Towards an 'MIT' for the North: A Modest Proposition

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December 2019

Summary

- The UK as a whole has a productivity problem and needs to raise its game in term of investment in and exploitation of technology, where it has been dropping behind international competitors.
- The most successful and dynamic parts of the UK are currently clustered around key centres of science and technology research – eg Cambridge.
- The North of England led the way in global innovation and development of application of science and technology in the past and still has rich innovation assets and expertise – *a slumbering giant*
- However, levels of public sector (and private) sector R&D are well below the average and far behind to so-called golden triangle.
- A major injection of new pump prime government money to transform level of R&D and innovation in the North and so the UK as a whole is needed to wake up this slumbering giant and raise the North's and so the UK's productivity and contribute to the overall UK target of raising R&D levels.
- This would require strong place based concentrated investment in the North, coupled with strong networks and linkages to existing institutions and assets.
- The once in a generation sustainable long-term annual investment of £10 to £20 billion over a decade would create a new innovation institution to, in due course, rival MIT
- The new institution would need a core endowment to ensure longevity and political resilience but could be expected to attract very significant private sector and philanthropic contributions.
- This is a mould-breaking proposal and its full benefits, like an investment such as HS2, would materialise over the longer term. An annual £2 billion per annual R&D boost via *a "MIT" for the North* could see between a £ 4 billion up to potentially a £11 billion per annum boost to the UK's economy, but spatially concentrated in the North – helping boost overall UK economic performance and bridge the gap between north and south.

1 The Opportunity

1.1 The North of England was the cradle of Britain's Industrial Revolution. Its universities played a leading role in 20th century science. In 1917, the Nobel Prize winner Ernest Rutherford became the first person to create an artificial nuclear reaction in laboratories at Manchester University. Alan Turing worked at Manchester after the war, where, on 21 June 1948, Tom Kilburn built and successfully operated the world's first stored programme electronic computer, later founding a Department of Computer Science[i]. At Liverpool University, Nobel Prize winner James Chadwick, who discovered the neutron in 1932, built one of the earliest cyclotrons, later leading the British team that worked on the Manhattan project.

1.2 In spite of under-investment in industry, de-industrialisation on an unprecedented scale since the early 1980s and a relative concentration on government-funded R&D elsewhere, the North retains a major base of science and innovation. Research carried out for the Northern Powerhouse has identified a raft of economic strengths and innovation capacities of national and international significance[ii]. These include four "prime capabilities": **advanced manufacturing**, with a particular focus on materials and processes; in **energy**, especially in nuclear and offshore wind; in **health innovation**; and in **digital**. These are described by the Independent Economic Review as "*international-class assets, expertise, research and businesses that are genuinely distinctive for the North, are highly productive and can compete at national and international scales*".

1.3 However, the North in economic and innovation terms remains something of a "slumbering giant". Productivity levels lag significantly behind the UK and OECD averages and on most measures of innovation there is a substantial gap. This is lost opportunity for the North and its businesses and people. It is also a lost opportunity for UK PLC. There is an opportunity to re-balance the UK's economy and in so doing enhance overall UK productivity and competitiveness.

1.4 The North has strong research capabilities across our Universities and research institutions. But overall, as we note below, government funded R&D activity is well below par in the North. A strong knowledge base is a critical component to economic success as is the absorptive capacity of the economy to exploit ideas. The North has a large and diverse economy to absorb and develop ideas and a still strong manufacturing base. There is a need to invest in the innovative capacity of the North to unleash this potential. This paper argues for:

- An unprecedented increase in the investment in levels of R&D in the North, particularly in translational research[1];
- Focusing this investment to develop a new world-class capacity in technological innovation that can deliver sort of the step change that the Massachusetts Institute of Technology (MIT) has achieved for the US and for the North East area around Boston.

2 Issues and Challenges

2.1 As a nation we spend much less than others on R&D. In terms of government funding as a share of GDP, for university led R&D Britain comes 20th, behind Switzerland, Denmark, Norway, Sweden, Australia, Austria, Finland, Iceland, Netherlands, Singapore, and many others, spending only 0.24% of GDP. America comes even lower, ranking at 22nd. [iii]. Furthermore the UK's spend on all forms of R&D and as a share of our economy has been declining in relative terms. Over the last thirty years, the UK has slipped from being one of the most research intensive developed economies in the world, to being one of the least[iv]. The Government has committed to meet a target of 2.4% of GDP invested in UK R&D by 2027, and a longer term goal of 3%. This target is unlikely to be delivered through incremental projects and will need a major new institutional focus – and a quantum leap in thinking which will refocus the UKs research effort in the North.

2.2 As well as the average level of R&D intensity declining, R&D activity in the UK is highly skewed. Indeed, perhaps the most profound of the UK's regional inequalities relates to research and science. In a knowledge based economy, science and research are the bed rock of innovation and thus of the economic growth and productivity. A knowledge rich economy can prosper; a knowledge poor economy cannot. Knowledge resides in books, papers and institutions, but most important it resides in people's heads, and is transmitted by personal interaction, especially if the end result is to be applied, as innovation leads to profitable invention.

