

Science and Technology Committee

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

Tuesday 18 December 2018

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

Questions 138 - 263

Witnesses

I: Keith Thompson, Chair, Catapult CEO network, and CEO, Cell and Gene Therapy Catapult; Professor Richard Brook, President, Association of Innovation, Research and Technology Organisations; David Connell, Senior Research Fellow, Centre for Business Research, Cambridge Judge Business School; and Felicity Burch, Director of Innovation and Digital, Confederation of British Industry.

II: Dr Robert Massey, Deputy Executive Director, Royal Astronomical Society; Professor Dame Ann Dowling, President, Royal Academy of Engineering; Professor Neil Hall, Director, Earlham Institute; and Dr Charmaine Griffiths, Chief Operating Officer, The Institute of Cancer Research.

Written evidence from witnesses:

- [Catapult Network](#)
- [AIRTO](#)
- [David Connell](#)
- [Confederation of British Industry](#)
- [Royal Astronomical Society](#)
- [Royal Academy of Engineering](#)
- [Earlham Institute](#)
- [The Institute of Cancer Research](#)

Examination of witnesses

Witnesses: Keith Thompson, Professor Richard Brook, David Connell and Felicity Burch.

Q138 **Chair:** Welcome, all of you. Thank you very much for attending this morning. Felicity, may I thank you, in particular, because you have rearranged your annual leave to be here? That is beyond the call of duty. May we do very quick introductions?

Keith Thompson: I am CEO of the Cell and Gene Therapy Catapult. Recently we formed a network of the Catapult CEOs, to try to get a coherent network voice.

Professor Brook: I am president of the Association of Innovation, Research and Technology Organisations. Our members cover the catapults, public sector research establishments, national laboratories, three universities and a few large research bodies in private industry, such as IBM and PA international.

Felicity Burch: I am director of innovation and digital policy at the CBI, which is the UK's largest business representative organisation.

David Connell: I am a senior research fellow at Cambridge Judge Business School, but most of my career has been spent in the technology and venture capital sector. I am also the author of a recent independent review of procurement-based innovation, commissioned by 10 Downing Street.

Q139 **Chair:** With a panel of four, if you all answer everything at length, we will be here until very late, so will you be succinct? Don't feel that you all have to answer every question if others have said what you wanted to say.

The Government are committed to hitting 2.4% by 2027. Do you think that is achievable? Will it be met?

Felicity Burch: Clearly, 2.4% is quite an ambitious target for the UK to reach. We have had R&D spend stagnant at about 1.7% of GDP for around 30 years, so moving the dial towards 2.4% is clearly a challenge for the UK economy.

That said, it is the OECD average, so to imagine that the UK could not get to it would be selling ourselves short as a nation. We have many strengths in R&D, especially our very strong university base, and many highly innovative businesses, but we need to see a real transformation in the approach to innovation policy in the UK if we are to hit that target.

Q140 **Chair:** A similar target was set in the last decade, and it is clear that it was spectacularly missed. Why will it be different this time?

Felicity Burch: That is the thing. It absolutely has to be different. The key aspect is that this is a target that cannot sit just with BEIS or UKRI—



it has to be a cross-Government target. One of the key things CBI members have been calling for and would like to see is Government taking the approach of really making markets for innovation and selling the UK as a place to innovate.

That includes the way in which the Government use procurement, encouraging wider business uptake of innovation, so that we have a bigger market for innovation in the UK, and relentlessly selling the UK as a place for inward investment in R&D. At the moment, that is quite challenging, but there are lots of things that we can do to make the UK more and more attractive.

Q141 **Chair:** If more of the same will not get us there, what needs to change?

Professor Brook: We need to pay more attention to the innovation component. The key to getting more investment in R&D is to make sure that there is a path to successful application in everyday life, products and services. The greater the likelihood that there will be success in converting the outcomes of R&D into wealth—

Q142 **Chair:** What are the mechanisms to achieve that?

Professor Brook: The mechanisms to do that are to provide more support to the innovation component. We would not wish to take money away from research.

Q143 **Chair:** Do you mean that we underspend on the innovation end?

Professor Brook: We underspend massively on innovation, compared with the amount that we put into research. We are not suggesting that money should be taken from research and put into innovation, but we need to find ways of bolstering the support for innovation. Public procurement, and using the pull from public procurement to bring through innovations into everyday applications, is a key component. The focus needs to be on improving the innovation element of the total picture.

Q144 **Chair:** David, you have indicated that we need to get public money leveraging more private money—more bangs for our public bucks, as it were. How do we do that?

David Connell: I think that 2.4% is a hugely demanding target. We need a zero-based approach and to examine very critically the assumptions on which innovation policy is based. There are essentially two. One is that if you subsidise R&D people will do more of it. That is the basis of the R&D tax credits. The evidence is that that has not worked.

Q145 **Chair:** We might have a further discussion about that in due course.

David Connell: The other is that innovation in businesses is largely about exploiting IP from the academic community. Again, the evidence suggests that, in growing significant businesses, that is not the case.



I think that we need to see a much more zero-based approach. In particular, we need to see a swing from policies that are about subsidies and technology push to policies that are about creating demand for innovation through procurement and other contracts.

Q146 Stephen Metcalfe: I want to clarify what “a zero-based approach” means in this context.

Chair: Starting afresh—looking at everything that we are doing.

Stephen Metcalfe: I was just checking.

David Connell: You cannot start afresh—there is too much water under the bridge. What you can do is look at the basic assumptions and really examine the microeconomics—whether we are trying to do things that have a hope of working, or whether we should be focusing on other objectives and mechanisms.

Keith Thompson: I absolutely support the 2.4% target. It is the OECD average, and we are below it. Frankly, the academic base that this country has is an under-exploited asset. We will not live as a nation from publishing highly cited papers. That has to be turned into economic outputs that support the entire economy.

My colleagues are broadly supportive of the whole range of areas here. There are mechanisms to get out some of that university intellectual property. I can evidence that across all the catapults. In the Cell and Gene Therapy Catapult, specifically, university IP is being used to form companies. In 2012, there were only 20 companies. Collectively, they raised only £30 million. From 2012—and before that, from 2010 forward—changes to the innovation policy went in, including the formation of the catapults. Those were designed to help to bridge the gap between very risky intellectual property or business propositions and the point where it becomes more predictable. That has been a success story. IUK CR&D grants and thematic funding have helped both to reduce barriers and to crowd in private investment. We will get to 2.4% only by cleverly crowding in private investment.

I told you earlier that in 2012 there were only 20 companies, which raised £30 million. Right now, in 2018, there are nearly 70 companies. Collectively, they have raised £2.5 billion, nearly all of it from private sources. That has happened because the whole architecture of innovation has changed. It has changed such that the regulations are better and that companies have places like the catapults, which can support them in their journey, both with intellectual assets and with hard physical assets. That is de-risking it so that venture capitalists are putting money into the idea, not into a sink of general stuff.

Q147 Chair: Are you suggesting that, because we have seen this growth in private investment over the last five years, partly as a result of the catapults, we should just keep doing more of that, or are you suggesting that we need to change levers, mechanisms and incentives to get more



HOUSE OF COMMONS

private investment?

Keith Thompson: At the moment, only about 10% or 11% of the UKRI budget goes towards innovation. Arguably, it is a little bit more than that, but that is the figure if you just add up what is going on with IUK versus what goes towards all the research councils. I am not suggesting that the research councils should be cut in any way—they should be encouraged—but the amount of money that is going into Innovate UK and into innovation, both through the ISCF and through thematic CR&D funding that is targeted at sectors, really needs to increase. That is what will crowd more and more funding into those areas of the economy where we think that we will be able both to grow substantial economic value and to embed that for the long term.

Q148 **Chair:** Do you all agree with what Keith and Richard have said—that we need to increase the spend on innovation, as against basic research?

Felicity Burch: Yes. Our members have been saying that for a long time.

Q149 **Chair:** You are not advocating cutting spending on research, but you are advocating bringing up spending on innovation.

Felicity Burch: If we want to research the 2.4% target, spending on innovation absolutely has to rise. I will add to Keith's comments slightly. We need to look not just at the type of funding—whether it is funding for research or funding for innovation—but at the type of money that is there for innovation. We must make sure that we have not just these thematic funds but the bottom-up funds that enable businesses that have their own ideas that they are struggling to develop a bit further and to take to market to do that, without fitting into one of the themes.

Q150 **Darren Jones:** I am keen to think about where this money will come from. We have said that 2.4% of GDP is a stretch target for the UK and that the bulk of it needs to come from the private sector. We have said that we do not want to reduce funding—assuming, in relative terms, an increase in GDP spending—for the research councils, but that we want to increase funding for innovation. I am not quite clear how we increase the funding for innovation if we are not suggesting a decline for research councils or a higher target, in terms of the percentage of GDP. What is the answer?

Felicity Burch: The Government have committed to meeting this target. It is clear that, where Governments spend more on R&D, the private sector spends more on R&D. The UK is some way behind comparable nations on public sector R&D spend, especially on innovation spend. Per head, it is a tenth of what it is in Finland.

Q151 **Darren Jones:** But how do we get more innovation spend out?

Felicity Burch: The Treasury has to commit to putting more money into it.



Q152 **Darren Jones:** So, more Treasury money.

Felicity Burch: Yes.

Q153 **Vicky Ford:** When you say that you want to see more innovation spend, you do not mean just public sector money for innovation.

Professor Brook: No, of course not. That will help to de-risk the journey for the market and help private investors to have the confidence to put more of their own money into that journey.

Q154 **Vicky Ford:** Do you have any view on the multiple of public to private?

Chair: It is currently 2:1, isn't it?

Vicky Ford: Yes, but my banker's brain tells me that innovation is more likely to be somewhere that is close to market and, therefore, more likely to be private sector fundable than some of the further-from-market, early-stage research.

Keith Thompson: If you look at where universities and research councils generally finish, it is early in the technology readiness process—in the one-to-four space. Technology readiness goes from one—absolutely basic blue-sky research—to nine or 10, where it is fully commercial. The gap in the four-to-seven area is where you would expect to see the 1:1 or 2:1 ratio. At the far end, as things are de-risked, you would expect to see an increasing proportion of private money going behind them, but the private sector will never get to the point where it will invest in those things unless they have got over the little hump at the beginning.

Professor Brook: The problem is that four to seven is where the risk and the cost of making progress really start to ramp up. If we are under-supporting that area, investors do not have the confidence to bring their start point for investing earlier up the TRL scale.

Q155 **Graham Stringer:** There is always a certain amount of tension between money put into pure research and money put into developing ideas into technology. One method that the research councils and UKRI have brought in over the last decade or more is impact assessments when research projects are being assessed. Do you think that those are a waste of time? Could they be improved? Part of the argument for pure research is that you put in the impact assessment, which helps you to move into practical applications.

Professor Brook: My personal experience, as someone who is outside the academic sector but who sits on two university commercialisation boards, is that although the impact assessment takes a lot of work it helps us to think about why work is being done and what the most effective way of getting it out into the market is.

