RUSSELL GROUP

Becoming a science superpower: setting a trajectory to £22bn by 2024/25

Summary

- The UK's research-intensive universities, businesses and other research-performing organisations have a key role to play in supporting a rapid economic and social recovery from the Covid-19 pandemic. Capitalising on and scaling up the UK's R&D strengths will generate scientific discoveries and novel technologies, boosting economic growth and productivity, and helping spark prosperity in towns and cities across the country. It will also be vital in ensuring the UK's future resilience in the face of climate change and meeting the net zero target.

- Achieving the Prime Minister's ambition for the UK to become "a science and technology superpower" and ensuring we can sustain strategic advantage through science and technology, will require significant public as well as private investment. We therefore welcome the Government's commitment to increase public spending on R&D to £22bn per year by 2024/25. This is one of the most significant moves made by any UK government to back our science and ingenuity.

- We encourage the Government to use the forthcoming Spending Review to set out how these increases in investment will be achieved, recognising the need to deliver value for the taxpayer and positive economic, social, environmental and health impacts across the whole country. This should include a trajectory to 2024/25 with clear annual investment milestones to track progress against the Government's commitments.

- **We recommend the Government builds the investment needed to reach the Government's £22bn commitment in a consistent and predictable way, cumulatively adding £2.37bn extra to the baseline research and innovation budget in each year between 2022/23 and 2024/25.** This "linear" investment model would deliver a range of benefits for the UK compared to a "hockey stick" model, which would involve backloading the additional investment with less in the early years and more at the end of the period. The benefits of the linear model include:

    - **Leveraging in more private investment earlier**: a linear model would deliver **more than double the amount of private investment over a three-year period** compared to a "hockey stick" model (£5bn vs. £2.1bn respectively), and £5bn more private investment up to 2027/28. This means the benefits for the UK's economy and citizens will be felt sooner.

    - **Setting the UK on a course to meet its target to invest 2.4% of GDP in R&D** and to better compete with other research-intensive industrialised countries, which will be key to maintaining strategic advantage in science and technology.

    - **Improving our ability to fund the UK's R&D priorities** and realise the benefits more quickly for UK citizens and the economy.

    - **Enabling the UK's R&D sector to effectively plan** for scaling up research and innovation activity and to do so most efficiently.

- In a series of accompanying briefings, we will set out our thinking on where the additional R&D funding within the £22bn envelope could be applied to deliver the greatest return on investment.

1. Why prioritise investment in R&D?

1.1 The UK undoubtedly has one of the best research systems in the world[1] and the exceptional nature of British capabilities in research, technology and innovation across a range of disciplines has been demonstrated through the scientific response to Covid-19. Research-intensive universities have been critical to developing vaccines, virus treatments, ventilator technologies and outbreak simulation models, amongst numerous other areas. This is reflected in the Government's new Vision for Life Sciences, which rightly highlights the leading position of UK universities.[2]

1.2 Achieving the Prime Minister's ambition for the UK to become "a science and technology superpower" and ensuring we can sustain strategic advantage through science and technology, will require significant public investment.[3] We therefore welcome the Government's commitment to increase public spending on R&D to £22bn per year by 2024/25.[4] This investment will be crucial in enabling universities, businesses and a range of other stakeholders to support a rapid economic and social recovery from the Covid-19 pandemic, generating scientific discoveries and novel technologies and helping spark prosperity in towns and cities across the country. In particular:

- **Investment in public R&D is crucial in stimulating private R&D investment**. Analysis for BEIS shows each £1 of public R&D stimulates between £1.96 and £2.34 of private R&D in total, with the 'leverage effect' beginning in the same year.[5] Public investment is particularly important in high-risk, high-reward basic research which can lead to genuine technological breakthroughs but is often too risky for businesses to invest in without public backing.

