

Israel is another very interesting example. Again, it is a high spender; it spends 4.3% plus defence R&D, which is unknown. Therefore, one can think about expenditure on R&D of more than 5%. Israel, which in the '70s was a country that exported oranges, is now one that exports technologies. I think the lesson there is very clear.

Q70 **Stephen Metcalfe:** If we were trying to find a new model to inform an R&D strategy for the UK, is it Israel that we should be following or looking at closely? Is it Korea, Germany or the US? Do you have any suggestions, or are you all going to be parochial and say that it should be the Netherlands or Germany?



Dr van den Broek: I think the most important thing you should do is look at your current economic structure and where your strengths are now and where they might be in future. We did an analysis for the Netherlands, because we have the goal of moving from 2% to 2.5%. We looked at the industrial structure and found there were four sectors that were high spenders on R&D: automotive, high-tech, pharmaceuticals and ICT. We have only high-tech. For the other three sectors, we have basically some small firms. We looked at the high-tech firms and found they are spending twice as much as their competitors. If you want to improve your R&D percentage, it is hardly going to come from them because you cannot expect them to raise it even more. You have to think about other measures to improve your R&D spending. You can look at attracting foreign R&D or trying to invest in new kinds of firms. It is not only about looking at other countries but your own country and what the current situation is.

Professor Edler: I think the question contains the wrong assumption. The assumption is that you can end up copying certain traits of other systems. Clearly you cannot. You can look at good examples elsewhere structurally and in terms of expenditure and see how they fit your model. I give one example. When the Catapults started, it was about wanting to have a Fraunhofer. I wrote a little piece because I was slightly irritated. I am not sure that the Fraunhofer model in Germany would work in your industrial structure; it is a different industrial structure.

What has happened to the Catapult? I think it is a nice model that fits the UK, but it has its limits. Some people do not realise what the limits are and they may be even greater than people realise, but it may fit the UK system better than to roll out a full Fraunhofer model. The basic idea to take something from another country and think, "What can we do with it in our system?" is not what I would follow—not the Netherlands or Korean model. That would not work.

Ernesto Fernández Polcuch: I fully agree. That is a question that arises in every country, and the answer is correct.

Q71 **Stephen Metcalfe:** Are there any aspects of the UK system as it stands that are particularly praiseworthy, unique or are being followed by other nations?

Professor Edler: The excellence of the universities. The way you extract citations out of the pound is fantastic. The science system is fantastic. At the same time, this may be one of your biggest challenges. The university as an institution in this country seems to be what we call eierlegende Wollmilchsau. I do not know whether anyone here knows German, but it means a golden goose for any purpose. In Germany—I now make the comparison—we have a very stratified system of public research that is accessible for different kinds of stakeholders. It has different functions and clear incentive structures. Universities in this country seem to be doing everything. You ask Manchester to build up a graphene-based regional economy and to be excellent in the REF at the



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same time. You have an excellent system, and you are so proud of it. It is fantastic and world leading, but it may lead to all kinds of issues that have to do with structural decisions taken decades ago.

- Q72 **Graham Stringer:** You witnessed the previous panel talking about the golden triangle and Oxford and Cambridge. Is this phenomenon apparent in other European countries? Do you get an imbalance between the spend on research in particular parts of other countries?

Professor Edler: Speaking for Germany again, we are a federal state. We have 16 states that somehow do their own policy. They are responsible for the main funding of universities, so there is a bit of a counterweight there. We have this discussion, but historically we have never been that focused on certain regions.

- Q73 **Chair:** Is it up to the regions to decide how much they spend, or is it a federal decision?

Professor Edler: It is both; it is more federal, but there is a lot of counterweight. After German reunification we have tried to use science spending and policy almost as creation policy, trying to build up the other part of the country, the new Länder.

- Q74 **Chair:** It is a federal endeavour; you are putting extra resources into poorer regions

Professor Edler: Yes. Science was already there and it was absorbed by the system trying to spend money. In some areas it has worked, but the idea that you can build a strong regional economy where there is not much else in the way of excellent research has not worked in all parts of the country, so we have a similar situation to the one the previous panel discussed. I think science spending in itself is overwhelmed by trying to lift up a certain region.

Dr van den Broek: Most R&D in the Netherlands is spent around the city of Eindhoven, so it is mostly localised. I do not think you should look only at R&D spend. We did an exercise that looked at regional innovation in the Netherlands. If you look at where the innovative companies are located, there are over 30 hotspots in the Netherlands and half of those innovative companies were outside those 30 hotspots, so it is much more dispersed than R&D spending and it is a broader picture.

- Q75 **Graham Stringer:** Where countries have seen this as a problem—I guess that some countries do see it as a problem—how have they tried to change the balance of spending?

Dr van den Broek: In the Netherlands there have been examples of what we call high schools or universities of applied science—previously, universities of applied science that are now technical universities. There have been efforts to try to establish a fully-fledged university there, with varying success. There has been some success in Twente, in the east of the Netherlands. The Netherlands is quite small. If you are in Enschede,



where this university is located, it takes you one and a half hours to get to Amsterdam by train, so it is still quite close.

There have been successes, but mostly because there have been efforts to build an ecosystem around the universities. Investing only in universities has the risk of investing in what has been called cathedrals in the desert. It should be about trying to build an ecosystem around it—innovative firms and technology transfer offices—and all kinds of system functions in order to establish it.

Ernesto Fernández Polcuch: Also look at the opportunities, depending on the type of country, in terms of natural resources or other specific opportunities that come up in different regions so you can build an innovation ecosystem on top of the advantages already there. It is difficult to build this cathedral from scratch.

