Regional policy and R&D: evidence, experiments and expectations

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Preface

This report contributes to the debate on the role of research funding in tackling regional inequalities in the UK.

Some readers may raise their eyebrows when they see that the authors are from UCL: one of the UK's larger universities, based within the 'golden triangle' of London, Oxford and Cambridge and attracting over £500 million in research funding annually.

Let us be clear: we agree unreservedly that bold actions are needed to address unacceptable inequalities in wealth and opportunity in the UK. This report is not a surreptitious attempt to get a better deal for Bloomsbury at the expense of the rest of the country.

A broader geographic spread of strong research and development (R&D) has the potential to attract more people to research careers, expand opportunities for university-business collaboration and provide the additional research capacity that is required for the Government to succeed in its ambition to raise overall R&D investment to 2.4% of GDP. A broader geographic spread of R&D should be welcomed widely.

There is persuasive evidence that investment in research and innovation plays an important role in regional economic development. Such investment, however, is not a magic bullet that will automatically meet the ambitions of policymakers or the aspirations of the wider population. Wishing for regional equality is not the same as delivering it.

Earlier attempts at regional R&D investment in various parts of the UK have had mixed success. Arguably, too many of these initiatives began with big promises and unrealistic expectations. They were then cut short before they had time to deliver results. The opportunity cost of these initiatives

was substantial. Any failures – whatever their cause – risk undermining confidence in R&D as an instrument of regional economic policy. That is not in the interest of any part of the research and innovation community.

The UK needs more effective and sustainable approaches in future. That means facing up to some of the challenges of developing a regional dimension to research policy, however inconvenient and intractable some of these challenges might appear. It also means being candid about previous attempts to use R&D investment in regional economic development, learning from both failures and successes. It means learning from other countries that face similar challenges. Received wisdom should be tested against the latest evidence.

We cannot leap to perfection in a single report. We can, however, begin to flush out awkward questions, identify obstacles and point to successful examples of progress.

We have used data in the public domain to compare regional distributions of R&D in several parts of the world, putting the UK picture into that wider context. We identify some of the ambiguities and dilemmas that are embedded in regional R&D policy.

We also identify some of the issues that government and funders may face in future if they increase their focus on geographic location when allocating resources for research and innovation. These include choices of metrics and choices of geographic granularity. Such issues might appear rather technical to the general reader but they have profound effects on graphical depictions of geographic distributions and on the policy choices presented to policymakers and research funders.

We compare the level of research concentration in the UK with that elsewhere. This demonstrates that the level of geographic concentration in the UK is somewhat less than in other major research nations. Furthermore, when we explore a range of credible measures of the geography of R&D investment, we find that there is no uniquely authoritative measure of concentration. These issues are inconvenient but unless they are addressed persuasively, it is not easy to see how this country can break its long-standing practice of paying lip service to the regional dimension of R&D investment.

We pose more questions than answers. We offer no easy formula for the use of R&D investment as the solution to regional policy problems. However, we do aim to:

- put the challenges facing the UK into a wider context;
- recognise a range of methods of analysing regional funding distributions;
- explore the role of collaboration alongside competition; and
- hopefully, encourage policymakers to persist with the search for solutions to the long-standing problem of regional disparities.

Our analysis is intended to provide insights that can inform debate and decisions in this complex policy space. We hope to build further confidence in the role of R&D as an important instrument of regional policy.

Absorbing these factors into future funding policy should help to set realistic but exciting ambitions and expectations, in due course leading to sustainable reductions in geographic inequality across the country.

Executive summary

Analysis

- **International comparisons**: Geographic concentration is a characteristic of research globally rather than an idiosyncrasy of the UK. The level of regional concentration in the UK is somewhat less than in other major research nations.

- **Dilemma of the denominator**: There is no uniquely authoritative measure of research concentration. The picture of regional concentration of UK R&D funding varies according to the metric used.