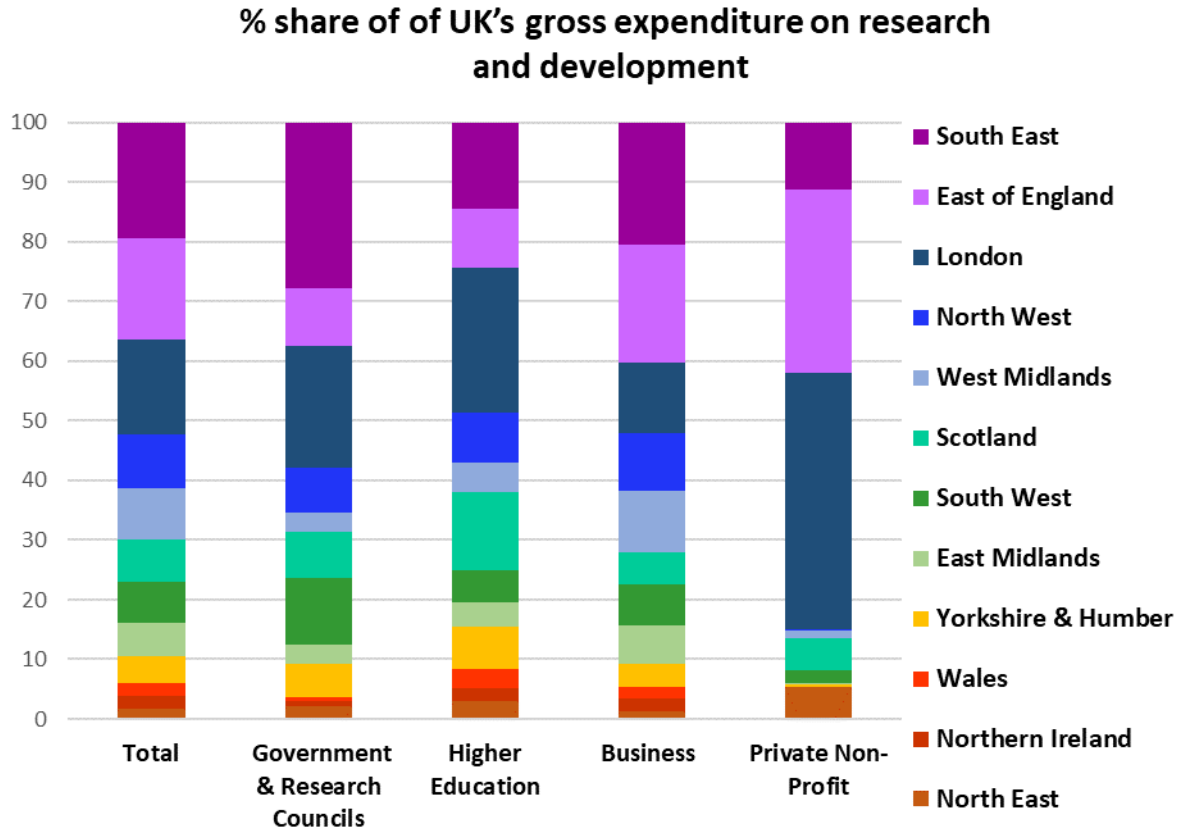
2.3 The distribution of science and research across the UK's regions is highly unequal, R&D carried out by government via its research councils being particularly uneven. Research by Manchester University's Urban Institute[v] (Professor Wong and colleagues) shows over 48% of this expenditure is accounted for by London and the South East and a further 11% by the South West. If we turn to the manufacturing regions the contrast is stark: West Midlands 3.23%, East Midlands 3.37%, North East

[1] A concept developed in medical research to describe the process of taking basic research and translating this into research and clinical outcomes that improve health outcomes

2.19%. Only the North West and Scotland have more than 6% (here however is something to build on).

2.4 The picture is similar in the distribution of higher education research, with over 48% in London, the South East and the East of England, and in the distribution of business R&D, with no less than 52% in London, the South East and the East of England. The picture for business R&D is better in the Midlands which has 10.42%. But it remains poor across most of the North: Yorkshire and Humberside has 3.96%, the North East only 1.23%.

SHARE OF UK'S GROSS EXPENDITURE ON R&D BY SECTOR AND REGION, 2017



Source: Industrial Strategy & Industry 4.0: Structure, People and Place 8 (based on Table 1, page 17)[vi]

The maps in Appendix 1, abstracted from a report by the Professor Wong and colleagues, graphically illustrate the issues.