- **The economic benefits of R&D investment in universities are clear**. For every £1 of public research funding they secure, our research-intensive universities deliver an average return of £9 to the UK economy.[6] This includes the direct impact of university research and the impact of productivity spill-overs associated with their R&D. The strength of the UK's science base has also been critical in attracting inward investment in R&D, with Merck, GSK, AstraZeneca and others choosing to invest billions in their facilities in this country.[7]

- **Boosting our world-class science base will also be essential in seizing opportunities to confront grand challenges such as climate change – helping achieve the ambition for net zero carbon emissions by 2050 – and an ageing society**. The breadth and depth of expertise in the UK's world-class universities means that there are few research and innovation challenges that they can't tackle with the right support and demand. Universities can bring together science, technology, design and social science thinking to tackle challenges from all angles. Capturing the opportunities presented by AI, for example, requires a multi-disciplinary approach to the application and governance of data use bringing together social and data sciences, while

[1] With only 3% of the world's researchers, the UK produces 7% of the world's publications and 14% of the world's most highly-cited research.
[2] Life Sciences Vision (2021)
[3] Build Back Better: Our Plan for Growth (2021); Global Britain in a Competitive Age: the Integrated Review of Security, Defence, Development and Foreign Policy (2021)
[4] At the March 2020 budget, the Chancellor committed to invest £22bn in R&D by 2024/25 and this commitment was reiterated in the Government's R&D Roadmap published in July 2020.
[5] 'The relationship between public and private R&D funding', BEIS Research Paper Number 2020/010
[6] The economic impact of Russell Group universities (2017): https://russellgroup.ac.uk/news/economic-impact-of-russell-group-universities/
[7] 4 For example, Merck is planning to build a £1bn UK hub including research laboratories and GSK is launching a £10m UK AI hub. Previous investments include AstraZeneca's £330m strategic R&D centre and global headquarters in Cambridge.

decarbonising the economy requires a multi-faceted approach with climate scientists, engineers, policy and behavioural experts working in tandem to effect change.

- **Investment in blue-skies research leads to the spreading of innovation into the economy.** Major advances can often be traced back to fundamental research where the applications could not have been foreseen at the start. Lasers, DNA, genetics and magnetic resonance imaging are a few examples where there are a growing range of applications in everyday use. R&D is a crucial component in delivering innovation in industry, with universities providing knowledge and technology to enable companies to develop new products, processes, and services. Universities work with businesses big and small to provide access to research, facilities and trained manpower. Having access to high quality human capital within universities and engaging with research is essential for firms, especially SMEs, to make the best use of advanced knowledge.[8]

- **To ensure future technological advantage for the UK and to deliver on the Government's science superpower ambitions, the UK will need to strengthen its research worker pipeline**. This cannot be achieved without significant investment in postgraduate training at university: it will require significantly more places for PhD students and increases in funding should be set aside to support this. Increasing the number of PhD students will also require properly funded undergraduate programmes which adequately prepare students for research and graduate study. Alongside these considerations, efforts will be needed to retain current R&D workers in the field and attract more talent from overseas.

2. Setting a trajectory to £22bn

2.1 In order to make the Government's commitment to invest £22bn in R&D by 2024/25 a reality, the Spending Review will now need to set out how these increases in investment will be achieved. This should include a trajectory to 2024/25 with clear annual investment milestones in order to track progress against the Government's commitments.

2.2 In this paper, we have considered two options for the trajectory to £22bn by 2024/25. See **Annex A** for more information on the assumptions underpinning our modelling.

Model A: a linear model

2.3 The linear model would involve building the additional investment needed to reach the £22bn target in a consistent way, **providing an extra £2.37bn cumulatively each year to the baseline research and innovation budget between 2022/23 and 2024/25**.