Q76 **Chair:** Do you think it is a worthwhile or valid endeavour to seek to use this budget in a way that encourages development in other parts of the country?

Professor Edler: Yes, but not with a broad brush and some kind of formula that says that each region or part of the country needs to have a certain percentage. You have to look at opportunities and maybe more at the D side of R&D spending, not try to do high-class science in a desert. It is more D; it may even be more innovation.

If it is really about cohesion and all these peripheral regions, I am not sure that the science project is key. I understand the problem of balance and it can be done in certain areas in certain ways where there is some kind of basic absorptive capacity and an agreed plan. Look at Manchester. There is huge hope for graphene, which we discussed earlier, and materials. It is just enormous—a whole new university is building up, with unbelievable investment.

What will be the economic benefit? I think there will be quite a lot, but I am not sure what the chamber of commerce in Manchester would say if you asked it, as we have. It will say, "It won't mean much for most of our members; it means nothing to them. It is a different economic model. We hope that it also attracts production, not just science." That is a big hope. I think that the University of Manchester does a great job in trying to combine these kinds of things, but it does not mean that the local SME community will immediately benefit. We will have this kind of disconnect. The big question is: how can we track companies that then stick? That is the main issue.

Q77 **Graham Stringer:** Is there any example from anywhere in the world that has tackled this problem successfully?

Professor Edler: Partly, east Germany around Saxony has done so. It has rebuilt its industrial structure based on science, but we also have failures in Germany where one may think, "Was that money wisely spent?" There have been good examples in Germany.



Q78 **Chair:** Are there lessons to be learned from Germany about why some areas have succeeded and others have failed?

Professor Edler: That has to do with the ecosystem and the area that has succeeded.

Q79 **Chair:** It suggests that, if you do focus not just on an institution but on building an ecosystem, potentially there is scope to achieve good outcomes.

Professor Edler: Absolutely, but it has to lead to something. You cannot just put it somewhere and then try to create a new ecosystem just like that.

Dr van den Broek: You need to build on previous expertise and skills. New industries do not come from the sky; they build on skills that have been built up over years. You need to look at what skills and expertise there are in the regional economy that you can use for future economic benefit.

Ernesto Fernández Polcuch: The more it is owned by the social actors in the chambers of commerce and the existing industry—this is not coming from the centre; it is owned by the community at large—the greater the possibility of success.

Q80 **Bill Grant:** How do other countries set their compass or make decisions on research priorities? What data do they use? What sources direct them in that direction primarily? How do they decide their priorities?

Professor Edler: Are these Chatham House rules? The German ministry might be watching. Germany's priorities are now very different from, say, 15 years ago. That has been done through a high-tech strategy, starting in 2006. The idea was to try to define a limited set of challenges around which to bundle research expenditure. These challenges do not have a clear pocket of money attached to them; they are different instruments and measures by different ministries, but they feed into the programmes. How can I put it? It started a bit like the relabelling of existing programmes, but slowly, with the long-term ambition of being more mission-oriented, with a political, public and social discourse on what was wanted from this research system, we now have, I think, 12 missions in the new high-tech strategy. It started in 2006 and it runs up to 2025. Tell me of one initiative in the UK that has run for 19 years.

The missions are changing and adapting. I am not saying that the process of defining the missions is perfect; quite the contrary. I think there should be much more public debate about the missions. Anyway, they did some orientation. They are flexible enough to give them some orientation. They are linked to economic strengths and to challenges that are perceived as being of high priority for the country. For me, the main thing is persistence and stability in the system.

Q81 **Bill Grant:** Have those 12 years of change worked for Germany? Has the



decision taken 12 years ago improved the outcome?

Professor Edler: I do not think there has been a holistic evaluation of that. There has been evaluation of individual aspects. My hunch is that it has been working. It gives orientation; it signals to research organisations outside university and in the university, but also to large companies, what the areas are where there will be more investment. The German system is less developed in then trying to support the creation of lead markets—there is a diffusion issue, which we have not discussed at all, and there is still a bit of a gap in delivering that.

Ernesto Fernández Polcuch: I want to refer to the Japanese case. There is a really interesting process going on currently in priority setting for science and technology. They are coming from the concept of Society 5.0. There is bit of a dialogue with industry on the 4.0 concept. They are now building a road map for science and technology towards SDGs. They are taking the sustainable development goals as their framework, working them back to science and technology. What are the needs in terms of scientific and technological content to accomplish the sustainable development goals? Based on that, they are setting the new priorities for their STI policy. This is in the works, so do not ask me about the evaluation, but I have seen this. A few weeks back we were in Japan. It is an extremely complex endeavour, but it is quite interesting.

Q82 **Chair:** Is it designed as a public national discussion?

Ernesto Fernández Polcuch: Yes. They are using big matrices and flow charts to understand how the different goals relate to each other. The advantage of the sustainable development goals is that they are internationally agreed goals that can be set as an umbrella beyond the priorities of a specific Government. They are using that as a measure to think about the very long term—they do not need to think in the short term.

Q83 **Chair:** Are you saying they are aiming to hit 5% in the long term?

Ernesto Fernández Polcuch: No. They call it Society 5.0.

Q84 **Chair:** What does the 5.0 mean?

Ernesto Fernández Polcuch: It is like a new step in society. They are moving towards a new society; they are including artificial intelligence and all the processes for a new society that is sustainable and inclusive. This is the model they are aiming for. From that model they have built they are seeing what type of science they need to get there.