2.5 There is recent evidence which suggests things may be deteriorating in the peripheral regions to the benefit of the so called 'golden triangle' (bounded by London, Oxford and Cambridge). In 2000 a major decision was taken to base a new 'Diamond Synchrotron' project at the Rutherford Appleton Laboratory in Oxfordshire rather than at Daresbury in Cheshire, which had been home to Britain's

existing Synchrotron. There was further debate in 2008 about the funding of a new light source facility between the Daresbury location and others in the golden triangle[vii]. In 2007 the Francis Crick Institute project to consolidate biomedical research was launched in London and completed in 2016. This has 1,500 staff, including 1,250 scientists, and an annual budget of over £100 million, making it the biggest single biomedical laboratory in Europe. Limited or no consideration was given to a location outside the golden triangle.

The success of the Cambridge - how concentration of research can spur innovation

2.6 Largely by accident, Cambridge has emerged as the part of the UK where the concentration of world class research has coupled with a thriving business sector to create a relatively small but internationally significant area of innovation and growth. The so-called Cambridge phenomenon is well researched and stands out in the UK[viii]. By the 2000s biotechnology was emerging as a formidable part of the Cambridge high technology cluster, caused in part by the development of human genome research as well as high profile engagement with big pharmaceutical companies. Cambridge has benefitted enormously from the location of the government funded Laboratory for Molecular Biology (LMB), established in 1947, where Watson and Crick announced the structure of DNA in 1953. The LMB has had direct long term funding from the Medical Research Council and recently moved into new facilities at the £200 million Addenbrooke Hospital complex.

2.7 An important example of the 'Cambridge effect' is the alliance between Cambridge Antibody Technology, a company which had emerged from the LMB, and the UK pharmaceutical giant Astra Zeneca. In 2014 Astra Zeneca announced the closure of its in house research facilities in North West England at Alderley Park, near Manchester, and a relocation of its research facilities to Cambridge, where it could take advantage of knowledge transfer and alliances with institutions such as the LMB.

2.8 In his statement as Chancellor in 2010 George Osborne announced significant national investment in science. Every major project in Osborne's list was in London and the south: the UK Centre for Medical Research and Innovation (London); Molecular Biology Lab (Cambridge); Animal Health Institute (Pirbright), and Diamond Synchrotron (Oxford).

2.9 Cambridge has been extraordinarily successful at spinning off new high technology companies across a wide range of sectors - although it has often lost promising start-ups to predatory international buyers. John Butterfield, Vice Chancellor of the Cambridge University in 1984 argued that its isolation was advantageous. Amongst the many factors which had shaped Cambridge's

success in high technology business should be counted its relative isolation, and its ' sequestration from industrial society as it has evolved in Britain's cities since the last century'.

2.10 However, it is arguable that the remoteness of Cambridge based science research and innovation within the UK has deprived manufacturing in other regions of the opportunity for interaction with bright researchers and new ideas which have so readily entered the world market. That issue was put into sharp focus for the Massachusetts, USA economy by Professor Michael Best of the Lowell Centre for Industrial Competitiveness:

> '*We run the risk of turning into Cambridge, England: we'll have isolated clusters of the very best university research and a number of small R&D firms but not the downstream production, service and support jobs that make a vibrant economy. We'll create all the new ideas – but others will get too much of the benefit'*.

2.11 Cambridge has certainly excelled at innovation; but largely at one (highly internationalised) model of high end innovation. Like other institutions in the golden triangle it has given powerful leadership – benefitting from its own institutional power and its close connections with powerful people (including its own alumni of course).

3 Models of Innovation and Funding

3.1 In their discussion of the new American policies for Innovation and specifically US Advanced Manufacturing Institutes[ix], William Bonvillian and Peter Singer at MIT identify several models of innovation.

- First is the **pipeline model** – the traditional US approach to provide "a stream of new scientific knowledge to turn the wheels of private and public enterprise[x]
- Second the e**xtended pipeline**. Support is given right the way from front end R&D to demonstration, test bed, and initial market creation, via defence orders. The pipeline bridges what is sometimes known as the 'valley of death' between research and implemented tech.
- Third is the **induced innovation** model. Here technology comes from firms spotting opportunities: the market creates demand and technology is pulled rather than pushed into innovation.
- The fourth model is **manufacturing led** innovation in tech, products and processes. It is a more purposeful version of induced innovation, where industry leads, but with strong government

support. Applied R&D is integrated with manufacturing process. Asian countries including China , Japan, Taiwan, and Korea have used this planned approach. It is a serious gap in USA policy.

- Finally we have i**nnovation organization**. Essentially this is hybrid taking the best characteristics of all the earlier models: it incorporates a pipeline component, extended pipeline component, manufacturing led innovation and support for back end production, going well beyond the extended pipeline model.

3.2 In Germany, the Fraunhofer Institutes are a permanent programme for advanced manufacturing support, with no finance cut off and with long term strategic leadership outside government. The Fraunhofer Gesselschaft supplies overall leadership for the network of institutes with a senate and general assembly representing the 60 institutes. Individual institutes are tasked with carrying out the organization's research work. This provides substantial autonomy, but under central guidance. The scale of funding is notable: German funding is in the order of $2 bn. per annum.