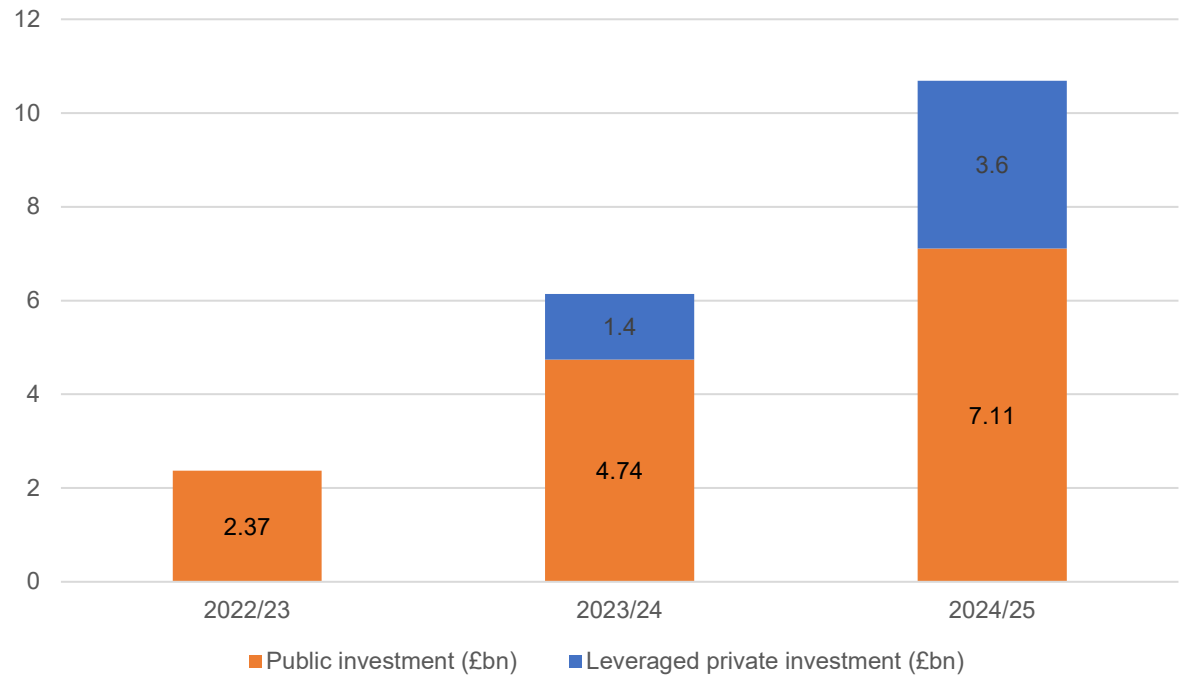
Model B: a "hockey stick" model

2.4 The "hockey stick" model would involve backloading the additional investment needed to reach the £22bn target with **less additional investment in the early years and more at the end of the period**. For illustrative purposes this could look something like an additional £1bn in 2022/23, then £2bn in 2023/24, followed by a sharp increase to over £7bn in 2024/25.

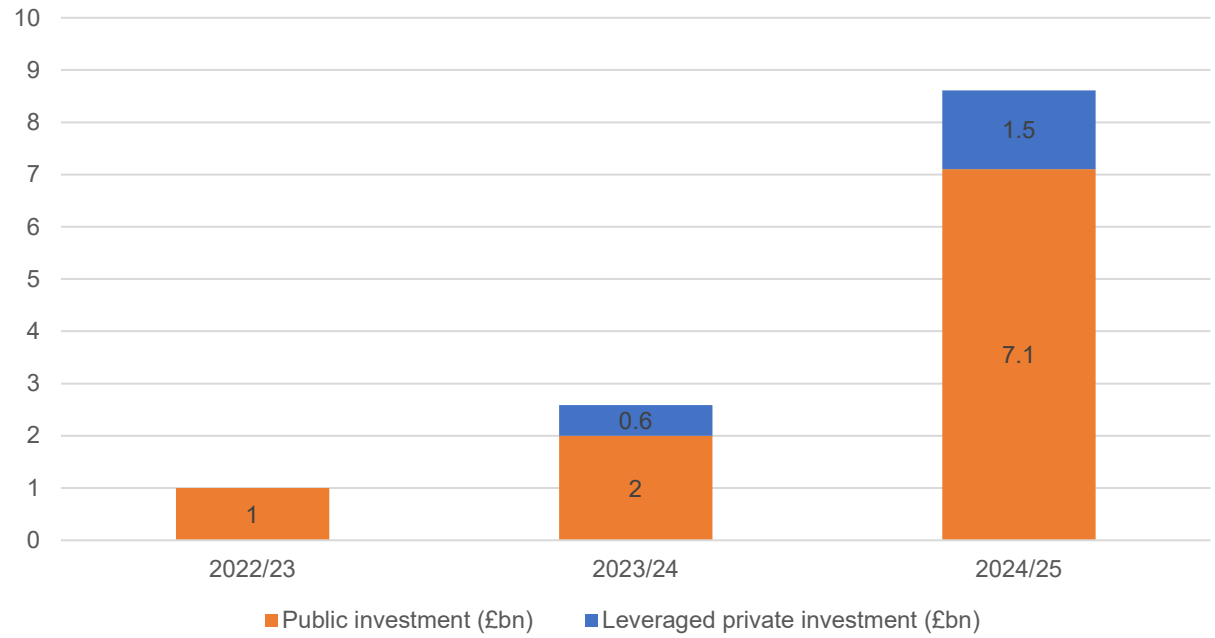
2.5 Graphs A and B below show for each model the effect of the distribution of additional public investment in leveraging in additional private investment.