Too many times, I see a knee-jerk reaction that, when you have a successful R&D outcome, you should set up a spin-out, and off you go, without necessarily thinking about whether that is the best way of getting



the biggest impact. If you focus on the impact, people will consider a broader range of exploitation options, including licensing into the existing supply chains. In my view, the need to focus on impact is helpful.

Keith Thompson: It is about the way in which you construct that impact. The catapults are judged purely on impact, in the long run—are we moving the needle? Overall, if you are making the assessment that there is an impact from academic research in the health sector, you may be looking at the societal impact for health. If a university is looking for impact as regards licensing revenue, that is fine and dandy. However, if all that licensing revenue is coming from an overseas firm, it may help to shore up the financial situation but it is not contributing to the economy. Therefore, I am always thinking, “How does it impact on the long-term economy of this country—the health and wealth agenda?”

David Connell: The question of how you pay for it is really important. In my written submission, I have proposed a series of policies that would enable the dial to be shifted, based on using the money that is already in the system in different ways. It is really important to look at the details of the individual policy instruments—R&D tax credits, grants, procurements, which are 100% funding, and so on—because those differences affect what impact they have both on the commercialisation of technology, particularly the growth of new Mittelstand companies we are looking for, like the Arms of this world, and on the amount of money that they leverage.

The key and best way of leveraging money for R&D into small companies, for example, in the short and long term is to fund them right at the start of the journey—particularly through customer development contracts, from the public or the private sector—so that they have a much better chance of raising money, if they need to do it, of finding other customers and of growing over time, without ending up being sold to overseas firms for their technology. That is what happens if you rely totally on venture capital. It is about putting money in early, preferably through customer contracts, and then letting the market do the job that it can do—

Q156 **Chair:** You are saying that, quite apart from the case for extra public investment, we could be spending the existing money more effectively to leverage more money from the private sector.

David Connell: That is where we need to start; otherwise, we are just putting more money into mechanisms that are not delivering as well as they could. We can see that they are not delivering.

Q157 **Chair:** The Catapult network’s submission argues that we need to look at the interaction between innovation policies and the overall mix of schemes, not just the individual policies themselves. Who is best placed to look at the innovation system strategically when policies are spread between Innovate UK, BEIS and others?



Keith Thompson: There is no doubt that there are a lot of schemes. The way in which they interact is really important. To try to avoid the “batteries not included” model, you need to make sure that, when you put a capital scheme up for translation, there is a stream of other funding that will crowd investments into it and that that will work with the R&D.

BEIS is charged with trying to orchestrate the entire landscape. Therefore, I would say that orchestration sits with BEIS. UKRI is its child and, of course, the Treasury has the money.

Q158 **Chair:** Do you think that the number of schemes is over-complicated and that they need to do some work on the overall architecture?

Keith Thompson: The issue is the way in which they are all playing together, especially with the new 500-pound gorilla that has just been launched—the new industrial strategy challenge fund, which is extremely welcome. These challenge-led initiatives are going on, and they are putting together challenge-led themes that have industry in them. We really need to say, “That’s great, but what effect does it have on all the other schemes, especially if money has gone into the scheme and it has disrupted things elsewhere?” That holistic look is really required.

Professor Brook: There are elements of the way in which the industrial strategy challenge fund is deployed that do not go far enough into the innovation component. Therefore, looking at how far that funding can be extended into the innovation journey would be helpful. Most of the schemes are not that well suited to supporting innovation, as opposed to the research element.

Felicity Burch: From a business perspective, the mix of schemes is quite large. You get quite a split picture between companies that have engaged with the system for a long time and know their way around it, and those that do not and have not engaged with the system. If we want to get to 2.4% and to leverage more private sector funding, we absolutely need those companies that, typically, have not engaged with the system to do that.

To make that happen, there are a couple of things that we need to see. First, we saw a strategic prospectus from UKRI in April. We are really looking for UKRI to publish a strategy and to make some choices, as well as some good decisions about how we spur more business innovation and support our innovation sector.

The second point is around marketing. Something that came out really strongly from our member consultation was that there is a lot of good support out there and available—our members are hugely supportive of Innovate UK and the way in which it is working for business—but often it is hard to find what it is.

For smaller companies, the issue is good marketing. For larger companies that, typically, have not engaged with the system, an account



HOUSE OF COMMONS

management approach, to guide them through the breadth of support that is available—which has been tried by Government in the past—could help a lot of companies to navigate the system better.

Q159 **Chair:** We will take a quick comment from David.

David Connell: Your question was about who is best placed to pull together the different systems and funding sources. One issue we should be really concerned about is the lack of joined-up, strategic thinking between the tax side of the Treasury and BEIS. The tax side of the Treasury funds £3.6 billion of R&D tax credits, plus getting on for £1 billion of patent box funding for companies. BEIS funding for companies is £300 million—maybe £400 million, with the new Challenge Funds. The Treasury has the biggest purse. The communication between the tax side, in particular, and BEIS and others involved in innovation policy seems to me to be extraordinarily weak.

Q160 **Chair:** Clearly, this is a developing theme. We will come back to it.

Keith Thompson: I will add one thing to the mix for you to consider. All these schemes are great. For instance, an R&D tax credit is an annual cycle that a firm that gets used to doing this can get into, so that it knows where it is. Businesses plan. When they are trying to construct large-scale business contributions to collaborative R&D, for instance, they need the time to get their contributions into their budget cycles. It is all well and good if you have a core of £100 million that requires a £100 million match from industry, but if you cannot provide the time for somebody to get it into their budget only the very largest firms may be able to do that. The planning cycle and its predictability need to be in the mix.

Q161 **Vicky Ford:** We know that, to get to 2.4%, we need more investment from the private and business sector. I want to drill down a bit and to ask what you see as the strengths and the weaknesses of UK innovation support, so that we can both focus on and increase the strengths and identify some of the weaknesses, to get in more private sector investment.

Felicity Burch: On the strengths, I have already mentioned Innovate UK. Broadly speaking, it is a strength. I would also like to say specifically that the UK's innovation sector cuts through overseas. I am just back from the FutureTech fest in Delhi. The first thing anyone talked to me about was the UK's Catapult centres and how excited they were about them. We have some really good strengths that are being delivered through Innovate UK.

From a business perspective, the R&D tax credit and the patent box are hugely welcome. They are seen as some of the most internationally competitive parts of the UK landscape by businesses. It really matters, because a huge percentage of UK private sector R&D is delivered by international companies. Keeping that competitive really matters.



On weaknesses, first, the level of funding is low. We have already covered that. Secondly, we have seen a lot of chopping and changing in the last 10 years or so. That is very damaging from a business perspective, because it makes it very difficult to navigate the landscape. It makes it difficult for funders to guarantee that a funding mechanism that was there last year will still be there next year. We are constantly told by companies about the frustration of having to figure out again how the system works.

The final point is about the joined-up approach from the whole of Government that we would like to see.

Professor Brook: In addition to the catapults, there are some 30 other organisations: companies limited by guarantee, industrial research organisations and national laboratories. The innovation sector, as we call it, is two and a half times the size of the German Fraunhofer network, which puts some scale on it. There are some 50,000 scientists and technologists employed in it. Interestingly, it does twice as much business beyond Europe as it does in Europe. Many of the members of our network have establishments all over the globe, in terms of their footprint.

We have a very varied and diverse set of organisations that do either exactly what the catapults do or things closely aligned to that, covering specialist expertise on issues such as regulation and how you deal with all the things that you have to do, beyond the R&D, to get things taken up in the marketplace. There are plenty of places to go where people can get that support.

Keith Thompson: I would reinforce the point that predictability is really what needs to be improved. The environment has changed. It needs to be reasonably settled for a period of time. Frankly, reflecting colleagues here, I think that we need to understand fully the assets in the system that can be leveraged, whether they are in the university systems, in independent research systems or in the catapults. Given time and consistent approaches, firms will step up to the plate.

Look at the High Value Manufacturing Catapult, for instance. Although it is the same age as my catapult, it is older, because it is a collection of half a dozen organisations that had existed for five years. It has crowded in more funding than it gets from Government. There are long-term relationships with business that have been built up. Once you get that role going, you can keep it going, but if you keep pulling and changing—

Q162 **Chair:** So, stability—

Keith Thompson: Stability is important in the system.

Professor Brook: One of the weaknesses is that many of these organisations, such as the catapults, are companies limited by guarantee, so they do not have shareholders to go to. If they are public sector



research laboratories, they are reliant on their capital funding from the Treasury on a year-by-year basis. Therefore, capitalising these organisations adequately is a real challenge. If there is a significant weakness that needs to be looked at, it is how we capitalise the public sector research laboratories, the national labs and those people, like the catapults, who are companies limited by guarantee.

Q163 **Vicky Ford:** When you say “capitalise” and that “they are reliant on their capital funding,” are you talking about what I would call capital, as in fixed infrastructure, or are you talking about ongoing running costs?

Professor Brook: It is both the human capital and the fixed infrastructure.

Q164 **Vicky Ford:** Their revenue funding as well as their capital.

Professor Brook: New buildings, and then the effort that you need to put into recruiting and training people with the skillsets that are required for the future business—not necessarily the business that you are doing today.

Q165 **Vicky Ford:** You would like to see more than just a year-by-year context.

Professor Brook: Yes, absolutely.

Keith Thompson: I have to live this on a daily basis. I spend far more time on making the numbers add up than on working with industry. You get cliff-edge year ends and cannot port money from one year to the next. We do not have a balance sheet and cannot borrow. Therefore, every year I have to land it to within 1%. That is within an environment where over half of my funding comes from commercial sources and, therefore, is less predictable.

Q166 **Vicky Ford:** Do other countries do that?

Keith Thompson: They have mechanisms that can port money from one year to the next.

Vicky Ford: It would be helpful to get more detail on that.

Chair: If you could offer us something more on that, that would be good.

Q167 **Vicky Ford:** Especially if there is somewhere else we can learn from. David, do you want to say anything on that?

David Connell: On strengths and weaknesses, there are two things that I would say. First, I think that the innovation instruments are not quite right for what we need. We have talked about R&D tax credits. We may talk more about those later.

The instrument of choice within BEIS is, and has been for decades, collaborative R&D. I do not know whether you know how that works, but what it means is that you persuade two or more organisations to work



HOUSE OF COMMONS

together on a project and you fund them separately. You give them a percentage, so they have to find the rest of the money elsewhere.

That is not the way in which industry works. Industry may collaborate, but it does so through contractual relationships, rather than collaborative relationships. For smaller companies, in particular—I am talking about companies of, maybe, 250 people that have more of a service model, which are some of the best places to look for growth as they transform—our approach does not make a lot of economic sense. I know lots of very good companies with that kind of model that would not get involved in a collaborative R&D project. Customer contracts are better. That is also the way in which US policy works.

The other point that I would make is about the weakness of the UK's economic-geographic situation. We are a small economy. We speak English. Everyone speaks English. That has a number of implications. It means that, if you have the cure for cancer, it will almost certainly be bought by a foreign company, with a reduction of downstream R&D in the UK. Graphene, for example, was invented in the UK. The UK has only 2% of the patents. The odds are against us.