3.3 It is increasingly recognised in the USA that a significant government role is needed in securing innovation, as in Germany and China. In particular, manufacturing institutes need to be joined together in a supporting network with operational autonomy for each institute, but a public private council to oversee broader performance.

3.4 Compared with Germany, levels of funding for R&D in general, and for the new British advanced manufacturing institutes in particular, are very modest. In 2010 the Coalition government provided £200 m to establish seven catapult centres for advanced manufacturing over a four year period (£50 m per annum). In his review of the UK's Catapult Initiative in 2014, Dr. Hermann Hauser called for a £1 billion pa programme by 2020[xi] – comparable with, but much less than, the German programme. The UK government in August 2018 announced a further £780 million investment in the UK's Catapult network. The funding builds on the £180 million investment announced by the Prime Minister for Centres in the North East earlier in 2018, taking the total of additional funding to almost £1 billion over the next five years[xii] . This sounds impressive, but at £250 million per annum is only a quarter of the funding implied by Hauser's 2014 review, and only a fraction of the nearly £2 bn. per annum in Germany[xiii]. A great deal is being done and that is very welcome. But there needs to be a huge shift in volume and quality, with a strong new skew towards the North.

4 The Proposal: Objectives, Funding, Location, Challenges

4.1 To summarise the arguments so far: Britain spends too little on R&D compared with many other advanced countries. In particular it spends much too little on innovation organization and manufacturing led innovation compared with other countries and especially in comparison with Germany. Our national research efforts are overly concentrated in the golden triangle, distant from the North and much of our manufacturing base.

4.2 Although we have some excellent research universities and individual departments in the North, our globally important institutions with scale and mass are largely in the golden triangle. Government research institutes and increasingly private sector research activity are congregating in the golden triangle. The North has been left out in the cold and the opportunity to build on the excellent business base and sectoral strengths is hampered.

4.3 Our proposal for an *"MIT" for the North* is designed to create new a northern institute for science and technology, tackling all these problems and related difficulties, head on. It would aim to create a new globally significant centre for science and technology in the North, able to rival Oxbridge on its own terms just as the new Northern redbrick universities created in the 19th century outshone Oxbridge and woke it from a gouty slumber[xiv]. It could expect to attract very significant contributions from the private sector and philanthropic institutions, both in the UK and internationally.

4.4 We have chosen to call this proposal an *"MIT" for the North* in part to attract attention. However it certainly would not be a carbon copy of the original MIT based in Cambridge, Massachusetts. It would not be simply a new plate glass building, or simply a new university which would compete with existing institutions in the North. It would - like the USA's DARPA model[2] - carry out high level research on its own, pulling in some of the best research professors in the world. It would act as national counterweight to the golden triangle. It would also [be required] to work collaboratively as part of a distributed network sharing funds and research contracts across the North. It would work in partnership with the N8 and other universities, with advanced manufacturing institutes, the private

[2] DARPA (Defence Advanced Research Projects Agency) was created in 1963 to oversee the US space research programme, separating its civilian and military components. Through its support for high risk R&D projects at the frontiers of research, implemented through contracting institutions, it became a crucial driver and funder in the creation of the internet.

sector and with government research institutions [especially if they can be persuaded to relocate, in whole or part, to the north].

4.5 We set out below draft objectives for the new institution:

Prime objectives for the UK/the North

1. To act as a focus for **additional public, private and philanthropic investment** in the UK in research, especially translational research to raise our game internationally
2. To increase **rates of innovation** across the North and so productivity
3. To bring to and retain in the North the **best talent** in the world

Institutional objectives

4. To create a **new endowment-funded world class higher educational institution** in the north focused on science and technology with scale, independence and longevity, which would become equal in status to Oxbridge or the top-flight London universities over the next two to three decades, built on government research and public funding, in tandem with international business and philanthropy
5. To work in a collaborative way as part of a **network** working in partnership with the best of the north's existing universities, research bodies and businesses
6. To distribute and act as the central institution for funding and supporting the north's current and future **advanced manufacturing institutes**, focused on turning new ideas into monetised products, services and processes

4.6 To make all this work would demand long term thinking on a 20-50 year time horizon. It would have to be big. It would need to acquire huge institutional weight. It would require large scale long term and consistent funding, at least on the scale of the funding allocated to the German Fraunhofer Institutes – in the order of £1 to 2 billion per annum. This would give a ten year public funding profile in the order of £10 to £20 billion. This funding would be supplemented by private research contracts, international partnerships and philanthropy. It sounds like a huge sum, but even the upper end is less than a quarter of the current estimated cost of HS2 (£86 bn.[xv]) and in the same order of magnitude as the costs of Crossrail, London's new rail tunnel (£18 bn.[xvi])

4.7 To ensure that the funding is sustained across political cycles there would need to be effective ring fencing, whether by use of endowment funding or, as in the case of the 19th century US

technological universities (including MIT) through grants of land and property[xvii]. Cambridge University is the beneficiary of long term returns from its extensive land holdings.