Chair: That is very interesting.

Dr van den Broek: We have a national science agenda. The general public are invited to come up with questions for science. Everybody was invited; there was very little control, and 140,000 questions on which the general public thought science should focus were collected.



Q85 **Chair:** Was this an online process?

Dr van den Broek: It was online and there were also all kinds of meetings and workshops organised in the country. The discussions were turned into clusters of questions, and now we have 25 what are called itineraries or routes where all these questions are bundled. It is a kind of learning-by-doing policy because it is still quite unclear.

Q86 **Chair:** Do you think it has been a successful approach?

Dr van den Broek: I think it has been successful in inviting the public and getting some enthusiasm for science, but now you see that it has been taken over by science, so it has been incorporated and the general public is no longer very well connected, although you do get different kinds of proposals now.

Q87 **Chair:** You do not think it is just reaching the conclusions they wanted to reach in the first place.

Dr van den Broek: There is a strong risk of that.

Q88 **Bill Grant:** If, as a Committee, we were minded to do a case study on a country that had embraced a step change, whether it is increased R&D or a new system—you used the word “complex” when referring to Japan—is there one you suggest we can learn from to get the best from R&D expenditure, whether public or private?

Professor Edler: Is that in terms of change management, the general pattern of how they do it, or how they have developed? If it is a change pattern, I would go back to Korea, although people think it is too different.

Q89 **Bill Grant:** Is there a country that has been successful that we can look at and learn from?

Ernesto Fernández Polcuch: In this sense I would also look at China to learn from it, not necessarily to follow it.

Professor Edler: I am not so sure in terms of the social, cultural and political framework.

Ernesto Fernández Polcuch: Not to follow it, but to understand it. There are very different models.

Q90 **Chair:** This is quite an important exercise in seeking to understand the effectiveness of R&D spend and what lessons we can learn from other countries and so forth. We appreciate your coming to talk to us. Are there concluding remarks you want to make, or lessons you want us to take on board in the work we are doing, from your experience internationally?

Ernesto Fernández Polcuch: I would make a point about the systemic innovation concept and looking at innovation statistics. You were asking earlier which statistics this covered. To incorporate innovation statistics, in particular to focus on barriers to innovation, in the previous panel



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there was an issue about sectors that innovate and how much more you can get out of them. You will have sectors that have the intention to innovate and face barriers to innovation. That is where you have a policy opportunity.

Q91 **Chair:** It is looking at how you remove those barriers.

Ernesto Fernández Polcuch: Exactly. How can you address those businesses that are failing in their innovation, or not innovating as much as they could? How can you make them innovative? You need more and different information. It is not just R&D expenditure.

Q92 **Chair:** Are there any good case studies that have sought to identify sectors in which there has been a failure of innovation to improve productivity, or whatever it might be, and they have addressed that by the pursuit of a particular policy approach?

Ernesto Fernández Polcuch: I can look for that.

Q93 **Chair:** If you come up with anything that you think would benefit us we would be keen to hear from you. Are there any other concluding remarks?

Professor Edler: I think there should be a bit more clarity about what R&D spending is for.

Q94 **Chair:** What is the point of it?

Professor Edler: Of course, it is good; it is better to spend on R&D than on some other things, but for what? When listening to the questions, sometimes it is about keeping our scientific excellence; other questions are about making Yorkshire more competitive. Those are two very different things. I think it needs a broader approach than saying that with R&D spending you can have all these things. You may have to say, "For the function of scientific excellence in this country for the next 20 years these are the important things." You then link that to other functions. What does that mean? You see that universities are put under a tension that might break some of them. It is too much to ask of universities. Some can handle it but not all of them.

Q95 **Chair:** In other words, rather than just have an ambition to hit a percentage target, you start by working out what you are seeking to achieve and then make a plan based on that.

Professor Edler: I think that is the missing link. You have a traditional science-based model and you have excellent science, and then somehow you try to see how it trickles down, but there is something between the company world and the university world that is missing in this country. It is not just the traditional transfer to commercialisation; that is not what the model is. It is a co-generation of knowledge, and maybe universities are not the best place to do that in all industries.

Q96 **Chair:** Do you think Germany has that link that is missing here?



Professor Edler: I would say that the UK is better than Germany in many things. I am not here saying that Germany has a better system, but in terms of the overall science system there is a division of labour between universities and four different big non-university associations and societies, with hundreds of institutes between them that are not in universities, or sometimes are attached to universities. They have different functions—there are Max Plancks and basic science, and they are as good as Cambridge.

Q97 **Chair:** Have these just evolved, or has there been a specific Government intent?

Professor Edler: They have evolved over time. Max Planck goes back 100 years; Fraunhofer was formed after the second world war, but there has been a division of labour for the past 30 or 40 years where we have a clear model. The Fraunhofer is the one that does the co-generation of knowledge with industry. They work with industry, but they are not just picking up the knowledge of universities and transferring it; they co-generate knowledge with and for industry—of course, using universities, but not always. Therefore, they take some pressure off the university system to deliver economic benefit.

Q98 **Chair:** Although we cannot just translate one system into another country, as we have discussed, do you think there are things that the UK could learn from that Fraunhofer model?

Professor Edler: I think they have tried with the Catapult centres. If I look at it through my own little lens, the incentive system you have for individual research means it is all about the REF and publication. One page later you learn that you also have to do the knowledge excellence framework, and one page further the knowledge. I think you put too much pressure on them. There needs to be more flexibility in how you govern universities.