[8] Value of Research: Policy Paper by the Research, Innovation, and Science Policy Experts (RISE), Luke Georghiou (2015)

Graph A: linear model



Graph B: "hockey stick" model



2.6 Graphs A and B show that a linear increase of an extra £2.37bn in public R&D spending added to the baseline each year from 2022/23 to 2024/25 would leverage in more private investment and do so more quickly than a "hockey stick" approach, meaning the benefits for the UK's economy and citizens will be felt sooner. **By setting a linear trajectory to invest £22bn in R&D by 2024/25, the Government could expect to leverage more than double the amount of private investment over a three-year period compared to a "hockey stick" model.**

2.7 **Table 1** below shows the short- and longer-term benefits of a linear compared to a "hockey stick" investment model. As well as delivering an extra £2.9bn of private investment over the three-year period to 2024/25, a linear model would also leverage more private investment up to 2027/28. Whilst a "hockey stick" model would deliver £24bn in additional private investment over the next six years, **a linear model would deliver £29bn – over 20% more private investment up to 2027/28**.

Table 1 – the effect of the distribution of additional public investment to 2024/25 on leveraging in additional private investment and improving the UK's R&D intensity

Total public investment of £22bn by 2024/25	**Linear trajectory**	**Hockey stick trajectory**	**Difference**
3-year leveraged private investment (2022/23 to 2024/25)	£5bn	£2.1bn	**+£2.9bn**
6-year leveraged private investment (2022/23 to 2027/28)[9]	£29bn	£24bn	**+£5bn**
R&D intensity by 2024/25[10]	2.34%	2.26%	**+0.08%**

2.8 In addition, we estimate that a linear trajectory would improve the UK's R&D intensity more quickly (standing at 2.34% in 2024/25 compared to 2.26% for a hockey stick model).

3. The benefits of a linear trajectory to £22bn

A linear model leverages more private investment earlier

3.1 As noted above, a linear increase of an extra £2.37bn in public R&D spending each year from 2022/23 to 2024/25 would leverage in more private investment and do so more quickly than a "hockey stick" approach meaning the benefits for the UK's economy and citizens will be felt sooner. The difference in private investment between the two models can be seen from 2023/24 onwards and will continue long after 2024/25.

3.2 Economic Insight finds that an extra £1 of public funding gives rise to an increase in private funding of between £1.13 and £1.60 (giving a mid-point of £1.36). The study finds that the majority of private expenditure occurs within the first five years from the public investment (£1.28 out of £1.36), with the remainder accruing over the following five years.[11]

3.3 It is also likely that setting a trajectory for public investment in R&D which involves committing to substantial spending earlier in the period 2022/23 to 2024/25 will provide greater certainty to business around the Government's intentions than a model which involves ramping up investment later on. This should improve business confidence,

[9] This assumes continued increases in public investment following 2024/25 at a similar rate for both the linear and "hockey stick" models with total public investment reaching £23bn by 2027/28 in both models.
[10] This is based on an estimated GDP of £2,528bn in 2024/25 in line with the OBR March 2021 update.
[11] Economic Insight (2015)

especially critical following the negative effects of the pandemic[12], with the potential to leverage in even more private investment.

3.4 Our modelling suggests that a linear trajectory to £22bn (Model A) will also result in private investment making up a greater proportion of the UK's total R&D spending over time. Under Model A, by 2024/25, 63% of the UK's R&D activity would be funded by private sources compared to 61% under Model B (the "hockey stick" approach). This would serve to bring the UK more into line with our international competitors where around two-thirds of R&D is undertaken by the private sector.[13]