It also means that venture capital makes less money. Venture capital in the UK does not compete with other, lower-risk, asset classes. That is partly to do with the market size. It also affects the probability of trade sales ending up in the UK, which is quite low.

The other point that is quite important relates to the challenge funds. The challenge funds are about big new areas. Everyone knows about those. They will be very competitive. The evidence suggests that the companies that have grown to Mittelstand size have started by selling into supply chains in some very specialised way and have then gradually grown. I believe that we need to evolve our policies in ways that support these success models, rather than the idealised vision of exploiting and commercialising our academic strength.

Professor Brook: I agree with that.

Q168 **Vicky Ford:** The CBI's submission points out that R&D spending is particularly concentrated on a small number of large sectors, such as pharma and the motor sector. Is that specialisation a bad thing? Should we be focusing on growing those sectors more or on other sectors? How does that relate to the industrial strategy?

Felicity Burch: In some ways, it is a strength of the UK economy that we have really good R&D intensity in sectors like pharmaceuticals and automotive. Ultimately, it means that we are very reliant on a few large companies—often, international companies—which makes the UK quite vulnerable. Therefore, we need to raise the base.



HOUSE OF COMMONS

If we look at the make-up of our economy as a whole, approximately 80% of it is services. Traditionally, I do not think that R&D policy has been aimed at supporting the services sector.

In terms of opportunities to develop our R&D policy, we should look at growing that, and we plan to do some research on it next year. We will be happy to share that with you once it has started.

Keith Thompson: Thank goodness for automotive and pharma. They do spend, as do aerospace and a few of the others—but do not characterise this as something that great big companies do. These are sectors that have big supply chains.

Both automotive and pharma are going through profound change right now. The idea that the disruption that is being caused through those sectors should be left to the market would be a mistake. In automotive, for instance, we all see how things are moving towards electric vehicles. We do not want to wake up in 10 years' time and find that the supply chain for all the electric components—the batteries and everything else—is offshored. That early stimulation in what is still risky can be achieved through intervention.

In pharmaceuticals, a lot of our R&D has been lost over the last 10 or 15 years, frankly, as international companies have closed their R&D bases. What happens now is that, essentially, R&D is outsourced to biotechs, which are then bought up and internationalised.

For cell and gene therapy, the entire system is changing. You cannot put a cell or a gene into a blister pack and sell it to pharmacy. That model has been disrupted. Therefore, the opportunity to embed the new manufacturing and distribution capacity in the UK—not only for the UK, but for global sales—exists right now. It is really important that we do that. Very few new factories have been built in the UK for traditional pharmaceuticals for decades. They have been closed.

Q169 **Stephen Metcalfe:** Keith, we have heard quite a lot about the role of the catapults. Will you expand on that for us? Will you explain how the model works? What do the catapults do on a day-to-day basis? How do they work and function? One of the first inquiries that I did when I joined this Committee eight years ago was on the catapults. I know that they have morphed quite a lot in that time.

Keith Thompson: I was very fortunate to be able to start in 2012. I started up the first de novo catapult. I had the benefit of a new mobile phone and a £70 million cheque. It has all been built from scratch on that basis. When it works well, it is terrific.

First, deciding the sector you need to go into is important—in other words, is there a research base that can be exploited? Secondly, is there an industry that could arise out of that academic base? Would a catapult make a difference, and could the outputs that are generated be absorbed



HOUSE OF COMMONS

into the economy? If those conditions are met, the core funding that comes from Government allows the establishment of assets—human, physical or technical—that can be exploited.

As you put these projects—often demonstration projects—together, you produce outputs that are interesting to industry or venture capitalists, who then come in alongside you and participate in collaborative R&D. In the biotech sector, at least, winning a collaborative R&D grant is almost seen as validation for a venture capitalist to come in and to put more money into it. Then, of course, if you have developed unique assets, industry starts to put contracts into the catapults, because they are exploiting those unique assets. The catapults have to have unique assets; otherwise they are just competing with ordinary industry.

I can exemplify this through the Cell and Gene Therapy Catapult. We have built process development teams and a large manufacturing centre out at Stevenage. We have also put together a regulatory team, which has helped to reform regulation to make clinical trials go faster. We have a health economics team, which has helped us to understand how you might pay for cures. The NHS is great at keeping us healthy, but it does not cure you of diseases very often.

That model works. The Government funding comes in. It allows the catapult to develop assets and to take risk, and then it crowds in private sector and CR&D funding. After five or six years, the amount of income that is coming into the Cell and Gene Therapy Catapult from industry exceeds the core grant. It is the same for HVM and several others. We see the impacts starting to develop, in businesses being built and staying in the UK. Those are often high-value businesses that are highly productive, generating high rates of return.

Q170 Stephen Metcalfe: The model has changed from the original model for the technology and innovation centres, which was a “one third, one third, one third” model of funding and was based on a collaborative approach from the start. I think you are saying that you search for assets, try to do something with them and then push them out to industry and bring industry in. Is that correct?

Keith Thompson: I would not say that the “one third, one third, one third” model is dead, but it is unlikely ever to get to the point where the amounts of collaborative R&D in the system are enough to sustain that. However, they remain an important part of it.

The assets can be physical assets—very large amounts of capital that SMEs, in particular, could not afford, with big instruments and stuff like that—or intellectual assets, which might unlock those systems. You put those together and work at two levels, one of which is slightly ahead of where industry is on the D side. You work on that space, but you also spend a lot of time unlocking the environment, to speed up the process.

I will give you an example.



Chair: Keep it tight. We are short of time.

Keith Thompson: Sure. An example would be the time that it takes for a cell and gene therapy to get into clinical trial. When we first started, it was over a year, with literally a maze of committees. Now it is a couple of months. That is valued.

Q171 **Stephen Metcalfe:** What are the best measures for evaluating the work that you do? It is publicly funded, to start with. How do we measure our return on investment?

Keith Thompson: At the end of the day, it has to be the impact. You start off with how much is going in—what is that input? What is the output of that? You measure what you are putting out there, usually through case studies. What outcomes are there? What technologies are being developed, and what is the impact—in jobs, investment and exports? The long term has to be an economic impact.

Q172 **Stephen Metcalfe:** Who should do that evaluation?

Keith Thompson: It is BEIS. An independent is appropriate. BEIS should commission that.

Q173 **Stephen Metcalfe:** Is there a lead time for a catapult? When conducting that evaluation, what should we see? Should we see a return on the investment within three years, seven years, 10 years or 20 years?

Keith Thompson: It depends on the sector and the speed at which it goes. In fintech, for instance, you would expect the cycle times to be quite short. You would expect to see impacts there more quickly. In drug development, the old-fashioned way of thinking about these things is that it takes 10 years to develop a drug. That may well be the case, but you would want to see the first outcomes coming out, with some impacts, after five years. You would certainly want to see impacts within 10 years. You would probably see the transformation over a longer period, but you would want to see and to quantify impacts within 10 years.

Q174 **Stephen Metcalfe:** Finally, are we putting enough money into the catapult network. Is it a question of “more in, more out”? There is no point in just putting in money—we have to know what we are trying to do.

Keith Thompson: Right now, unless there is a compelling reason for a new catapult, let us drive the ones that we have. I think that the amounts of money going into the core grant are about right. It is a £1 billion investment, which is great. That is a big number. Commercial money is being attracted.

What concerns me most is the availability of collaborative R&D in similar amounts that can oil that machine. Oil for the gearbox is what is needed. We are extremely keen to see that that oil is created, through ISCF and UKRI. It is harder to get traction in Europe. It was always difficult, frankly. There are other funds out there, like the Aerospace Growth



Partnership and so on. That middle bit is what we really want to see tightened up—not in the sense that there is less money, but in the way in which it is delivered.

Q175 **Stephen Metcalfe:** Would the other members of the panel like to comment on the effectiveness of the catapults?

Professor Brook: Catapults have a disruptive role, in a sense, to play. They are filling a gap between supply chains that exist, new demand and unmet customer needs. Sometimes there needs to be somebody in that space in between in order to start to de-risk the journey across that gap and to demonstrate the potential for applying intellectual property and new ideas, to help to bring in the private investors.

Frequently, the catapult, or any other RTO, will find itself working to satisfy customer needs that the existing infrastructure is not meeting. That can cause tensions, because it can be seen to be competing with the industry that is its parent, for example. Catapults have a disruptive role. I believe that that is largely why we have them. Without that disruptive intervention, the gap will remain, there will still be a failure and we will fail to pull through the outcomes of our R&D efforts. Therefore, I think that we need to keep catapults going.

In my experience, it can take 15 years from a bright idea through to getting a viable business based upon it. Therefore, I think that you have to give that length of time before you pull it up by the roots and really look at whether it is working. There is a long time constant in all of this that needs to be accommodated.

Felicity Burch: I very much support what Keith has said. Certainly, the business community's view is that the Catapult network is really valuable and needs continued investment. That is the point that I would like to make here. The UK has a history of building some really good institutions and then not continuing to invest in them. The catapults are good institutions. We need to continue to invest in them.

We absolutely should be measuring them. If centres really are not working, and are shown not to be working, we should not continue to back something that is not delivering. Businesses want to feel about the Catapult network in the same way as they feel about universities. You never question whether universities are going to be here in 100 years' time. It should be the same with the Catapult network.

David Connell: I have done quite a lot of work on catapult-like organisations. I have visited Fraunhofer Institutes and other institutions in the States, the far east and so on. I was also a member of the senior management team of one of the Cambridge consultancies—a company called TTP Group, which is a sort of private sector catapult, operating without Government money. It is very profitable.

The key driver of all of those organisations is the fact that they undertake contract developments for customers, developing technologies for them.



HOUSE OF COMMONS

The private sector ones cannot invest much in R&D prior to that stage. They cannot build technology platforms. They can do so to an extent, but they do not have money to do a lot of work in that area. The catapults do—roughly two thirds of their money is for doing that.

What the Ernst & Young report on catapults shows is that, with one or two exceptions, all the catapults are failing to generate enough contract revenue—the more market-facing end. It is the old story, I am afraid. To my mind, the solution is that we have to find ways of increasing the demand for that kind of work.

Q176 **Chair:** The Ernst & Young report that you have just mentioned concludes, “implementation of the Catapult concept has been inconsistent and could have had a significantly greater impact in delivering innovation, economic benefits and value for money that would have been more consistent with” the concept that was defined at the start. We have heard a lot of positive stuff, but it is quite a significant criticism that they have under-delivered on what was hoped for from them.

Felicity Burch: A good approach to innovation is continuing to feed back and continuing to build on it.

Q177 **Chair:** What needs to change? Do you agree with David that it is about growing demand for innovation?

Felicity Burch: I absolutely think that growing demand has to be part of it. I genuinely think that the Catapult network has struggled because of inconsistency of funding. It makes it very difficult to build long-term partnerships with businesses if you do not know that your funding is going to be there for a long period. We have heard from the business sector that that has been a reason why it is difficult for it to engage with the network.