Q99 **Chair:** You have to look at the incentives that we apply to the system.

Professor Edler: Yes, absolutely.

Dr van den Broek: It is important to take a broad look at innovation rather than focus on just R&D. The Netherlands has been trying to improve its R&D percentage from 2% to 2.5% for 10 years now, and we have been between 1.7% and 2% for 50 years.

Q100 **Chair:** Have you defined a clear objective of why you are doing this, or have you just seen it as good in its own right?

Dr van den Broek: There is no clear objective of why we are doing it. Often the means and ends are misunderstood, because it is a means to improve your R&D percentage. I think it is a good idea to have this point on the horizon to go for, but what do you want to achieve with it and what is your goal? What is the broad idea of innovation? Broader measures of innovation are all flawed, with different rankings. Both the



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Netherlands and the UK have been quite high in the rankings, but the UK is quite effective with very small percentages of R&D expenditure. Maybe you should think more about understanding what you want to achieve than about just trying to get to 2.4%. There are possibilities of achieving that, but at what cost?

Ernesto Fernández Polcuch: I think you asked about examples of what the UK is doing well and has been taken up by other countries. I have a note here. One is the policy on gender equality in institutions, for instance. This has been taken up as a model in many countries. Gender equality and inclusiveness overall is another issue that needs to be present in the discussion about R&D and innovation policies

Q101 **Chair:** Although we have a long way to go in terms of gender equality.

Ernesto Fernández Polcuch: Yes, but in particular the idea of Athena SWAN and different levels of silver and gold has been taken up. Last week it was explained to me by the AAAS that it is trying to implement a similar model in the US, and it is being taken up by many other countries.

Q102 **Chair:** Are you referring to the Athena SWAN award?

Ernesto Fernández Polcuch: Yes; it is just my pronunciation.

Chair: Thank you all very much indeed. We really appreciate your time this morning.

Examination of witnesses

Witnesses: Professor Paul Nightingale and Professor Joanna Chataway.

Q103 **Chair:** Welcome to all of you. Thank you for your patience in waiting. May we have very quick introductions from you?

Professor Nightingale: I am professor of strategy at the University of Sussex. I am formerly deputy director of the Science Policy Research Unit, and in January I will be the incoming director of strategy and operations for the ESRC. I am currently not employed by the ESRC or UKRI, so I am talking only as an academic.

Professor Chataway: I am head of the science, technology, engineering and public policy department at UCL, and I am professor of science and technology policy at the Science Policy Research Unit.

Q104 **Chair:** Thank you very much. As we have been discussing all morning, the Government have committed to a 2.4% target by 2027. Do you support that as a policy objective?

Professor Chataway: I think that increased spending is a necessity. Other participants in this discussion have highlighted the dangers of thinking of it only in terms of the target, and that is very well taken, so, yes, with some qualifications.



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Professor Nightingale: I would agree 100% with that as a target. We do underspend. I think it is a good target. There are some caveats that we need to place on this. It is an input rather than output measure, so we need to pay attention to what we actually want to do with it. You could argue that in a very super-productive innovation system R&D would be quite low because you are getting more bang for the buck, so you can increase it by being less productive.

The other issue we should highlight is that R&D spending is not all of innovation. High-tech manufacturing is about 3% of the UK economy, so we need to make sure we are hitting the other 97%, and some of that is not science based. Innovation is broader than R&D spend. Overall, it is a good idea, but it needs to be seen in the context of why you are doing it, and it is not just R&D.

Q105 **Chair:** Paul, the first panel discussed the need for a better spread of investment in R&D throughout the country. What is the evidence for an impact by regional R&D investment on the local economy and any other relevant measures? Incidentally, I noticed as I was challenging Paul about investment in excellence resulting in increased dominance and concentration that you were nodding like mad from the back row. Expand your thoughts on that.

Professor Nightingale: It is a very complicated issue. You have to think about where you are and where you want to go. I think the UK has quite concentrated allocations.

Q106 **Chair:** Geographically.

Professor Nightingale: Yes. There is a bit of a mismatch in the concentration of publicly funded research in relation to privately funded research. That may be worth looking at. Paul made the point about not wanting just to throw money into a particular area. It needs to be allocated in a way that matches local needs, which may not necessarily be R&D, and built up over time; it does not just change instantaneously.

The evidence on this is difficult from an academic perspective, because often areas that grow will attract research, so the relationship is complicated. Studies have looked at the allocation of universities and research in the United States. When universities were set up often there would be a lottery, so that gives you some randomisation. They have shown that they have had a very positive impact on the local economy.

Q107 **Chair:** You mean a lottery between different locations.

Professor Nightingale: Within a state. If they were going to set up a state university they would have competitions. Sometimes they had a lottery; other times you can compare a city that came first with a city that came second and did not get it and see how they have grown. That evidence suggests that universities are a significant driver of local economic growth.



Professor Chataway: We noted in the previous discussions that there is a change in the debate overall. As Paul says, we are not looking only at input measures, or even output measures; we are looking at outcomes. Once we begin to look at outcomes and the broader things we are demanding of R&D, regional distribution questions become very important.

Broadly, I agree with Paul. These things are complicated; there is no easy answer. Weakening a power base is not necessarily a way of strengthening other areas; it has to be a more nuanced discussion.

Q108 **Chair:** But is it a legitimate policy objective to seek to create a more balanced spend across the country so that other regions benefit from that public spend?