4.8 We are conscious that there are different models for how such an institution could work. There needs to be a strong spatial focus to ensure cross fertilisation and the place specific development and generation of ideas. This could lend itself to a highly centralised institution in one location. However, equally there is an opportunity and indeed need to work across the North and work with and enhance the excellence that already exists. This points potentially to a more distributed model with outlets or nodes in several different parts of the North.

4.9 Equally, there are different possible models on how it works with other bodies in the North (and elsewhere in the UK). The pure MIT model would be very much a stand-alone institution carrying out the bulk of teaching and reach in-house, albeit one working with others. An alternative model (similar to DARPA) would be where the new institution primarily works with other universities and bodies in the North to contract for research [and teaching].

4.10 Whatever model is followed, it will needs to have its HQ located in a place which is already strong on technology and R&D, with high speed connections to the other northern university cities and to London, as well as international airport connections. It may be beneficial to have a link across to existing educational institutions particularly in the early years of set up – acting as a host.

4.12 We realise that any location decision would be contested and highly political, as indeed would the proposal as a whole if it is if perceived as a threat to existing institutions. There will also be a legitimate debate about whether a similar institution is needed in the Midlands. With the arrival of HS2 the Midlands will be much better plugged into London's research base as well as the rest of the golden triangle. We think that at this stage the north should be the location with a potential second, sister institution, in the Midlands if good progress is made.

5 What Difference Will It Make?

5.1 We conclude by setting out the potential benefits of our proposal, with particular emphasis on the difference it could make to the North.

5.2 *"MIT" for the North* would become a world leading centre for science and advanced research. It would have stability and scale in funding, over long timescales, working in active partnership with, and giving support for, five star rated university departments and others across the North. It would become a focus for attracting and managing national and international private sector and

philanthropic funding on a very large scale. It would be a focus for attracting government and private sector research institutes (within and beyond the UK). And it would be a focus for attracting and supporting Venture Capital funds into northern high technology and business.

5.3 There is strong body of literature on the economic returns from investment in public R&D. A recent review of the wider economic returns in the UK to publicly funded R&D concluded that "recent evidence, looking at how different industrial sectors interact with publicly-funded R&D, has estimated positive and significant social returns of around 20% for UK public R&D investments"[xviii]. The report also confirmed that private sector return on private R&D average around 25% to 30% and that the wider social returns could be 2 to 3 times this (as a result of spillover benefits). Furthermore the report concluded that this estimate is likely to "to understate the economic return to public R&D spending". It is also the case that public R&D spending can lever in international and private R&D spending, estimated by some as "every £1 of public spend leveraging about £1.40 of private spend".[xix]

5.4 This means that at a UK level the return from every £1 invested in public R&D on average could produce a wider economic return of £1.2 as the very minimum, but that the full returns could be as high as £4.5 to £5.0[xx]. So, over time, a £2 billion per annual R&D boost via an "*MIT" for the North* could see between a £ 4 billion up to potentially a £11 billion per annum boost to the UK's economy, but spatially concentrated in the North – helping boost overall UK economic performance and bridge the gap between north and south.

The economic impact of MIT
Research carried out based on contacting the 104,000 living alumni of MIT has identified the major role they play in creating businesses and jobs. As of 2014, the research estimates, MIT alumni had launched around 30,000 active companies, employing roughly 4.6 million people, and generating roughly $1.9 trillion in annual revenues. Around a third of alumni setting up business have done so in the State of Massachusetts itself (compared to 8% of students from there). MIT performs strongly in terms of commercialising its research. In fiscal year 2018, its Technology Licencing Office (TLO) received 822 invention disclosures, filed 425 new US patents, had 360 US patents issued, executed 154 licenses and options, had 32 companies formed using MIT intellectual property. MIT employs around 13,000 staff and in 2018 had total income of $3.6 billion
Source: Entrepreneurship and Innovation at MIT, Continuing Global Growth and Impact, (2015) Edward B. Roberts, Fiona Murray, and J. Daniel Kim, MIT Sloan School of Management and MIT web site

5.5 A northern location should be an important attraction for top professors and leading research students, internationally. Because congestion and the cost of living is much lower in the north it

should offer a better lifestyle and work life balance, with rapid access to the golden triangle and London via HS2

5.6 *"MIT" for the North* would have the potential to supply stable long term funding – on a much larger scale - for the north's advanced manufacturing institutes with strategic direction from above on the German Fraunhofer Gesselschaft model, promoting much stronger connections between thinkers and makers. We would expect to see, over time, substantial spin outs on the Oxford and Cambridge model. Especially in medicine and life science, already recognised as key northern strengths, there would the opportunity to utilise a key challenge and a uniquely important research issue and data base: ill health and relative stability of family cohorts.