Q178 **Chair:** So a guaranteed increase in the longer term in contracts for—

Professor Brook: I also think that there is not a one-size-fits-all business model that all catapults can apply. It needs to adapt to the sectors they are working with. There was a desire for uniformity of business model at the outset. The weakness is that that has not been allowed to adapt sufficiently to match its operation to what the particular sector it is operating in requires.

Q179 **Chair:** Keith, do you have a response to the Ernst & Young criticism that the network has underperformed?

Keith Thompson: What it actually said was that it is too early to tell, but that there were already encouraging signs that some of the catapults, such as HVM and my own Cell and Gene Therapy Catapult, were making a difference.

Q180 **Chair:** It says, “implementation...has been inconsistent.”



HOUSE OF COMMONS

Keith Thompson: I agree that implementation drifted over time. I think that it has tightened up now. There were certainly some underperforming catapults, which have been changed and restructured. If you look at their performance now—notwithstanding the comments I have made about CR&D—you find that they all start off with a significant amount of core funding, to build the asset base to exploit. Starting up a catapult from scratch, with nothing, takes a couple of years. Once you have done that, you see them start to leverage in collaborative R&D and customer contracts. They are all on that journey.

Q181 **Chair:** At the start, you described how you have established a network of catapults. Is that partly designed to improve the effectiveness and implementation of the model?

Keith Thompson: Yes. It is for a number of reasons. First, it is to interact better with IUK—and, therefore, with UKRI—as a network, rather than as individual catapults. Secondly, it is to interact with Government, so that we can walk the corridors of Whitehall, and what have you, to try to pull together disparate bits. With the best will in the world, you need people on the ground to do that. Lastly, it is to communicate all that information.

Q182 **Bill Grant:** My question is primarily, but not exclusively, for you, David. It is around your report. Your review of the small business research initiative made a series of recommendations for improving SBRI. Do you sense, or can you evidence, that those recommendations are being taken up or are beginning to get traction?

David Connell: There was a small reaction after I published the report—the establishment of a thing called GovTech Catalyst, which is around £6 million or £7 million for digital stuff and is done by the Cabinet Office. That is interesting, but it is not what I was looking for. As you will know, I think that SBRI needs to go to about £200 million a year.

Q183 **Chair:** Is that the optimal level, or will it ultimately—

David Connell: It feels about right.

Chair: That is very scientific.

David Connell: It is a good target to go for. If it all seems to be working out, I think that one can go beyond that, but it is the right target to go for over a period of about five years, as a managed goal.

I am getting some quite good feedback from BEIS at the moment. There seems to be a serious interest in doing something on procurement. I had a good meeting with Greg Clark in the summer. I am getting positive feedback, but the issue is the right amount of money and getting the governance and the mechanics right, so that these contracts are well managed.

Q184 **Bill Grant:** In essence, we are moving in the right direction, at a fairly



HOUSE OF COMMONS

modest pace.

David Connell: I will tell you after I have heard the spending review announcements.

Q185 **Chair:** In blunt terms, you want the spending review to announce a central fund for the small business research initiative—or whatever we then call it—that Departments will bid into.

David Connell: Exactly. What is the problem at the moment? What the review shows is that, when it is done properly, SBRI can be extraordinarily productive, both for spending Departments and, especially, for companies. It can be transformative. Significant companies are created on the back of SBRI contracts, or the equivalent.

The basic problem—the bottom line—is that spending Departments do not believe that it is their job to fund R&D in businesses, and BEIS does not believe that it is its job to fund innovation for spending Departments. It has other things in which it is interested.

My view is that only the Treasury can cut this Gordian knot. I have been involved in SBRI, in different manifestations, for about 14 years. I have seen a lot of things tried. My view is that the only way to get it to work is to have a central fund—over a period of five years, ideally—that spending Departments or agencies that are interested in running programmes can bid for, in a series of competitions. Their bids will be judged on the basis both of what they are planning to do and of how they are proposing to do it. Do they have the right sort of people involved? Are they approaching it in terms of best practice, as from the private sector?

Q186 **Chair:** You think that this could be very impactful in growing innovation businesses in the future.

David Connell: Absolutely.

Q187 **Chair:** I do not want to get full contributions from all of you, but do you all agree with David's argument?

Felicity Burch: It needs a bigger, more strategic approach. David's point that you need the Government Departments pulling together to deliver better procurement outcomes and more innovation through procurement is absolutely right. The issue is whether SBRI is the right tool. Even £200 million will not be enough really to shift the dial on the UK landscape. SBRI suffers from a challenge a lot of innovation programmes suffer from, which is extremely low awareness among businesses.

The Government need to take a more holistic look at their procurement practices. SBRI is probably part of it, but they should look at how they support research and innovation more generally. Departmental expenditure on R&D needs to be part of that mix. Potentially, it would be the bigger shift.

Q188 **Bill Grant:** May I bring David back to give his response?



HOUSE OF COMMONS

David Connell: Over the last 15 or 20 years, R&D has been squeezed out of Departments, both in terms of the top-line numbers for R&D spending and in terms of what it goes on. The R&D budgets that Departments have tend to be spent much more on research—on things like research on policy, rather than on technical development. There is huge change there.

In my review, I looked at SBRI in the context of other innovation policies and other procurement policies. There have been a lot, but none of the others has delivered, over 15 years. They have just faded away. SBRI is the kid that is on the block. It should be called something different. The branding needs to be changed. I have no doubt that it can grow—actually, I would like to see it grow beyond £200 million—but the first thing is to get it working properly across Government Departments.

By the way, we also need to get all relevant parts of the public sector to participate. For example, Arm was basically a spin-out from Acorn Computers. Acorn was created through a BBC contract. The BBC is a very interesting potential public sector sponsor of this kind of activity. Equally, there are the research councils. I am thinking of UK research not as a source of technology, but as a customer base for new technologies. As Felicity said, we need to take a much more comprehensive view across Government, but we must do it in a way that will work properly.

Q189 **Bill Grant:** David, you touched on a very modest amount—£20 million—of GovTech funding.

David Connell: Yes—over three years.

Q190 **Bill Grant:** That is right; you have the £7 million. In your report, you also discussed what was needed for research on the demand side. Is it beginning to work? I know that the £20 million is modest compared with the centrally held fund of £200 million that you want to be drawn off, but is it doing anything? Is it acting as a catalyst, as it was intended to do?

David Connell: I am not up to date. The way in which the £20 million—£7 million a year—works is that the Cabinet Office invites anyone in the public sector to nominate a topic for competition. My sense is that it is likely to be quite fragmentary. What we would like to see, for example, is the Department for Transport saying, “Let’s talk about the big infrastructure projects we are going to be involved in over the next 15 years, and work back from that. Where are the unmet needs?” and putting in place competitions to address those needs, in a much more strategic way. Does that answer your question?

Q191 **Bill Grant:** It does.

Have you spoken to the chief scientific adviser, Dr Patrick Vallance, about how departmental CSAs could assist in bringing this forward?

David Connell: I have not.

Q192 **Bill Grant:** Might it be on your radar to do?



HOUSE OF COMMONS

David Connell: I would be interested to do that.

Q193 **Bill Grant:** I think we need to understand the demands.

David Connell: I did have a meeting with a large number of the chief scientists right at the start of the project.

Q194 **Bill Grant:** Did you believe that to be helpful?

David Connell: It would be good to have that.

Professor Brook: AIRTO is doing that in conversation with Patrick Vallance and his team, so we are talking about the topic of public procurement.

Q195 **Bill Grant:** You have to understand what the demand is. You have a supply and demand end. We need to understand what is needed and wanted rather than working away in a wee cupboard and discovering that nobody wants your product.

Do you sense a reluctance in governmental Departments to take a risk or gamble with small innovative companies?

Professor Brook: Absolutely.

David Connell: Yes.

Q196 **Bill Grant:** Have they failed to overcome that hurdle? I wrote down three words: "risk", "gamble" and "trust." Are these hurdles that the Government are frightened to jump?

Professor Brook: Yes.

David Connell: Yes.

Q197 **Bill Grant:** It is almost like "The X Factor"; we get four yeses.

David Connell: Yes, and for quite good reasons. No permanent secretary will ever be hauled in front of the Committee of Public Accounts for not spending enough on SBRI.

There are lots of other things on spending money incorrectly. What the evidence does show is that when money is available to Departments to run SBRI programmes people are really interested in doing it. Some innovators that emerge are interested in running programmes; they can see the opportunities, which is why we need the fund to tease out these people and give them a mandate to do this job, which is counter-cultural.

Q198 **Martin Whitfield:** You mentioned a change in the architecture. David talked about the role of procurement being effectively 100% investment. If we were to look around the world at other models, do any countries get their public procurement right? Where should we look for a model that works? Do the CBI want to start, Felicity?



HOUSE OF COMMONS

Felicity Burch: I am afraid it is not my area of policy specialism, but there are good examples where the UK has got it right on public procurement. The problem is that it is not consistent. There are some key principles that Government can enact—for example, being clear in advance about the areas that they want businesses to procure: setting the problem rather than the solution they want to have. Probably from the business side there is a thing about giving Government scope and permission to take risks.

Q199 **Martin Whitfield:** I know we can define public procurement better, and we have certainly had a lot of evidence this morning, including written evidence, about it. Is there anywhere we can look to and say they are doing it well?

Professor Brook: I think elements of this are done well in the US. It uses DARPA. The defence budget is used to pull through all sorts of things through DARPA and SBIR.

There are examples in the US. I am aware of a couple in France that are effective. We should probably look also at Israel. I think it would be worth while commissioning an investigation into who is doing it well to get a much better picture overall.

David Connell: US innovation policy is basically run through procurement, so the job of most of our research councils is done by the Department of Defense. A lot of funding is related to defence needs; it is 100% funded over and above SBRI. In DARPA there is a hell of a lot of additional funding, which is more difficult to document, so it appears to do that quite well; it works at it and there is a lot of money.

In the far east you get the sense that Governments have been much more actively engaged in growing national champions in areas like telecoms through procurement, but it is quite difficult to document it.

Q200 **Martin Whitfield:** In summation, this is an area the Committee should look at and delve deeper into to find those examples.

Keith Thompson: The value-for-money agenda collides head on with innovation and procurement.

Felicity Burch: It is not just in procurement by Government where there are challenges. A lot of our large members say they find it quite difficult to procure from small companies for many of the same reasons as Government.

Building markets for innovation and thinking about that as a holistic picture is not my area of specialism. We are planning a lot of research on it next year. We are planning some work with the Cabinet Office and our members to try to answer some of those questions. We know that it is a tough nut to crack, but, if we can crack it, it can really build the market in the UK.



Q201 **Martin Whitfield:** Further research is beneficial and the prize for doing that will be a boost to innovation because it is a direct investment.

David Connell: Part of the answer is that you have to start small and manage the risk. Companies start by doing small things and then develop their skills and track record.

Martin Whitfield: It is using procurement to fuel that.

Chair: That was very succinct—brilliant, Martin.

Q202 **Darren Jones:** I want to get into R&D tax credits. We have been dancing around the subject a bit this morning. I sense there are some different views on the panel about how effective they are, or not. I do not want to give open floor for a monologue on them, but I am conscious that, according to our briefing, the percentage of GDP to innovation has stayed the same for a very long time, even though we have pumped in billions of extra pounds of public funds, or 1% of GDP. What return do we have for our £20 billion of public funds?