Professor Nightingale: Yes. If the UK Government decided that they wanted a major global standing research university in the north of England, it would be very expensive but it would be a legitimate policy aim. But it depends on why you want to do it and whether that would be the best tool with which to do it. Certainly, that would be a legitimate aim.

Q109 **Chair:** We have the Strength in Places Fund. Is that the right mechanism? Is it sufficient, or should we be looking at alternatives?

Professor Nightingale: This is a difficult one. It is probably a step in the right direction. It is early days yet. It will be good to see the results of some evaluations.

Q110 **Chair:** It is fairly modest in scale.

Professor Nightingale: It is quite modest in scale compared with the size of the interventions you would need in order to drive major changes. There are very strong structural effects in the UK. If you look at the income rankings of cities 100 years ago and compare them with today, they have not changed that much in relative position, apart from the seaside towns. London has gone up. It is not an easy thing to do. I think you would have to have R&D and university spend policy aligned with lots of other policies, and it may not be the first lever you would pull.

Q111 **Chair:** Therefore, there has not been over the past 100 years a great concentration of economic activity and success in London.

Professor Nightingale: You have had a concentration, but in the relative rankings they have not changed that much. The rich areas 100 years ago are similar to the rich areas today.

Q112 **Chair:** But the gap may have grown.

Professor Nightingale: Yes. Clearly, London has pulled away.

Q113 **Stephen Metcalfe:** The Government have introduced their four grand challenges. There are 15 themes so far that have been funded through the industrial strategy challenge fund, and the research councils have



their own themes as well. Is this an example of trying to be all things to all men or women, or can you see an underlying strategy to all that?

Professor Chataway: To quote Will Smith, diversity is our superpower and, in a time when the contours of spending on R&D are changing and we are asking more of R&D, it is appropriate that we have a diversity of challenges, mechanisms, tools for spending and aims and objectives.

I think the earlier discussion with the first panel on UKRI's potential to give cohesiveness and strategy across those instruments is well taken and I suspect that will evolve over the coming period, but in and of itself I do not think that diversity of challenges, aims and ambitions is a problem.

Professor Nightingale: The UK is a very sophisticated economy. We have a very sophisticated society and it is appropriate that our R&D portfolio undertaken by UKRI reflects that complexity, so I am not too worried about that. It is useful to have some degree of co-ordination. That is helpful within a system.

We are dealing with uncertainty. Our portfolio needs to be diversified and there are certain things we will not be prepared for, so having built-in resilience to those future shocks is a good idea. I think co-ordination is good and it provides direction.

The issue from a strategic perspective is the choice of those and continuously evaluating them to make sure they remain good options, but, if anything, the UK could become larger and more diverse in the portfolio of issues that it addresses. Those particular issues are good ones, but there are other significant ones and some that are very significant, such as productivity, that really need a boost.

Q114 **Stephen Metcalfe:** I suppose that one of the aims of investing in research, development, science, technology and so on is to meet the social challenges that any society faces. Do you think that the various challenges that have been adopted and the wider lists that are quoted are sufficiently connected to tackle some of the social challenges that we face?

Professor Nightingale: That is a very good question. The effectiveness of the R&D system does not depend on just the effectiveness of the R&D system; it also depends on the absorptive capacity of the organisations that use that research—we need to work to improve that—and the alignment between research and what society needs. It is generally a bad idea to let people like me decide how much money I get and what I do with it, so it is good that there is this alignment, and we are looking to make sure that the research system is aligned.

The recent exercise in which Government Departments highlighted the areas of research in which they were particularly interested gave rise to an issue involving the Haldane principle, but that is very useful because it sends a clear steer to the universities that these areas are important.



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I should note, with the caveat that I am incoming director of strategy for the ESRC, that over 60% of them are social science questions, so there may be an issue as to whether this reflects the needs of society. That could be broadened out. We could perhaps democratise more and, following the Dutch model, talk to citizens about the areas that most concern them and what areas of research are most needed. What is most needed in Stoke may be different from Manchester, Kensington or Brighton. We could have better alignment there, but overall it is good that we are moving in that direction.

Professor Chataway: I think we will need to refine those grand challenges. They are designed to give that broad steer, not to be implementation mechanisms. We will need more tightly crafted missions and things that ground the grand challenges.

One underlying point that has come through in various ways in the discussion is how we evaluate. One clear steer from the discussions so far is that we do not do enough evaluation; we do not spend enough on it. To get answers to the questions you are posing we will need to do that. That is a tough thing. Spending on evaluation is notoriously difficult, but we need to do it.

Q115 **Stephen Metcalfe:** I suppose one of the dangers is that, when we think of R&D spending, we think of developing a new science and potentially over a long period transforming it into some product or service that we can sell. Do you think there is too much emphasis on this and perhaps not enough on social sciences and getting society ready to adapt to some of the changes that are already in the pipeline to make the most of the money we have already spent on R&D? I am not making this very clear. We are in the throes of a fourth industrial revolution—if you want to call it something else, do—and it has potentially a huge impact on society. Will people be embracing that and, therefore, make the best of that new technology, or will we try to hold it back? Is there a role for trying to educate the public?

Professor Nightingale: There are a lot of very interesting and important questions there. There are certain things that we need to pay more attention to. In terms of productivity and the diffusion of existing technology, rather than the development of technology, we need to recognise more that the UK is part of an international system. A lot of technology is developed around the world, not necessarily in the UK, so it is a question of bringing that technology in, diffusing it, finding out what high-productivity firms are doing and pushing that down. That is a very experimental process and is all down to performance. The shift that we are seeing towards more attention to diffusion is a very positive one and is very encouraging.