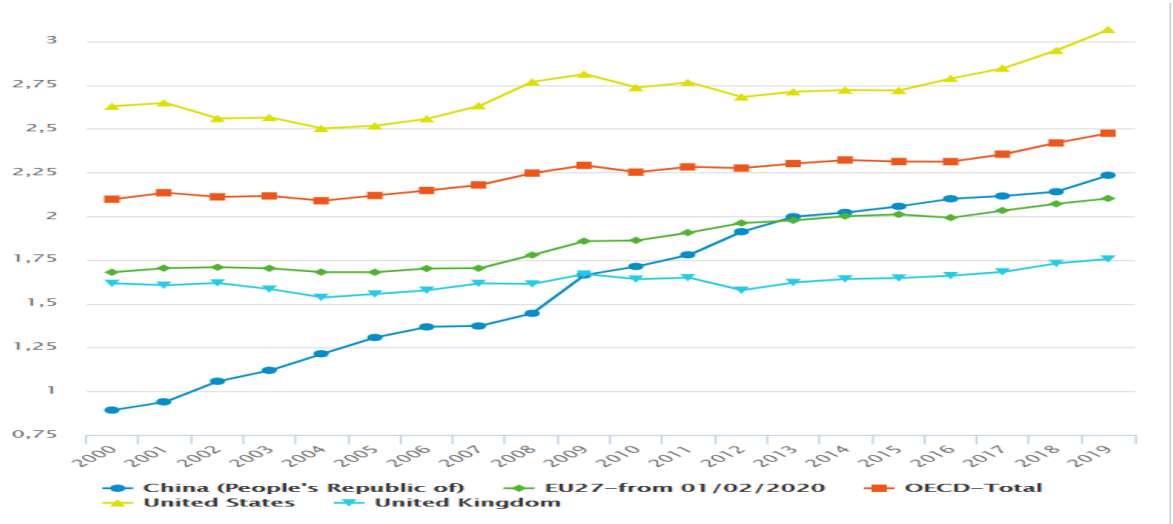
Reaching 2.4% sooner would help the UK keep pace with competitor nations

3.5 The linear trajectory to £22bn (Model A) would set the UK on a course to meet its 2.4% target early and put it on track to better compete with other research-intensive industrialised countries, which will be key to maintaining strategic advantage in science and technology.

3.6 For many years, the UK has lagged behind competitor nations in R&D intensity. The latest figures show the UK's R&D investment equivalent to 1.76% of GDP in 2019 is well below the EU27 and OECD average (both 2.47%) and below European countries such as France (2.19%), Germany (3.18%), and other major research economies such as the USA (3.07%) and Korea (4.64%).[14] See **Graph C** below.

3.7 Our international competitors are seeking to build on this advantage, investing to increase their R&D intensity further. In the USA, for example, the Biden administration recently proposed the largest-ever increase in non-defence R&D spending. China's spending on R&D has climbed steeply, reaching a record high 2.4% of GDP in 2020 and is targeting annual increases of 7% or more in each of the next five years.[15]

Graph C: R&D intensity in the UK vs OECD, EU27 and selected other countries, 2000-2019[16]



[12] The National Centre for Universities and Businesses found in May 2021 that more than 80% of businesses reported research and innovation activities were negatively affected by Covid-19 according to survey of 500 businesses. More than a quarter (28%) of these businesses cited insufficient government funding to leverage university collaborations as a key reason for making changes to projects, activities and interactions with universities.
[13] Of the world's top 15 R&D spenders, the average share of R&D expenditure by business (as opposed to public sources) is 67.9%. Unesco Institute for Statistics
[14] OECD, Main Science and Technology Indicators, March 2021 release
[15] https://www.sciencemag.org/news/2021/03/china-announces-major-boost-rd-plan-lacks-ambitious-climate-targets
[16] OECD, Main Science and Technology Indicators (2021)

3.8 In the Integrated Review[17] the Government set out its ambitions to become a scientific superpower and maintain strategic advantage in science and technology with a goal to remain at least third in the world in relevant performance measures for scientific research and innovation, having established a leading edge in critical areas. To reach this goal, the UK should aim to reach 2.4% R&D intensity ahead of 2027/28 given so many of our competitors have already achieved this and will keep investing to improve their R&D intensity over the coming years. Setting a linear trajectory to invest £22bn by 2024/25 would take the UK to an R&D intensity of almost 2.4% by 2024/25, with an expectation that this would continue to increase in the following years to help keep pace with our competitors.

Greater ability to fund the UK's R&D priorities in 2022/23 and 2023/24 and realise the benefits for UK citizens and the economy

3.9 By spreading the additional investment needed to reach the £22bn target evenly between 2022/23 and 2024/25 (Model A), there will be a greater opportunity to capitalise on the UK's R&D strengths earlier. This will mean research and innovation can be translated into tangible benefits more quickly for citizens right across the country and for the economy, helping to create a fairer, greener, healthier and more prosperous Britain.