Felicity Burch: When I talk to international investors in the UK about R&D, the R&D tax credit is one of the first things they talk about in the UK landscape, and how important it is for the UK being an attractive location for them to invest, so it is a key support mechanism.

Q203 **Darren Jones:** Is that because of BBSRC or because it helps to drive innovation?

Felicity Burch: The two things are quite strongly linked to each other. Innovation is costly, and enabling businesses to locate here to do their innovation will help them do more. Even if it is not then used to invest in innovation, it will be used to invest in capital equipment and people. All of this is necessary for innovation. We do need these companies to locate here and innovate here, so the two are inextricably linked.

Q204 **Darren Jones:** Do you agree that, if we are looking at a graph of public funds and the money has gone like that but the percentage of innovation stays like that, they are not linked? They are decoupled, are they not?

Felicity Burch: I do not think they are decoupled. A lot else needs to happen to make the UK a strong place to innovate.

Q205 **Chair:** Why do you think it has not led to an increase?

Felicity Burch: Because of the broader points about the ecosystem and the fact that other aspects of the innovation and support landscape have chopped and changed a lot. The R&D tax credit is one of the few areas where businesses are consistently aware it is a support mechanism that is open to them, and when I talk to companies it is the first thing they talk about as supporting their innovation.

Q206 **Darren Jones:** I am sure that companies like tax subsidies, Felicity. What I am trying to get to is how we use the R&D system better to improve the innovation output.



HOUSE OF COMMONS

Felicity Burch: HMRC data show that the R&D tax credit does have an impact on innovation, so that is a clear example. Looking at the global landscape that we have right now, reversing the R&D tax credit would make the UK less attractive to invest in, at a time when companies are strongly considering their innovation investment in the UK anyway. Eighty per cent. of companies have put their investment on hold because of Brexit uncertainty. Effectively, reducing the R&D tax credit would be a tax increase on innovative companies, which would damage our innovation ecosystem.

Q207 **Darren Jones:** Who would like to go next?

Professor Brook: Nesta has done a piece of interesting work on the psychology of the R&D tax credit and where it goes into the company accounts. The R&D tax credit goes into the treasury pool of money available to the company, but where the R&D appears and how the R&D tax credit helps is not made terribly explicit in the accounts. Furthermore, when companies are trying to protect their share price and the view of investors R&D will tend to get cut. It is not terribly visible, and the spend on R&D does not really feature in the parameters used to create the bonus pool for the chief executive at the end of the year. A lot might be done in terms of how the accounting treatment of R&D and the tax credit is handled in company accounts in order to increase motivation to reinvest in further R&D.

Keith Thompson: It goes without saying that firms value it. I am also a director of the BioIndustry Association, which is funded largely through venture capital and is extremely keen on it. The point I would like to make more than anything is that, while I have argued for thematic and targeted funding, it cannot be just that. The R&D tax credit can go across sectors in a way that many other measures cannot. We need to get the sectors that do not invest in R&D picking up innovation and using things like R&D tax credits to soften the blow in getting into the market, so it is about how you get it out there.

Q208 **Darren Jones:** Do you have any thoughts on how we do that?

Keith Thompson: In particular, while the manufacturing and high-tech industries are generally quite well aware of it, the question of how we get the service sector going is absolutely crucial. I cannot give you a potted answer to that, but I do know that, while some parts of the service sector will not be amenable to innovation, there are many others that are. Some of the catapults—transport systems and things like that—are firmly in the service sector, and trying to get firms moving in that direction is important.

Professor Brook: That, and some aspects of R&D do not qualify.

Q209 **Chair:** I am keen to get David's response to the case for the current position.



HOUSE OF COMMONS

David Connell: I wrote a bit about R&D tax credits in my submission. Starting with the bare numbers, R&D tax credits have increased since 2001 from nothing to £3.6 billion. During that time business R&D expenditure as a percentage of GDP, which is one of the dials we are trying to move, has not moved from 1.1%—significantly.

The only difference is that 15% of that cost is now paid by the taxpayer. You have to start by asking why. To do that, you need to look at four different groups. I will try to do that quickly, if I may.

The UK is already extremely competitive with regard to inward investors. They are interested mainly in the skills they can recruit. Wage costs are competitive. We have a tax system that is competitive. In addition, if we look at Germany, Sweden, Switzerland and Finland, none of them has R&D tax credits. The US has R&D tax credits, but it costs about one third, or even a quarter, as much in relation to the amount of R&D supported. The words of Mandy Rice-Davies come to mind when thinking about what potential investors say. Of course they are interested, but does it make a difference?

The next group we have to look at is big companies. I will skip that and give you some good news. For venture-backed companies, it is a really good subsidy and it will attract more venture capital, which we need. We have to remember that companies that are backed through that sort of model, if they are successful, will almost certainly be sold for their technology. That is a mixed blessing.

If we look at the big corporates, it was said earlier that the R&D tax credit is spent at divisional level and comes back into the treasury department as part of the budgeting process. Boards have to decide how much of that extra money is spent on dividends, buying distributors, investing in physical assets and how much is spent on technology development. When it comes to technology development, they have a choice: more R&D or acquisition of companies that have already done it. For big companies, acquisition is probably the best way forward in lots of circumstances, so there are lots of reasons why you would not expect that to flow through.

The big issue for me is that the companies we would like to support are those started in people's back bedrooms with very little funding or few contracts, which have created the Arms Autonomy's and the CATs. The successes have in the main been created through that route.

If you are building a company on sweat equity, you cannot pay salaries, so you cannot claim R&D tax credits; so the R&D tax credit for that sector is very small.

You have to look at the totality. In principle, it is pretty useful for some sectors, but what we need to think about is how to repurpose that so that we continue to support all those categories of companies in a way that



encourages them to do more of the higher-risk R&D, preferably involving other parts of the UK.

Q210 **Chair:** You are advocating not abolition but repurposing. Is that right?

David Connell: My proposal in the submission is that for companies that are receiving more significant R&D tax credits—say, more than £500,000 or £1 million—20% should come in the form of vouchers. They can use those vouchers at their choice to do three things: they can place contracts for technology developments with universities; they can place contracts for technology development with catapults or IROs; or they can place contracts for technology development with SMEs.

That would help to achieve a lot of the objectives and issues we have talked about across different parts of the ecosystem. At the same time, it would help the larger corporates, because it would help them to become more engaged with the ecosystem and encourage them to do more higher-risk R&D—step-out R&D—rather than just sticking to lower-risk R&D.

Felicity Burch: You cannot take the R&D tax credit out of the context of what has happened since 2001. In 2001 we had the RDAs. Since then we have had the TSB and Innovate UK. We had grant and then loans; then we have the industrial strategy challenge fund. A lot has changed for businesses in that time in the innovation support landscape. The R&D tax credit has been a constant for businesses. It works in a different way and it helps businesses in a different way; it enables them to bring ideas from the bottom up in a way that other funding mechanisms do not necessarily do.

Crucially, when it comes to innovation and the challenges businesses face when they innovate, there are two things: one is risk and one is access to resources, and the key resource is finance. R&D tax credit does free up finance for businesses in a relatively simple and straightforward way.

Q211 **Darren Jones:** We have talked about how we want to leverage more private sector investment to get to our target of 2.4% of GDP. We have just touched on repurposing. We have talked about how we may perhaps change some of the accounting rules, which sounds quite good; we have talked about how in the US it is more about contracts-based modelling. David, maybe you can speak a little more about that. Is there anything else that anyone on the panel thinks would be a good thing to change to try to increase the amount of spending on innovation?

Felicity Burch: There are three opportunities that might be worth raising. One is the whole of government using the grand challenges a bit better. Whenever I talk to businesses about the grand challenges they say, "That's quite exciting. That is something we would like to get engaged in." I think some of the recent news on the industrial strategy challenge fund has started that, but there is more to do on that journey in communicating what government is doing.



HOUSE OF COMMONS

The second one is that international collaboration and growing those links is hugely important. We are still waiting for the Government's international research and innovation strategy. I think that setting out how the UK can grow its international links would be a good thing not only for innovation but for our exporting links longer term.

The final opportunity is about the UK shared prosperity fund. This was proposed as part of the Conservative party manifesto as a replacement for European structural funds. Developing something that is more UK-specific and less bureaucratic would be a good opportunity to raise innovation capacity in the UK.

Professor Brook: The Frascati definition that we use for R&D is limiting in a number of respects. For example, when we look at R&D tax credits—we have already alluded to it—activities that many industries undertake to pull through developments do not qualify as R&D. It would be very helpful to look again at the envelope within which R&D tax credits apply and which definitions we use.

Q212 **Chair:** Felicity, are you attracted by David's suggestion of vouchers as part of the tax credit?

Felicity Burch: I have a concern with that suggestion, in that it would make the R&D tax credit more complicated. The CBI has called for some change to the R&D tax credit, but not along those lines, so that it better reflects what modern R&D looks like in businesses. For example, the R&D tax credit does not currently include the use of algorithms in research, but for a lot of businesses that is a new and growing area and could open up opportunities for the sector.

Q213 **Chair:** Therefore, you are open to exploring how it can be fine-tuned.

Felicity Burch: There is probably a case for doing a wider review and making sure the system works as well as possible, but one of the credit's real strengths is its simplicity.

Chair: Thank you all very much indeed.

Examination of witnesses

Witnesses: Dr Massey, Professor Dame Ann Dowling, Professor Hall and Dr Griffiths.

Q214 **Chair:** Welcome, all of you; it is very good to see you. May we please have very brief introductions, starting with Robert?

Dr Massey: I am deputy executive director of the Royal Astronomical Society.

Professor Dowling: I am president of the Royal Academy of Engineering and professor of mechanical engineering at Cambridge University.



HOUSE OF COMMONS

Professor Hall: I am director of the Earlham Institute and professor of genomics at the University of East Anglia.

Q215 **Chair:** In Norwich.

Professor Hall: Yes.

Chair: I am an impartial chair.

Dr Griffiths: My name is Charmaine Griffiths, chief operating officer at the Institute of Cancer Research.

Q216 **Chair:** Thank you very much. You will have seen that the previous panel overran, so if you keep your comments succinct we would appreciate it. Please try to avoid answering if you think somebody else has dealt with the point you want to make.

Many of the submissions we have received call for an increase in the quality-related element of funding. Do you agree? What would be an effective balance between quality-related and project-based funding? What would it look like, if you think it needs to change from where it is at the moment?

Dr Griffiths: We definitely agree that quality-related funding needs attention. Given the conversations we heard in the previous session, I would strongly encourage us to protect that and recognise the value it adds to biomedical research.

We are a research-intensive institute. I cannot overstate how important quality-related funding is for our research to undertake the discoveries to defeat cancer. We have about 1,100 staff and scientists working primarily on research, and QR funding allows us to do projects that charitable or other funding will not—to underpin all the other kinds of funding we have with brilliant infrastructure and exploration of areas that grant funding might not undertake. It also allows us to provide stability for some of our senior scientists in their delivery. Quite simply, it is the bedrock of the work we do.