The UK focuses a lot on creating value. We could spend a lot more time looking at how firms capture value. If the US develops a technology that we can take and capture more value from, that is fantastic. Innovation is



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creation and the capture of value. We focus more on the first bit; we could focus more on the second.

There are issues about alignment. What are the needs of society in crafting research programmes that are better aligned? We could do more of that. We see plans for that to be done. It is a complicated issue, but there are key things, particularly diffusion and capturing value, which I highlight as ones we should invest in.

Professor Chataway: I agree. We could spend a lot more understanding how R&D is used and absorbed, and we should probably spend more on looking at the implementation of science.

Q116 **Stephen Metcalfe:** You may or may not have heard that at the beginning of this session CaSE felt that the Government had not set out a vision for what they wanted to achieve from the general increase in R&D to 2.4%. What would your vision be in increasing that figure to 2.4%?

Professor Chataway: That is a question. Wow!

Professor Nightingale: I would see the 2.4% as a unifying goal that we move towards, and behind that there are issues we want to address. Clearly, productivity would be a massive one. Everyone should be losing sleep over that.

Geographic and social equality within UK society need to be addressed; climate change is a very important thing we need to be thinking about; the position of the UK within the world—where we sit and that changing position—is important; and the efficiency of public services is very important.

Are there significant issues in the UK that we could change? Therefore, one is looking at the upstream causes of downstream effects, so, rather than treating people when they are sick, are there smaller scale interventions that are much more cost-effective that we could do earlier in their lives?

That is a really interesting agenda for us to pursue and it is potentially transformative for the UK. All these things could, as part of a well-conducted strategy, have a very positive impact.

Professor Chataway: One can go beyond R&D to promote economic growth and look at the range of social, environmental and other goals that can be achieved.

Part of the vision might be to engage broader communities in science and R&D. There is huge potential for doing that. Lots of exciting stuff is going on around citizens' science and creating a sort of ownership, which is much broader than R&D, of spending on science and getting people involved so that in the longer term that broader base is created to argue for spending on it.



Q117 **Stephen Metcalfe:** Building science capital.

Professor Chataway: Building engagement and a broader base for science.

Professor Nightingale: Doing that does not necessarily require investing in just R&D. The ability to diffuse technology is a different skillset from the ability to create it for the first time, so linking up research thinking with higher education and further education—local skills issues—needs to come together to drive the diffusion process. Creating stuff first in the world may require PhDs; using it may require masters, graduates, non-graduates and technical skills, and there may be gaps within that system that we need to address. Just looking at R&D away from those other bits is to miss out important issues. It may constrain the value we get out of R&D if those bits are missing.

Q118 **Chair:** The industrial strategy challenge fund now has 15 different challenges, some of which match the four grand challenges; some do not. It includes transforming construction and transforming food production, for example.

We also have all the themes and priorities of the different research councils. Does it matter that there is a mismatch? Incidentally, some of the themes of the research councils match the grand challenges; some do not. Does that matter, or should we aim to try to achieve a greater consistency, starting with the grand challenges and ensuring that the whole system seeks to support those, or is it legitimate to look at a whole range of other priorities as well as that?

Professor Nightingale: This is a difficult question.

Q119 **Chair:** That is why we are asking it.

Professor Nightingale: There is no counterfactual world in which this has not happened that we can compare it with, so what is our gut feeling about this? Is it a good approach?

The general idea of having more co-ordination and thinking about whether we are working at scale, or are we aligning research with real societal needs, is a good one. That can be done using this kind of approach, but this approach can also fail to do that. Aligning with societal need is not enough; we need to have the mechanisms in place to do that, and that is where the real issue is.

The answer is that it depends on whether those connections are being made and the research is generating the outputs we want, but in general it is good to have a diversified portfolio of options in a highly uncertain world. I am not too concerned about what may seem unco-ordinated from the top down. It will certainly be far more unco-ordinated once you get into the lab, but the science system can be quite good at getting its co-ordination from that apparent complexity to achieve outcomes. It is a



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difficult issue. It may be more a matter of presentation than reality if one looks at what is actually happening in the labs.

Professor Chataway: My concern would be if there was too much co-ordination.

Q120 **Chair:** It becomes a bit of a straitjacket, as it were.

Professor Chataway: Yes. We do not know enough about the pathways for these new missions and challenges, so there needs to be an openness about it.

Q121 **Chair:** Are we capable of solving these big four challenges, or is there a risk that we set ourselves up to fail?

Professor Nightingale: One could be cynical and suggest that the definition of success may be flexible. It is not really a sense of, say, solving healthy ageing. People will get old and they will become sick. The question is whether we can improve from where we are now.

Q122 **Chair:** Can we make progress?

Professor Nightingale: Can we make progress? Are we making progress in the right direction, and is the extent of that progress enough? I think they are the questions rather than solving them. As long as they are done in an intelligent way, that seems an intelligent way to move.

Q123 **Darren Jones:** The whole purpose of our hearing today is to try to home in on how this inquiry can add value to holding the Government to account on their spending target so we get the best impact for the country. We have talked a bit about how we probably need to be better at evaluation; we have talked about productivity and other issues; and we need a bit more vision around the industrial strategy challenges. If you take a step back, is there anything that you think is glaringly missing that needs to be new, or is it just about assessing and tweaking what is currently in place?