3.10 This could mean, for example, enough public investment would be available to scale up blue skies research which is vital to the creation of new knowledge and discoveries which lead to transformative innovation. This could be coupled with additional support for the commercialisation of research through university-business collaboration schemes with a proven track record of boosting innovative activities with local businesses and supporting the development of regional innovation ecosystems across the country.

3.11 Another priority is likely to be the need to boost international collaboration to address the shared global challenges we face and maintain the UK's global competitiveness. Committing to a linear trajectory to reach £22bn by 2024/25 would help to ensure a long-term commitment can be made to the UK's association to the Horizon Europe programme, enabling us to maintain strong mutually beneficial research relationships with EU member states, as well as boosting the UK's international research collaboration activity outside Europe alongside the new trade agreements being struck.

3.12 There would also be opportunities to invest in other Government priorities including the new Advanced Research & Invention Agency (ARIA), the National Institute for Health Research (NIHR), the Strength in Places Fund, and commitments to be made in the forthcoming Levelling-Up White Paper, for example.

A linear planned approach to investment would best support the scale up of research base capacity

3.13 In order to achieve the Government's ambition for the UK to become a science superpower, universities, businesses and other research-performing organisations will need to work to collectively scale up research base capacity. Securing staff with the appropriate qualifications and experience as well as ensuring equipment and facilities are available with the required capacity is a complex and long-term endeavour. As there is a relatively long training period for people to become R&D workers, an increase in the recruitment and training of postgraduate research students will be essential to build a strong research base, meaning we need to start increasing investment in this activity now.

[17] Global Britain in a Competitive Age: the Integrated Review of Security, Defence, Development and Foreign Policy (2021) https://www.gov.uk/government/publications/global-britain-in-a-competitive-age-the-integrated-review-of-security-defence-development-and-foreign-policy

3.14 Pursuing a linear model to reach £22bn of investment in R&D by 2024/25 would provide consistency and predictability for research-performing organisations, enabling the UK's R&D sector to effectively plan for scaling up research and innovation activity and do so efficiently.

4. Conclusion

4.1 Public spending is vital in boosting business confidence and crowding in the private investment in R&D which the UK will need to achieve a rapid recovery from the pandemic. A linear approach to reaching the £22bn commitment by 2024/25 would help to unleash the potential of the UK's research-performing organisations, including our world-leading universities, to deliver on the Government's ambition for the UK to become a science superpower and to maintain strategic advantage in science and technology.

4.2 To make the Government's ambitions a reality, the forthcoming Spending Review should set out how the increases in public investment will be achieved with a clear trajectory to 2024/25. Delivery of this commitment is essential if the UK is to catch up and keep pace with its international competitors and realise the economic, social and health benefits of increased R&D activity, maximising opportunities for a rapid innovation-led economic recovery. Moreover, this public commitment is a global signal to business and other investors that the UK is open for business.

4.3 To meet the Government's ambition to reach 2.4% of R&D intensity by 2027/28 and to enable us to compete more effectively with the rest of the world, additional public *and* private investment will be required. Other R&D intensive countries have been willing to make significant public investments and are reaping the benefits. The need to invest in people and ideas to support a rapid recovery and improve prosperity for all UK citizens has never been more urgent.

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Annex A: Modelling assumptions

- Public investment baseline in R&D at £14.9bn (2021/22 BEIS R&D budget allocation)[18]
- Private spend in R&D increases in line with GDP (using OBR forecast March 2021) from 2018 GERD figure[19]
- Leveraged private investment based on an economic leverage ratio of £1 of public spend yielding £1.36 of private spend over a ten-year period[20]

[18] BEIS research and development (R&D) budget allocations 2021 to 2022 (May 2021) https://www.gov.uk/government/publications/beis-research-and-development-rd-budget-allocations-2021-to-2022/beis-research-and-development-rd-budget-allocations-2021-to-2022

[19] OBR Economic and fiscal outlook (March 2021) https://obr.uk/efo/economic-and-fiscal-outlook-march-2021/

[20] Economic Insight. 2015. "What is the relationship between public and private investment in R&D?" https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/438763/bis-15-340-relationship-between-public-and-private-investment-in-R-D.pdf
and BEIS Research and development: relationship between public and private funding (July 2020) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/897470/relationship-between-public-private-r-and-d-funding.pdf