Q217 **Professor Dowling:** The QR element is assessed through the REF, so it is assessed on a retrospective look at what university and research organisations have done. It plays a really important role. I agree that it gives continuity of funding, but it places it in the hands of universities to take a strategic view of what they are doing. It is important.

If we are trying to reach the 2.4%, is it the most important thing we should be doing with the additional funding? I would say not. I sat in on the previous session. If you really want to get to 2.4%, you need to encourage business investment in R&D. I do not believe we do that through the QR element, although it is important for the underpinning capability; you do that by focusing on the innovation end, and I shall come back to that.

Q218 **Chair:** Do any of you have a view about what the ratio between the two



HOUSE OF COMMONS

elements, QR and project-related, ought to be?

Professor Dowling: It is very hard to talk about ratios. To me, where the QR element is now is about right. The Government have made a commitment to increase their expenditure on R&D, and I believe they are going to use that as gearing to get to 2.4%. The increase ought to be more towards the innovation side, and that is going to mean on the grant and strategic initiative side.

Professor Hall: I have a very specific perspective on it because I am at a BBSRC-funded institute that receives no QR funding whatsoever. Essentially, all of our funding comes through strategic programme grants from the BBSRC or response mode funding or special initiatives.

The problem that creates is that, in part, the point of an institute is that it has some continuity and strategic funding and creates infrastructure for the research community as a whole. We do that through our natural capabilities. Essentially, the equivalent QR funding for an institute, which would be non-hypothecated money to be used strategically, or to maintain infrastructure, has disappeared almost completely. I think most institutes in that situation feel it is very difficult to take a strategic view. We are essentially competing for money most of the time. Project-based funding does have the security that it is generally peer reviewed and is of high quality, but there is a cost that comes with it: 80% or 90% of it is never funded and there is huge infrastructure underlying it.

Q219 **Chair:** Is it a particular problem for institutes like yours rather than universities?

Professor Hall: Yes. A lot of institutes now have become parts of universities and that is one way in which you can start getting QR back, but it means that the university has a strategic interest in what the institute is doing and continues to support it through the QR funding it receives. It also puts different pressure on the institute and people, who used to spend 100% of their time on research, get involved in teaching or university administration. You lose the strategic long-term planning, which is what research institutes are for, whether it be through the containment facilities at Pirbright, our national capabilities or the Roslin Institute animal facilities. Those are infrastructures maintained by institutes that make the UK an attractive place to come and work, and that is really important at the moment.

Dr Massey: I think the reflection from our members, most of whom are based in universities, is that QR funding will come into the institution at the top level. It is not necessarily the case that the high-performing research group gets to see that. That depends on the attitude of the institution. It is incredibly important. It provides the financial stability that you have heard about, but we should not kid ourselves that it necessarily rewards the research groups that are performing at the highest levels. It is part of their job to bring in that money, but it is not necessarily something that they benefit from directly.



Q220 **Chair:** What evidence does UKRI collect to determine whether future changes to the balance between the two sides of the dual support system have a positive effect?

Dr Griffiths: We are very happy to be working with David Sweeney in the Research England team and other colleagues to provide data on a range of things in their assessment. In particular, we are interested in painting a clear picture of how we balance the costs of doing excellent research, which we are committed to continuing.

In understanding the interplay between all the factors and players in the research ecosystem, whether they be a combination of pharmaceutical input, Government funding and charitable funding, an important assessment would be looking at all the components in the research ecosystem and taking a holistic view to make sure it stacks up and can support the very best research so that we keep our position as a global leader in R&D.

Q221 **Chair:** Neil, you have talked about the effect on your institute of a reduction in or disappearance of QR funding, and I guess the impact of that affects both of your institutes. Is it possible to quantify that impact?

Professor Hall: Ours is a fairly new institute.

Q222 **Chair:** You have never experienced it.

Professor Hall: We have never really got the benefits of what you could call QR income in its purest form. Our core income—strategically funded income designed to deliver specific research outcomes—has dropped from 71% to 44% of our total income. Our income in total has generally grown, but that is because people are going after project grants. My primary concern is that we lose the focus of what we are here to do, which is to deliver strategic science for the BBSRC on data-driven biology in agriculture, food and health. Inevitably, once researchers become almost self-employed, going after the money where they can find it to support their groups, the strategy is lost.

Q223 **Chair:** What is the impact on the nation?

Professor Hall: For example, our institute was set up primarily by the BBSRC because it saw a gap that affected the competitiveness of UK bioscience around computational biology, skills in maths and so on in the biosciences. Our job has been to fill that gap and provide technologies, training and research to bridge it. That strategic area will slowly be eroded. For example, a large component of our non-hypothecated income now comes from contract research through large agricultural industry, which is good, but it will affect what we can deliver to the UK research base, and that is what we are there to do.

Dr Griffiths: In response, let me paint a bit of a picture of the impact of this on our institute. I shall give you a sense of the gap in funding between project funding and making it stack up. In 2017-18 we spent



£25.6 million filling the shortfall that underpins grant research in our institute, which is clearly substantial. For that reason, we would strongly advocate an increase in available QR funding. We do everything from basic research right through to the clinical end of things—bench to bedside. For us, that is part of the magic of the institute and it has helped to power so many cancer research advances over the decades in its 100-year history.

For us, that gap is hugely substantial. In addition, in both the research assessment exercise and the most recent REF the institute came top for research quality and impact, yet it received a 10% and 8% reduction in its QR funding. That is a worrying direct measure of the impact on us in sustaining our research, and we would advocate more funding.

Q224 Vicky Ford: My questions are to Dame Ann and the engineers, and they follow the first-panel discussion about innovation support.

When you look at the innovation side, which you said may be less funded than it is in some other countries, do you see it having the equivalent of dual support: block funding and project-based funding. Do you see R&D tax credits as being a block-funding element of that?

Professor Dowling: I had not thought of it in that way. I am not sure that is particularly helpful. Perhaps it is because, like QR funding, R&D tax credits are retrospective. As we have been hearing, one of the problems with tax credits is that they do not really help SMEs, which are people-poor and time-poor and probably do not have that much income against which to claim tax credit. For the large corporates, tax credits provide a good infrastructure, but I think the rather more direct, grant-type collaborative support at the point of undertaking innovation is far more important.

Q225 Vicky Ford: How do you view the difference between an innovation policy, a business support policy or a general support policy for an innovative business?

Professor Dowling: What is innovation? I sat in on the previous session. When you get very close to delivery and the product is almost ready to go to market, clearly that is in the business's hands, but in the middle, where interaction between universities and research councils and research stops, there is still a very risky stage. We know that at that stage investment in innovation does not necessarily bring the benefits to the business that was involved in that investment.

That is why there is a role for public support at that risky stage, which is moving ideas forward, but it is not quite clear how they will be commercialised. Someone needs to be doing it. Businesses will co-invest in it, but they are not willing usually to take 100%.

Therefore, on innovation support, one is trying to get ideas across that commercialisation gap. Innovative businesses will be stepping up to be involved in that, and that is not quite the same as business support. It is



HOUSE OF COMMONS

supporting ideas that the businesses involved may want to be using, but it is also benefiting that pool of knowledge.

Q226 **Vicky Ford:** Do you think there is not enough clarity on what the objectives of the innovation policies are?

Professor Dowling: At the heart of it, there is just not enough money going into it in the UK. We have a very strong research base in the UK and we invest in that, whether it is through QR or the research councils and grants. At the innovation side, public investment in that in the UK is smaller than that of our competitor nations.

Q227 **Vicky Ford:** Is that the public procurement side of the investment?

Professor Dowling: It is a whole range of things. With the 2.4% in mind, the academy recently undertook a study in which it asked, sometimes, the CEOs but, more often, chief technology officers of engineering businesses that invested in innovation what made them choose where they did it in the world. What are the levers? Lots of good things came out. The strength of our research base is one of them, but time and again the lack of public funding to co-invest in innovation came up as an issue. They liked the tax credits but were also looking for direct investment in innovation.

Q228 **Vicky Ford:** Was that in particular sectors?

Professor Dowling: It was looking across engineering, but engineering impinges on a whole range of sectors.

Q229 **Vicky Ford:** In your submission to us you spoke about changes to Innovate UK's core budget and a decrease in the next financial year. What impact do you think that could have?

Professor Dowling: We think that is really serious. It is great that we have investment in the catapults and the industrial strategy challenge fund. Innovate UK is managing some of those, and that is good because Innovate UK has a business focus. Its customers are businesses and businesses should be having influence in that, but up until now Innovate UK has also been there for businesses across all sectors to come up with opportunities for co-funding. That has been squeezed. Therefore, just at a time when we want businesses to be co-investing more in R&D, the open part of Innovate UK's funding is reducing.

Q230 **Vicky Ford:** But is it not because more of that is being given to catapults?

Professor Dowling: Catapults are in very particular targeted areas and they are good things, but we should really be scaling up the whole of the innovation investment that we are making.

Q231 **Vicky Ford:** We are scaling up the whole innovation investment, but you are saying you should keep more of it in a more general fund.



Professor Dowling: What is not clear is how much of the industrial strategy fund is going to innovation at the moment. Because it has taken challenge headings, a lot of it is fundamental research within that challenge area.

The issue with innovation is that once you get to that stage it is inherently more expensive. How do you scale up? You cannot scale up, or even probe the way to scale up, without spending more money than a small lab-based research project, so you need to prioritise. It ought to have a higher level of investment, whereas Innovate UK's budget is small on the scale of the other research councils.

Q232 **Vicky Ford:** The Innovate UK funding pot has gone down. That does not necessarily mean there is less money for innovation, but we do not know.

Professor Dowling: We do not know because the other money is in the pot.

Q233 **Vicky Ford:** Would the recommendation be to try to make sure that the money for innovation throughout is increasing, not decreasing?

Professor Dowling: A very helpful thing would be to have more transparency about TRLs and where the pot is going, and, for something headed "industrial strategy challenge fund," could we have clarity on what type of projects are being funded?

Q234 **Graham Stringer:** It may surprise you, but I have seen a lot of witnesses before this Committee and not once have I heard them say they have too much funding. There is never enough funding.

Is not one of the problems cultural? A study of two or three years ago looked at the success of innovation and businesses around the University of Cambridge. It seemed to indicate that a lot of the success was not the traditional model of getting through the valley of death; it was when businesses had a problem taking the super-clever people out of the laboratories in Cambridge and putting them in the business. They learned about the business and the business learned from the clever people—both benefited. Is there not a cultural problem about getting academics looking at problems as they exist in active businesses?

Professor Dowling: I could not agree more. There are two elements to that. We talk about curiosity-driven research as if it is only pure research and academics dream up the ideas themselves. There is curiosity in all sorts of things. You only have to dangle in front of an academic researcher an interesting problem and they are curious to find the answer to it, and businesses have a huge number of problems. I looked at that in a review I did for the Government a couple of years ago on business-university research collaborations.