Professor Nightingale: I suggest there are two things. We are changing the social contract. We are increasing spending enough that we are changing the social contract with research, and with that increase in money we are demanding more of the university and R&D system. It is no longer a case of saying, "We will give you some money and you go off and do some research." We want some output from that. Therefore, we need to build up an ability to make sure we get that output and build up skills by which people can deliver that output. I think the whole impact of change within the UK is world leading in that regard and could be pushed further.

In my view, two things are missing from that beyond even the lack of capabilities that we have in evaluation. As part of the evaluation community, I need to highlight that we do not want to over-promise because evaluations do not necessarily give you the answer to what you want.



Two things are missing. One is that when you have an evaluation how does that connect to the policy process? How do you close that loop? There needs to be an institutional structure in place. There is a lot of evidence on what does and does not work, and getting that evidence fed into the policy process to drive change is difficult. The What Works centres are doing a fantastic job in that, but more could be done.

As a more general issue of public policy, sometimes when very bad evaluations come back it is very clear that a big technology project is going wrong. It would be useful to have a better institutional structure for killing bad projects. Once they get big, they become powerful and difficult to stop. Historically, there have been a number of big scientific and technological adventures that in hindsight should not have been pursued.

Q124 **Chair:** Are there current examples where you think we are continuing to spend for the sake of it and should not be? Feel free to be controversial.

Professor Nightingale: May I use an international rather than a UK example? The ITER fusion research programme in the south of France involves billions and billions of spending. One could ask whether, given the fantastic reductions in the cost of renewables, that is still a good spend. It was set up to consolidate a cold war joining together of hands between the United States and the Soviet Union. Is that still appropriate today? It would be great if we could have institutions that looked at projects like that and said, "We want to see evidence that these are going to deliver what they claim to deliver and, if they don't, we will kill them off," because once they get big they get very expensive. That expense comes out of a pot, and there are areas of the R&D budget that are less than well funded.

Q125 **Darren Jones:** You said we are asking universities to deliver more and to give more. We heard a concern from the previous panel that perhaps we are asking universities to do everything and that some might not be able to meet that ask. Do you agree? If so, who else should we be asking?

Professor Nightingale: Universities are sophisticated institutions and are very responsive to economic and political signals. I have seen senior figures in many universities who are very prepared to step up to the new challenges. I think they are good, and they could do more. I am not too concerned about asking them to do more. It is a very large amount of money we are pushing into the system, so our expectations should be high. It is public money and we should hold the people who get it accountable for the promises they make and make sure they deliver.

Professor Chataway: Universities perform very well in the UK—there are lots of metrics and data to support that—and can do more, but for sure they cannot do it alone. If we are looking at grand challenges, missions and outcomes, universities will need to partner with all sorts of non-academic bodies that are responsible for delivering on the frontline and implementing it.



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We do not understand those partnerships well enough. All sorts of partnerships exist; some conventional industry-university partnerships are less studied, and we understand more about that. There are other sorts of partnerships. There is a lot to be learned about that.

There is a lot to be learned in the area of leadership. We know that interdisciplinary research requires a different kind of academic leadership from disciplinary leadership, but we do not know too much more about that. Who are the emerging leaders who succeed in this space? Why do they succeed, and what sort of support have they received? What has worked in supporting interdisciplinary research that can deliver on the missions and challenges?

Q126 **Chair:** We heard about international comparisons from the previous panel. Are there any lessons from looking overseas at countries that have done it effectively from which we should be learning?

Professor Chataway: There are all sorts of lessons to be learned. The discussion about Japan was very interesting. Sweden is also moving to align itself to SDGs in a good part of its spending on research. I think those efforts are very interesting.

Q127 **Chair:** Do you think the approach in Japan, which appears to try to promote a national discussion about it, is important? Should we in this country be learning from that?

Professor Chataway: I am particularly keen on that. The promotion of engagement and discussion around science and innovation policy will be an important part of a sustained commitment to increased spending on R&D.

Professor Nightingale: It is important to learn from other countries, but that needs to be done in a smart way where you take into account institutional differences and where they are. We can learn from Japan and Korea; we can look at countries that have increased their R&D. In the case of Korea, it was behind the technological frontier, so a lot of that process of development was driven by production engineering. I go back to my earlier point about it not being just R&D. It was production engineering capability. As it has approached the technological frontier, it can move into a more R&D-centric innovation system. That is a very different world from the UK. Therefore, we can learn from that, but we need to recognise those differences.

The other thing we need to take into account—this was very clear from the work I carried out for a previous inquiry you did on industrial strategy—is that there is a big selection effect. People do not wash their dirty laundry in public. Lots of examples of disastrous failures are pushed away. The literature is full of great successes, but when you talk to people from those countries they give you a very different picture. It needs to be nuanced. Recognise that the UK and its institutions are different. What we want to do will be different, but there are certainly



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opportunities to learn. The University of California, which is driving economic growth in California, is fantastic.

Q128 **Chair:** That is a good example of where an investment in a university has delivered an economic development impact.

Professor Nightingale: Yes.

Q129 **Chair:** Where is it in California?

Professor Nightingale: It is distributed around California at lots of different campuses. It has an explicit view that it takes money from California and then rolls it to support California. I think it does it very well. If we do research, we want to create jobs with it. It has more of an output and outcomes view than just wanting to create citations, which is to say, "We have reproduced research; here it is." It has a longer term view and is very locally focused on California and responsive to the needs of California.

That is one institution, but there are lots of fantastic institutions. There are also some fantastic institutions around the UK from which other institutions in the UK could learn.