5.7 There would be other wider benefits which would not be trivial. *"MIT" for the North* could help to transform the north's international image. It would bring significant and independent institutional power to the north. It would help to utilise and develop key current and future assets – Manchester International Airport, HS2 and Northern high speed rail. And there would be catalytic and symbiotic effects with urban regeneration, sustainable transport and high speed rail, especially in city cores.

Recommendation

6.1 Our recommendation is that government should, in partnership with Northern leaders, develop a firm costed proposal for an MIT for the North, addressing the issues we have outlined in this report, including funding, phasing, location, and the relationships with business, with a particular emphasis on the scope for levering private and philanthropic research and innovation led investment, from international sources including, but not restricted to, China, Europe and the USA.

Appendix 1: Extracts from Wong et al (2019), Industrial Strategy and Industry 4.0: Structure, People and Place

R&D EXPENDITURE BY SECTOR, 2017

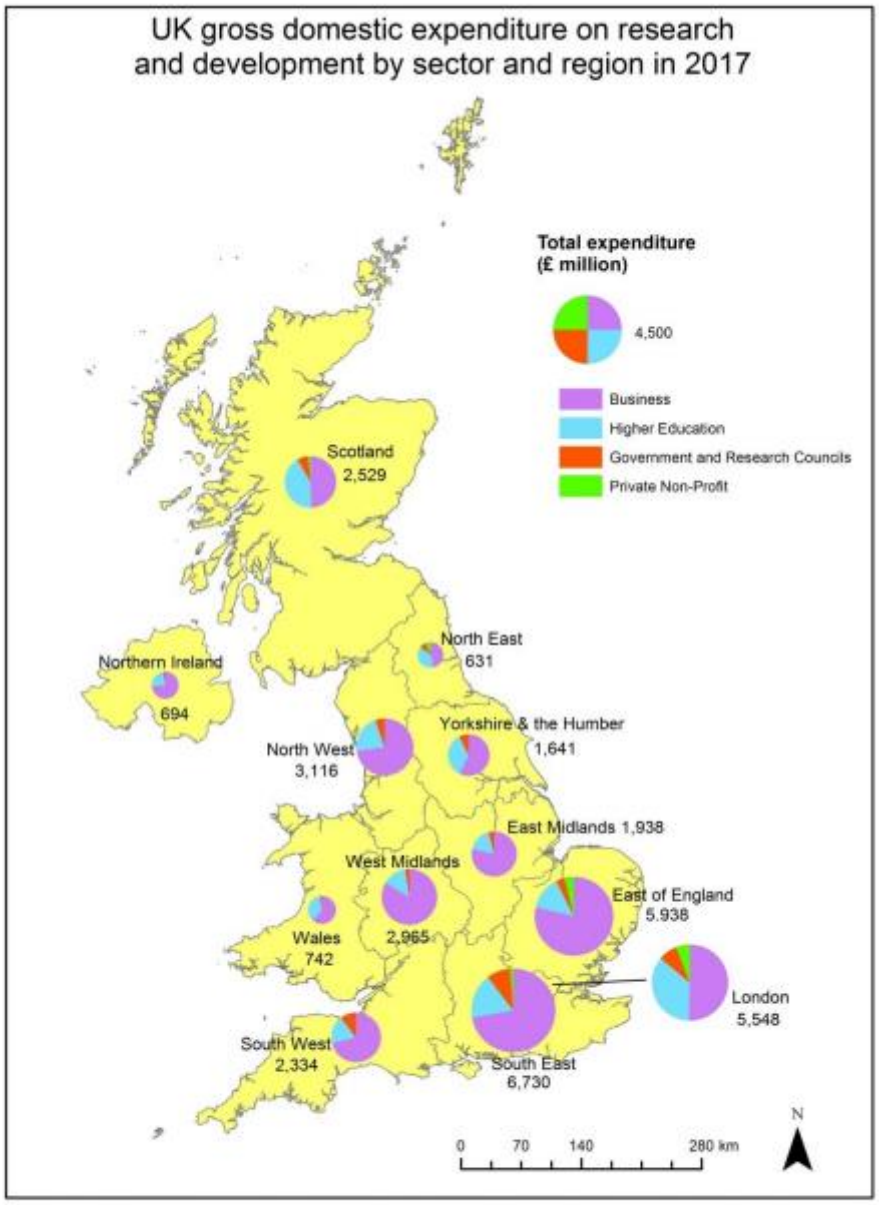


Figure 22 R&D expenditure by sector, 2017

ESTIMATED R&D EXPENDITURE BY NUTS 2 REGION

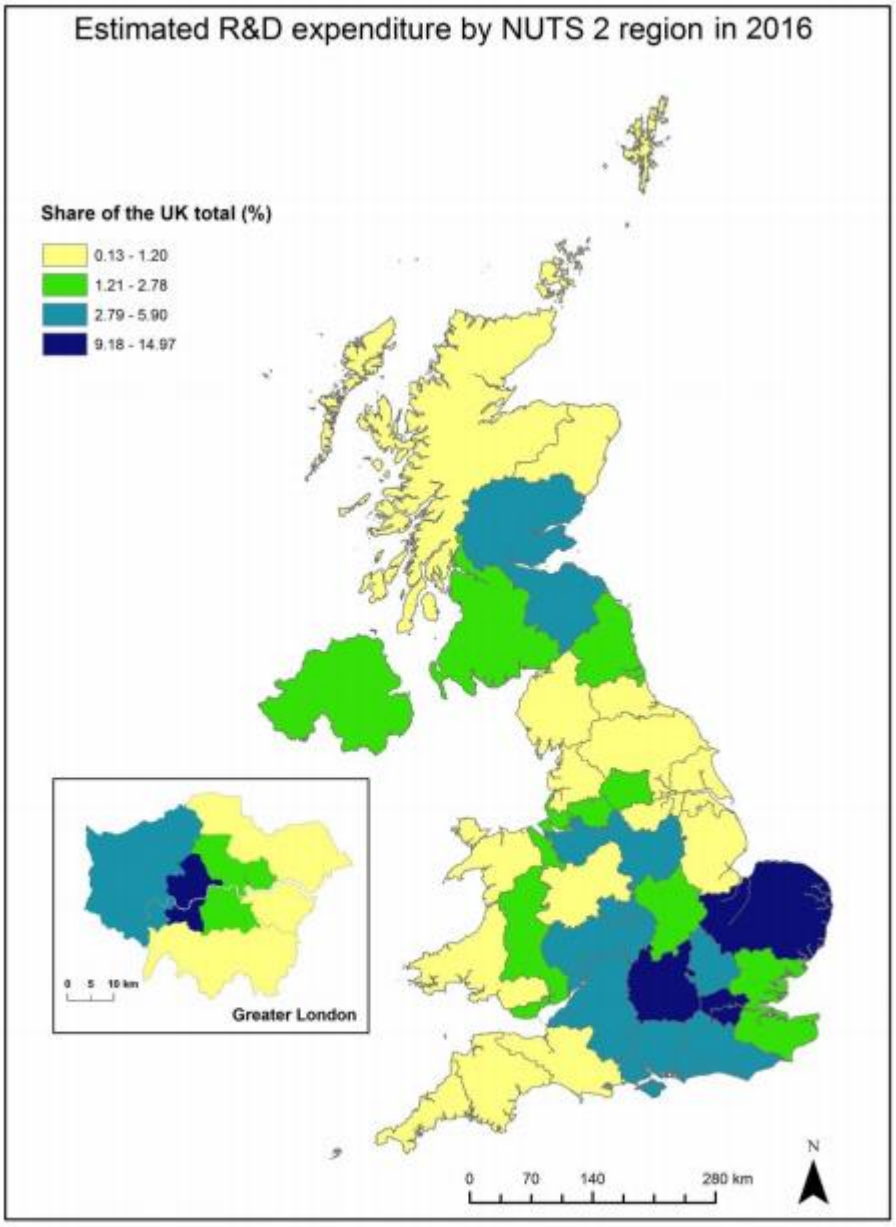


Figure 23 Estimated R&D expenditure by NUTS 2 region