I think we have a lack of respect for research that is driven to solve the interesting problems that businesses and industries have. If we break down the barriers and have more mobility between academia and



HOUSE OF COMMONS

industry, we can get some smart brains in industry and academia thinking together about solving things that will have real commercial benefit.

Professor Hall: You are absolutely right that academics have a lot to give to companies and so on, but one of the problems is that maintaining a research programme in a university or institute environment is hard work. Part of it is that most academics do not want to take their foot off the gas of their day job to do that when they do not necessarily understand or know what the rewards will be and what the implications of failure might be in going into industry. One of the reasons for the low uptake of certain mobility grants is that people feel they cannot take their eye off their day job for a second.

Q235 **Chair:** Is that an argument for not doing it?

Professor Hall: Yes. Having some secure core QR funding is one of the ways you could help that to happen.

Q236 **Chair:** To give them a bit more incentive.

Professor Hall: Yes. Project grant funding is essential.

Dr Massey: The culture of academia as a whole is an interesting question. In astronomy and space science we catalogued dozens of examples of people who had done exactly what you describe. They had taken very basic concepts and research out into industry and worked to set up spin-out companies, which is one side of it, but also deployed their ideas to solve completely unrelated problems.

If you take a 100-year timespan, GPS derives from general relativity, and a UK-led expedition to verify that took place 100 years ago next year. At that time no one could have predicted the consequence that we would have smartphones, the just-in-time movement of goods and so on.

Another esoteric example is that the timing of cosmic ray signals was used to improve Scottish railway timetabling. I will not comment on anybody who uses Scottish trains and whether it has made a tangible difference, but the technology was used in that way.

Q237 **Chair:** There was some giggling from the Scottish contingent.

Dr Massey: Exactly. I hesitate to mention it, not having used it recently. I do not think there is an unwillingness on the part of academics to do this, but there is undoubtedly a timing issue. If you have to maintain a higher-risk research profile, teach students and do all the other things you are expected to do, there needs to be some kind of buy-out of time if you want those transfers to happen.

Dr Griffiths: In a nutshell, the institute has a portfolio of pharma partnerships primarily. Those very thorough and robust relationships with pharma partners enable us to take discoveries through to patients ultimately. We have valued the higher education innovation fund in



HOUSE OF COMMONS

enabling us to get capacity in the organisation and train our people. We have a good flow of people back and forth between academia and pharmaceuticals that helps to adjust that cultural expectation both ways.

Professor Dowling: We must not forget the students, particularly the PhD students. The skills they are learning as part of their research are extremely valuable in industry. I understand about academics being pushed for time—I have been there—but, if every PhD student had to spend three months working in industry as part of their PhD to see how their skills were valued and recognised in industry, we would find more of those who had been doing quite esoteric research projects looking at a career in industry rather than perhaps hanging on for an academic post.

Professor Hall: The BBSRC does that; they have to spend three months in industry.

Q238 **Vicky Ford:** I want to hold that idea about PhDs being involved in industry placements. Do they do that in Germany or in other countries?

Professor Dowling: A number of PhDs do that. The ICASE scheme from the research councils, which is only a subset of students, has placements.

Q239 **Chair:** For under-18s?

Professor Dowling: That will vary.

Q240 **Stephen Metcalfe:** I want to go back to the balance of funding and how it is applied. A discussion you hear constantly is about where the balance should lie between the funding of basic research and funding for applied research. Some of the submissions indicate that too much of the funding is going towards the applied end of the spectrum. First, is that your collective perception? Secondly, does it matter? If it does, why?

Professor Hall: I echo the examples from physics. Watching the previous session, there was the sense that the point of research is innovation and translation. In genomics, where I work, I could say that Crick, Watson and Franklin were not really thinking about translating their work. I do not think Fred Sanger, who invented the method of sequencing, thought about the translation of his work. Taking a modern example, Shankar Balasubramanian, who invented the technology used for clinical sequencing, was doing basic research on enzyme kinetics in a chemistry department.

Those people built a multitrillion-dollar industry of personalised medicine. The fundamental point of research is basic understanding of natural processes, certainly in my field. If we do that right, a lot of the problems about how industry would engage with UK scientists would probably be solved.

I would worry if the Government were taking my advice on how much money to put into innovation spending, but, from the other side of the fence, for people working in basic science it is hugely complicated. There



HOUSE OF COMMONS

are many different ways in which you can apply for this money; you have to get different levels of co-funding in different forms from industry. For someone working in that basic underpinning science field, sometimes it is quite intimidating when you feel that your primary job is to make sure your lab keeps its jobs and you can still get the papers out so people fund your grants in the future. Therefore, simplifying that interface would be hugely useful.

Dr Griffiths: I would agree with what Neil just said in terms of protecting the space for that basic research. I thought the examples he gave were brilliant. It is the same in cancer research. The things happening in labs in our institute today will be the things we thank them for in years to come. That space and the funding for it must be protected.

I mentioned that HEIF funding has been incredibly useful. As Neil described, other schemes are quite complicated, and we would welcome some simplification. We recommend that there be some simplification of the ways in which you can connect with opportunities to innovate. Therefore, we want the protection of HEIF and other moneys but also simplification.

Dr Massey: I would not want to come up with the amount of money to be invested in applied research, except that clearly we would regard growth in that as inherently a good thing. However, the fact is that investment in basic research in our area is pretty much flatlining, and has been for about a decade. I talked to the chair of the grants panel last week to verify that for about a decade £29 million in grants has been funded over three years, or about £10 million a year, so there has been a real issue for groups, not least because of inflation in a whole range of areas. Things like estate costs of universities have risen a lot in that time, and it is not very sustainable. For a long time you can run—I suspect this applies to a lot of areas of what you might call basic research—what look and seem to be very targeted schemes. Clearly, those are welcome for the people who access them, but, if you run them at the same time as throttling off the basic research base, at some point you will reach a problem.

Q241 **Chair:** The pipeline will dry up.

Dr Massey: Exactly. One could make the same argument about capital investment where “batteries not included” still applies and is pretty much as it was a decade ago. We see ministerial announcements, welcome as they are, to invest in large-scale international projects and the opening of new centres, and yet, if you talk to the people working in those places, they struggle to recruit the staff they need to make them run.

There are examples in STFC about the operation of its facilities that are quite well documented. If you look at its annual accounts, they talk about a cutback in the breadth of the programme of about a third over the past decade. These are serious issues.



It would be unfortunate if we saw the desire to reach the 2.4%, which I do not believe can be achieved without a significant uplift in public funding, happening at the same time as some of the areas where we currently excel are throttled off. That would be deeply regrettable. These are areas of real excellence in the UK; they supply many of the PhD students in industry, which we heard about earlier. About nine tenths of people pursuing PhDs in these subjects will move out into the wider economy, taking their skills with them. If you do not have those areas, you will not see that STEM attractor effect, either; it becomes a less inspirational sector for people.

Professor Dowling: I am not sure whether the distinction between basic and applied is particularly helpful. All research is trying to answer questions; it is just research. In my academy we would refer more to use-inspired research. It just depends on where you are targeting, or where you think your research might end up. To me, a more important distinction is between the research and the development end. If all we do is the research, in a way we are making a great donation to the rest of the world, because we have a strong research base, we publish our results and it is all marvellous, but we have to do more if we are to capitalise on the fruit of that research. That means more development on the innovation side than research.

Q242 **Stephen Metcalfe:** Should UKRI measure this to try to see whether the balance is right, or just let the system get on with it?

Professor Hall: Where to make the distinction is a really good point. I guess there is a potential distinction between investigator-driven research, academic-driven research and industry-driven research, which receive different strands of Government funding. My answer is yes. It is very important we ensure that investigator-driven research is protected at some level. Do not ask me what that should be—I would be biased—but it is important that that is protected. In other countries where it is very heavily based on the pull of industry you see a lot of young people leaving those countries to do research somewhere else, because they want to go to the world-famous labs that are generally doing this kind of underpinning or academic-led research.

Dr Griffiths: UKRI needs to look at it as an ecosystem. We describe the pipeline not drying up. We need to look at the whole picture.

Q243 **Stephen Metcalfe:** I think you are saying that some of the problems people have tried to highlight are being overstated.

Dr Massey: It depends on the problem you are referring to.

Q244 **Stephen Metcalfe:** I am referring to the balance between applied and basic research. I do not sense you are all saying there is a problem with it.

Dr Massey: I think there is, in the sense that the growth in R&D funding and the announced public investment has been very targeted, so that is a



problem with some areas of basic research. The core resource funding within the research councils—at least the ones we deal with—has been fairly flat. That is set against otherwise positive news about the growth in R&D spending, so there is an issue there. Whether that is defined as an issue of balance or whether it is about the point my colleague made about growing the ecosystem as a whole, that is the area to look at. If you talk about growing the R&D budget, that needs to be holistic.

Professor Hall: If the basic research council funding is flat, as it has been certainly for us at best, and there is growth in targeted industrial strategy or GCRF-type money, the net result is that people who were doing basic research tend to gravitate towards the more targeted cause. That will have a long-term effect. In my view there will be fewer fundamental discoveries coming through the system.

Q245 **Graham Stringer:** Dr Massey, you make the case that astronomy has lost out in funding. Will you explain how that has impacted on Greenwich Royal Observatory?

Dr Massey: That is a very specific point. I used to work there a long time ago. It is currently a public engagement establishment anyway, so it does not do much in the way of what you describe as core research. If you take the field as a whole, which is probably more pertinent, the issue is simply that there is a throttling off of the number of postdoc numbers and the time academics can spend doing that core research, because the way the grant programme works is that academics are given a kind of buy-out. They are supposed nominally to spend a certain amount of time doing research, and the grants they receive are supposed to cover some of that time. What we see is a diminution in that. From STFC, it is down on average to around 15% of their time, which is barely sustainable. If you think that 15% of your week is being spent on this kind of activity, it is very difficult to deliver very much within that.

As for the impact on somewhere like Greenwich, there are innovative people there who look for exciting ideas. There is no shortage of those coming through and, given it is a very international science, they have plenty of material to draw on. However, if it looks like a less healthy field to go into—say, you are considering your options at school, or you are even looking at it as an undergraduate student—you will see a fall-off in that.

At the moment undergraduate numbers are very healthy. If anything, they are booming at the moment; they were up 18% in astronomy over the past year on the basis of the figures we have. That is not the issue. My worry is about people coming into the field. There are fewer PhD places and we see a throttling off of ideas, so people just take their ideas elsewhere. If you want to inform innovation, having a cadre of very highly skilled and highly talented people coming through the postgraduate system is a very good way to do it, because we all understand that the majority of those people move out into wider industry.



HOUSE OF COMMONS

Q246 Graham Stringer: The predecessor Committee to this one looked at both the funding of particle physics and astronomy since PPARC was abolished. Do you share the previous Committee's view that that funding was the main source of the problem, and that that funding, in both capital and revenue, has never been replaced?

Dr Massey: I think that is fair. Since the financial crash it has been flat. Astronomers are extremely good at going out to European sources and substituting that, if you like. About 30% of the resource funding they now get comes from places like the European Research Council, and there is an obvious worry about what happens if after 29 March of next year that is switched off. It probably does still derive from the abolition of PPARC, even though it was a decade ago.