Q130 **Chair:** You probably sat through most of the other two panel discussions. Is there anything you heard earlier with which you violently disagree or want to reinforce before we finish?

Professor Nightingale: Coming from the science policy evaluation research community, I am probably more sceptical about how good we are at providing you with advice.

Q131 **Chair:** So we should not listen to you.

Professor Nightingale: I think you should listen to us, but we should not over-promise. If we give you an evaluation result that says, "We did this and it came up with only x," it does not follow from that what the next step will be. Sometimes our ability to evaluate things is such that the effects are quite small. It takes a long time for us to understand what the effects are, by which time the world has changed, or people who are doing an intervention have decided that that is not the thing they wanted to do at the beginning and they have changed their mind.

Our evaluation results are often very context-specific. Without closing that loop to inform policy, it is not going to be effective. You cannot just do more of it. More evaluation would be useful; we will need to do it if we are to become more strategic, but we should not over-promise that somehow you will be in a position where you can just pull levers and change the economy of the UK, because it is not going to happen like that.

Q132 **Chair:** Given that we are going to come up with recommendations to Government, do either of you have a view about what we ought to be saying to ensure the maximum effectiveness of our R&D spend for the



benefit of the country?

Professor Chataway: I think the message that diversity is good is important. There will not be a silver bullet whereby increasing one component of R&D spend means you achieve the overall aims. We will need to keep diverse spending. Thinking about innovation and outcomes rather than just spending on R&D is important. We did not talk too much about the role of regulation and standards, which are very important in driving this forward, particularly if we are focused on meeting SDGs and social outcomes as well as economic growth.

Q133 **Chair:** If you feel there is anything you want to contribute to our inquiry on regulation and standards, in addition to what you have already said and written, please send it to us. Paul, do you have any final comments?

Professor Nightingale: Given the change from, "We give you a small amount of money and you just produce papers," to, "We give you a very large amount of money and we want you to drive some kind of change in society," we need to be thinking about the missing bit in that change. We need to invest in alignment with societal needs; we need to think more about downstream. Is there an ability to absorb that research? Otherwise, we are just pushing a piece of string. We need to create demands in the system for research and close that loop.

A lot of these areas are very interdisciplinary. Implementation, capturing value, growing firms, delivering outcomes and improvements in public services are very interdisciplinary skills, so there is a gap there. Historically, that has been very difficult for any research system around the world to support.

We need to recognise that it takes time to develop this capability. There may be bits that are missing where we will need to make some long-term investments. The science system is not one where you do an evaluation and pull levers. If you allocate resources and there is nothing there previously you will probably get bad outcomes, and if you put a lot of money in a place and then pull that money later on those people will just be lost in the system. It needs to be subtly done.

Q134 **Graham Stringer:** Having listened to all three sessions, I find something deeply unsatisfactory, although I cannot argue against it completely, in the answer that you always send money to where there is excellence. Scientifically, that makes sense, but as a politician I might want to improve the University of Sheffield, which we talked about earlier, or Salford University. How would Government do that?

Professor Chataway: I think that can be achieved in all sorts of ways. There are partnerships between research-intensive universities—of course, Sheffield is a research-intensive university—and non-research-intensive universities, which are helpful. As various people said earlier, it depends on what you are aiming to achieve with the mission of diversifying spending, but, if you are looking more at the D end, certainly



there are ways in which funding can be distributed to good ends regionally.

- Q135 **Graham Stringer:** What if one is aiming to increase excellence and change the balance of expenditure? I think I would be right in saying that it is more than half a century since Sheffield won a Nobel prize in science. That is one of the metrics that is used. If we wanted Sheffield to get a Nobel prize in science some time over the next 15 years, what would we do to try to encourage that?

Professor Nightingale: These are entirely legitimate questions and policy issues to address. We are giving public money to people and we want to be careful that they are not marking their own homework, and they get to define what excellence is. If the political system decided that regional distribution of research excellence was a more important priority, that could be reflected in how resources were allocated.

If you put a lot of money into a particular area of research in Sheffield and attracted excellent people from around the world and managed them well, you might develop excellent research. I am sure that if James Wilsdon was here he would highlight that there is already excellent research there.

- Q136 **Chair:** He is here.

Professor Nightingale: He would be right to highlight that there is excellent research across the board in the University of Sheffield. I have some experience of working with the University of Sheffield. It has a lot of potential. If you give more support, perhaps it will be able to deliver on that potential.

- Q137 **Graham Stringer:** I visited Sheffield recently with another Select Committee and I have no doubt about that, but in international comparisons the metric of Nobel prizes has a huge weighting, and it was a long time ago. I am just asking a simple question. If the Government want to hit those high metrics by which Oxbridge, Imperial and UCL are measured, what would they do? You are saying it is money to attract the best.

Professor Nightingale: If you took a large amount of money and decided that chemistry at Sheffield needed to be world leading and you spent that money, the University of Sheffield is an attractive enough location and you could create excellence.

You have to be careful. Countries that have tried to move research excellence geographically sometimes have suffered. The Swedish example of trying to move research excellence into some parts of Sweden did not go well. We have had issues where things have been moved and people have not followed, but if it was done intelligently you could reduce the concentration of research and, by doing that, perhaps improve the performance of the overall system.



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It is not at all clear to me that, if you reallocated resources and put them into world-leading research departments outside the golden triangle in the south-east of England, you would not come up with equally good results. I think there is no evidence either way, so it could be done.

Chair: I think that is a good point at which to end. We are very grateful to you for your time this morning. Thank you both very much indeed. It has been a fascinating discussion.