ESTIMATED LOCAL GDP ON R&D EXPENDITURE, 2016

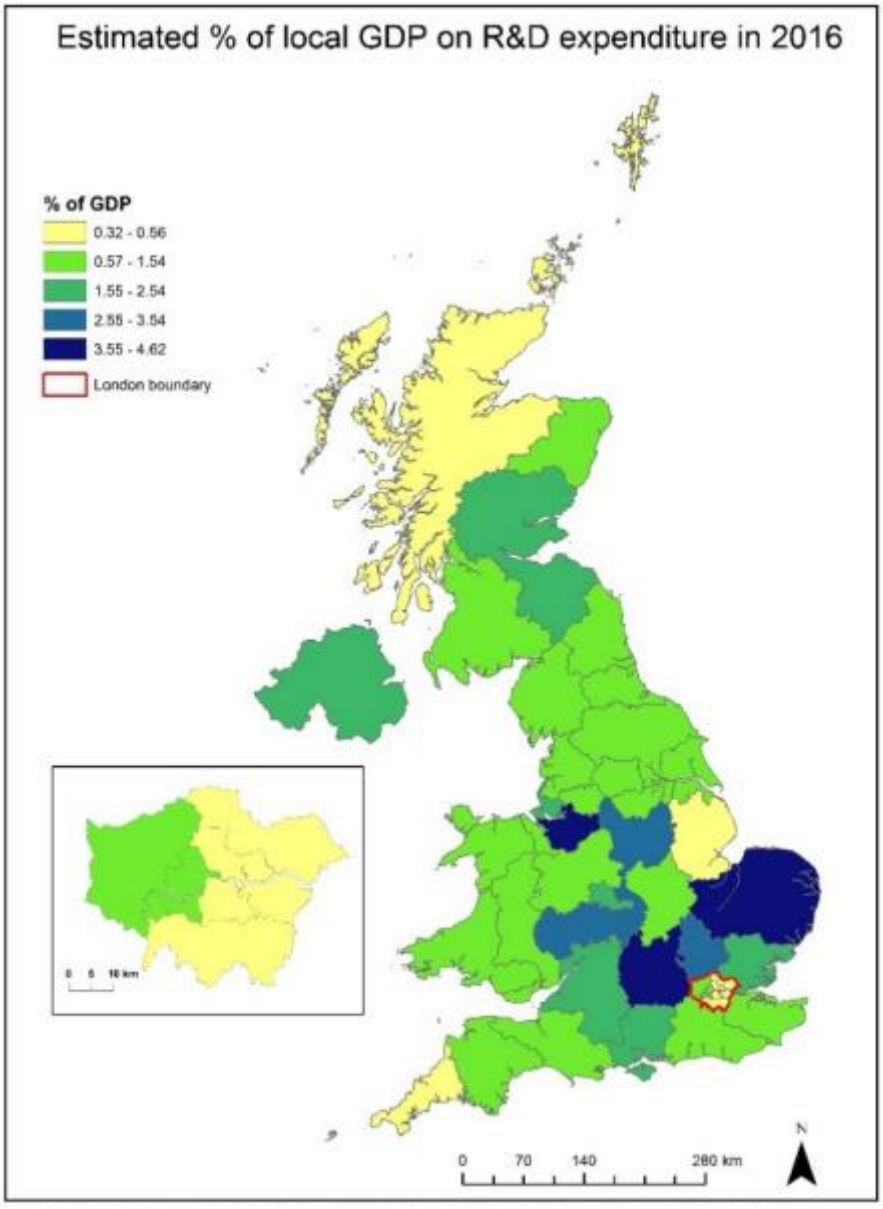


Figure 24 Estimated local GDP on R&D expenditure, 2016

Notes and References

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[ii] https://www.transportforthenorth.com/wp-content/uploads/Northern-Powerhouse-Independent-Economic-Review-Executive-Summary.pdf

[iii] Source : Information Technology and Innovation Foundation

[iv] See Jones, R.A.L. (May 2019) A Resurgence of the Regions: rebuilding innovation capacity across the whole UK. University of Sheffield

[v] Wong, C, Zhang, W, Schulze Baing, A, Koksal, C, Baker, M (2019) Industrial Strategy and Industry 4.0: Structure, People and Place, Spatial Policy and Analysis Lab, Manchester Urban Institute, University of Manchester

[vi] C Wong, W Zheng, A Schulze Baing, C Koksal and M Baker: Industrial Strategy & Industry 4.0: Structure, People and Place. Spatial Policy and Analysis Laboratory, Manchester Urban Institute, University of Manchester, May 2019. http://hummedia.manchester.ac.uk/institutes/ mui/spal/research/reports/industrial-strategy-andindustry-4-structure-people.pdf

[vii] Ibid

[viii] See for instance https://alanbarrell.com/wp-content/uploads/2018/09/AB-K-Kirk-Cam-Phen-10-Sept-20182.pdf

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[xii] https://ct.catapult.org.uk/news-media/general-news/uk-government-grants-catapult-network-%C2%A3780m-additional-funding

[xiii] Source: Bonvillian and Singer, (op cit)

[xiv] See: Rothblatt, S (1968) The Revolution of the Dons: Cambridge and Society in Victorian England, London: Faber and Faber, and Sanderson, M (1972) The Universities and British Industry 1850-1970, London: Routledge and Kegan Paul

[xv] https://www.bbc.co.uk/news/business-49048823

[xvi] https://www.theguardian.com/uk-news/2019/nov/08/crossrail-faces-further-delays-and-will-cost-more-than-18bn-tfl

[xvii] See: Williams, D. (2009) Morrill Act's contribution to engineering's foundation. *The Bent of Tau Beta Pi*, Spring. Available at: www.tbp.org/pubs/Features/Sp09Williams.pdf.

[xviii] See: Frontier Economics (2014) Rates of return to investment in science and innovation. A Report Prepared For The Department for Business, Innovation And Skills (BIS), July 2014

[xix] Estimate by UKRI based on Economic Insight (2015) "What is the relationship between public and private investment in science, research and innovation?" a report commissioned by BEIS

[xx] The lower figure is based purely on the direct social return from the public R&D, the higher figure also includes the estimates of additional private (and other) R&D levered in and the social return on that (40% leverage times 25% private return times 2.5 times wider social impact)