Q247 Graham Stringer: When Paul Nurse looked at setting up UKRI he noticed, as we did, that the proportion of funding to each of the research councils had stayed constant for a long time, whereas particle physics and astronomy, because their research council had been abolished, had lost out. In the new system, do you see any signs that any of that lost funding will be replaced? In the world of science funding is it still a live issue?

Dr Massey: It is very much a live issue. The fact is that the number of postdocs supported is not very sustainable now. We are reaching a crunch point. If you carry on being members of big international programmes, which I think we should, you need to have people who are employed to do the science to exploit those facilities. If you do not have them, you have to argue about what the point of membership of those programmes is. We do not want to be members of the European Southern Observatory and European Space Agency and support budgets for things like Gaia to map a billion stars in the galaxy and massive working data science but not be able to exploit them.

We now see the benefits of making some of those decisions well over a decade ago and see the science flowing from that. My worry is that now we are hosting the headquarters of the Square Kilometre Array, which is a fantastic global radio observatory. This will require many times the current internet traffic to work, yet you can see a situation where UK groups cannot exploit that properly.

Q248 Graham Stringer: The second part of the question is: do you think the new structures will mean that the live issue of historical unfairness of funding will be rectified in any way?

Dr Massey: It is early days. Without growth at least to keep it in line with that overall ecosystem and seeing that kind of reasonable shared growth in investment, I do not think the problem will go away.

Q249 Chair: You are not clear as to whether the new structure will be enough.

Dr Massey: We have not had clear messages on that, other than that because of the nature of the industrial strategy, as you would expect,



HOUSE OF COMMONS

fundamental research does not get mentioned anything like as much as applied research, for want of a better word, without wishing to open up that conversation again.

Q250 Darren Jones: I am conscious of time, so I am going to assume everybody agrees that the reduction in spending on capital from £1.2 billion 10 years ago to £340 million now is a bad thing. I am going to ask for specific recommendations to this Committee on what more we can do to evidence and enhance the output of capital spending in comparison with the amount of resource spending that goes in. How do we make the case for capital spending?

Professor Hall: There is the UKRI roadmap. The research infrastructure being devised at the moment is a really positive thing. Looking ahead 10 years and seeing what new infrastructure we may require, making sure there is no redundancy and it is used efficiently, is a positive thing.

There have been positive steps in the UKRI initiating that. That is one of the first things that has happened. It is being put together very quickly, which is worrying in a way, but my recommendation would be that that is used for financial planning and that a budget is put aside, for want of a better word, to support that. At the moment, as a core funded institute a lot of the infrastructure comes in dribs and drabs of money that is left over in the financial year. That makes it very difficult to plan, to be strategic and to spend that money efficiently. Lots can be done to improve that.

Professor Dowling: We find that capital investment is a very sticky form of public investment, in the sense that once you have invested in the capital it tends to attract inward investment and investment from companies on a year-after-year basis. It is a good thing to do.

Q251 Chair: It is sticky in a good way.

Professor Dowling: Yes, but you also need to train people to run it. The catapults have provided quite a good way of being an interface for those who want to use the catapults.

Dr Griffiths: I completely agree that the reduction concerns us deeply. As the recipient of a recent UK PIF grant to develop a new centre for cancer drug discovery within the institute, we can see the power of those capital investments both to give our researchers the kit and space they need to do the work, given advances in technology, but also to attract world-class talent into the UK so that we retain our seat as a global leader, particularly in R&D. In addition to the level of capital and infrastructure to keep the show on the road, which Neil described, the road map and large investments are very powerful and we advocate that they be built into the growth plan for research and investment.

Q252 Darren Jones: It works with the kit you have, so it is an attractive offer.



HOUSE OF COMMONS

Dr Griffiths: Yes. As I am sure all of my colleagues at the table would say, the environment is constantly changing; the requirements of scientists to do cutting-edge cancer research change monthly, let alone yearly sometimes, so creating space that can accommodate that and attract the world's best talent into the UK to focus on our big cancer problems is huge for us.

Q253 **Darren Jones:** To help us illustrate the case, does anybody have an example they are able to share with the Committee where they have not been able to do something because of a lack of capital spending?

Dr Griffiths: We made this case recently in attracting funding. An example would be not having world-class facilities to develop cancer drugs and then to partner appropriately with pharma. Along with our clinical partner, the Royal Marsden, we are one of the world's top four comprehensive cancer centres. Not being able to equip and attract world-class clinical academics, academics and scientists to achieve that ambition and address that research would be another example. Without that, would we be able to retain and attract the world's best talent and do the research we need to? No.

Q254 **Darren Jones:** It is purely a question of talent.

Professor Hall: It is really difficult to say what you did not do because you did not have the infrastructure. It is becoming a greater issue now because of the competition for excellent places around the world where you can do research. You can go to many places in Asia and look at the infrastructure. In my field of genomics, China now has infrastructure that we could not dream of. There are tons of things we could not do because I do not have £1 billion to spend on a whole new institute, but it means that we are trying to compete with the best talent in the world and places that have far superior infrastructure to what we have in the UK. We have other advantages here that are now mainly historical; they are based on legacy rather than what is currently in the UK. It is a good question but a very difficult one to answer.

Dr Massey: If you look at where the UK has exploited capital projects and large infrastructure projects, you will see plenty of examples of small businesses that have tapped into that. There are perhaps not as many as we would like, but that is important and it is an exciting opportunity. It also has reasonably good regional consequences. There is a company in north Wales that specialises in optics and supports the European Southern Observatory. I doubt that it would exist without those ongoing contracts. I am not saying that that on its own is a reason for this kind of investment, but it is an important by-product.

Professor Dowling: In my area, looking at combustion for the next generation of aeroengines, we have good research labs in universities in the UK, but when it comes to the next scale-up we do not have a UK facility that can do that at pressure. Those tests are done in DLR in Germany. That spins off problems. Whenever you do a scale-up of



HOUSE OF COMMONS

something it takes you right back to the fundamentals; it shows things you do not understand. We are currently able to be part of European programmes, but the concern would be that the next ideas for research do not come back to the UK.

Q255 **Chair:** Neil, your written evidence also implied that getting the balance right between revenue and capital is critical, and that sometimes there is a mismatch between the two that makes it harder to implement what you want to do.

Professor Hall: Yes. For reasons I do not fully understand, because the money comes in different flavours we suddenly have several million pounds to spend on infrastructure but no money for people to operate the infrastructure, train people to use it or run projects.

Q256 **Chair:** It needs more joined-up thinking.

Professor Hall: Yes. A good example is synthetic biology, where foundries were set up but there was no money to run projects through them. I do not think that money was used to best advantage. I would not say it was wasted, but so much more could have been generated or derived from it. There has to be joined-up thinking about that infrastructure and the revenue that goes with it.

Q257 **Martin Whitfield:** My question follows on from that joined-up thinking. My questions relate to the charity research support fund. From the evidence of the ICR, we seem to have a capital fund and the charities contribute to individual events. The question is whether there is a mismatch there. I was quite shocked to discover that in your submission you say that the charities fail to provide even for maternity cover cost. You are talking about the very essential people doing the research. Charmaine, what is the significance of the CRSF, and are the charities playing ball with their contributions?

Dr Griffiths: That is a good question. The institute is a proud partner with a number of charities in the UK and around the world. Roughly half our income is from grants. Of that, about 65% comes directly from charities such as Cancer Research UK or Breast Cancer Now. We work with them very closely to ensure we use their money as strategically and effectively as possible.

Understandably, charities and charitable donors want to see as much of their pound going towards direct research as possible, and the constraints on how we use that charitable funding are often on the direct costs of research. What they do not accommodate are any of the costs of running the laboratories, the payment of senior salaries and strategic investment. That leaves a deficit, and it is the charity research support fund that addresses that.

The fund was frozen for a number of years. In balancing the books and making sure we can do excellent research in a sustainable fashion, for us and other similar organisations it means that the value of that fund has



HOUSE OF COMMONS

dropped from 34p in the pound in 2008 to 22p in the pound today. Therefore, we are seeing a significant shortfall before inflationary pressures and other factors. We are lucky that we have other income streams on which we can draw at this point for a period to mitigate that, but that does need addressing in the long term.

You are right. Things like maternity costs fall to the host institutions, as do many of the other day-to-day operating costs. We strongly suggest that the review looks at increasing the value of the charity research support fund, partly because it leverages more charitable funding and partly mitigates the point about helping us make the books balance to do brilliant work, but we can also get really excited about that research and help them use that to leverage more and more charitable funding.

Q258 Martin Whitfield: That is not to say that the contributions people make to charities, and charities then make to research, are not absolutely essential. Better understanding among the public about how their £1 deposited in a box on a shop counter ends up, and a better understanding that research is the coming together of many things—not just the roof over your head or the individual doing the research but the opportunity for colleagues to discuss things—might help to unblock the funding conundrum of having millions of pounds for a lovely laboratory and no one to stand in it.

Dr Griffiths: It is a good point. I think better understanding of the role of research and how it works has to be a good thing.

Q259 Martin Whitfield: It is an easy win-win.

Dr Griffiths: It is something we should be super-proud of in the UK. It is a huge part of who we are and is a fantastic asset to the country. I agree. I understand that when you are running a 10k and fundraising you want the money to go directly to the research. That is why we would invite UKRI to look at the ecosystem and how we make the books balance across all funding sources, including charitable, industrial and Government. How we do that together is a very important question.

Q260 Martin Whitfield: It is a great opportunity.

Dr Griffiths: It is a great opportunity.

Q261 Bill Grant: Charmaine, the charity research support fund has diminished; it has significantly less value. It is becoming clear that charities are filling that gap. How sustainable is that? When money has been diverted to prop up the lack of funding, what element of your desired research is losing out as a result? How sustainable is that in the long term?

Dr Griffiths: That is the question. We talked in the previous session about the squeeze on funding in a number of situations. We are feeling that, because the business of doing viable and sustainable world-class research is becoming increasingly challenging. Charities clearly have a



HOUSE OF COMMONS

role to play. We are hugely grateful for the funding we get from our charitable partners and all the people who support them.

Q262 **Bill Grant:** Is it about 50%?

Dr Griffiths: Half of our funding is grant funded and 65% of that is charitable. We also have our own in-house charitable activity. We have brought in between £13 million and £16 million from our own charitable efforts this year. We work very hard at that because it helps us to balance the books. It is part of the equation for us, but it is increasingly challenging, increasingly competitive and the environment is increasingly tough.

Your question is a good one. What suffers? Increasingly, as we struggle to make all the pieces of the jigsaw fit we lose some of the strategic view as a sector. That is why we would encourage this opportunity for growth in terms of the increase in GDP to make the system work in a holistic way rather than particular spots. This review is so important because without that holistic view I am not sure we can make it sustainable.

Q263 **Bill Grant:** You need to complete the jigsaw—we cannot do it with a part-finished jigsaw—and that takes cash.

Dr Griffiths: Exactly.

Chair: Thank you all very much indeed. We appreciate your time. Thank you for your patience.