- **The granularity effect**: The picture of R&D concentration also varies with the granularity of the data. Comparisons between regions mask significant variation in funding within regions.

- **Underfunding of research**: Research in universities is funded below the full cost of performing the research. This means increasing research funding in a region leads to greater research deficits.

Policy principles for regional R&D

A. Set out measurable objectives: A clear vision and regional metrics for success could advance the regional R&D agenda.

B. Focus on impact: Regional metrics should focus on the impact of research, rather than the level of investment.

C. Build greater strengths through partnerships: Foster inter-regional collaborations to strengthen the impact of research.

D. Create strong civic partners at regional and local levels: Enable civic authorities to lead regional R&D initiatives within a national framework.

E. Integrate regional, national and global interests: Strong relationships between national and regional R&D are essential.

F. Ensure financial sustainability for university research: Improving the sustainability of funding would enable stronger regional R&D.

Introduction: Context to the place agenda

The UK has some of the greatest regional inequalities in the world.[1] The impact of the COVID-19 pandemic has further exposed and worsened inequalities in wealth, health, housing, education, employment and access to lifetime opportunities. Many of these inequalities are visible between geographic regions but they also exist to unacceptable levels within regions. In most of the UK's major cities, prosperous communities are found cheek by jowl with areas of social and economic deprivation.

Successive governments have tried to increase wealth and opportunity in 'the regions' (to counter London-centric policy processes) to levels found in the South and East of England. Of course, this focus on South East England versus the rest of the country, while important, can overlook some of the complexities of the UK's regional inequalities, not least within London.

Tony Blair's Government created devolved administrations in Scotland, Wales and Northern Ireland while forming Regional Development Agencies across England. The 2010 to 2015 Coalition Government scrapped the Regional Development Agencies and created Local Enterprise Partnerships and the Northern Powerhouse. Theresa May's Government outlined a 'place agenda' to drive prosperity in regions across the UK. The place agenda made explicit links with a UK Industrial Strategy and in particular with research and innovation. Subsequently, Boris Johnson's Government has scrapped the Industrial Strategy and is preparing a new Innovation Strategy and a post-Brexit Shared Prosperity Fund.

These ambitions have provided platforms for numerous regional development initiatives.[2] In recent years, efforts have been spearheaded through Business Links, Local Enterprise Partnerships and the government-owned British Business

Bank. The devolved administrations have created Scottish Enterprise, the Scottish National Investment Bank, Invest NI and, for a while, the Welsh Development Agency. More recently, there have been Science and Innovation Audits and local industrial strategies. Meanwhile, the EU invested billions of euros in parts of the UK through the European Regional Development Fund. Further initiatives have focussed specifically on research and innovation, including Public Sector Research Establishments, Catapult Centres, Industrial Technology Institutes and Innovation Centres in Scotland and Technium Centres in Wales.

There has also been renewed emphasis on R&D as an instrument of regional economic development. This echoes Harold Wilson's famous 'white heat' speech in 1963, setting out his vision for science and technology helping to 'provide the answer to the problem of Britain's declining industries and Britain's declining areas'.[3]

The idea is that, by supporting more university research in 'left behind' regions, public funding will generate wealth and opportunity, for example by attracting more R&D investment from businesses and charities. This has the potential to create virtuous circles in which academic research and business investment reinforce and expand each other as they seem to do in major research clusters around the world.

Boris Johnson's Government now has a £4 billion 'Levelling Up' Fund, announced in the November 2020 Spending Review, and a UK Research and Development Roadmap emphasising the role of research in 'ensuring our R&D systems make their fullest contribution to our levelling up agenda'.[4] The Government also promised a 'new UK R&D Place Strategy later this year [2020] to unlock local growth and societal benefit from R&D across the UK'.[5] That strategy had not been published at the time of writing this report.

The Levelling Up Fund arguably has a distinctive context. There has been increased devolution of powers to cities across the UK, including the creation of metro mayors and City Deals. Acknowledgement of intra-city disparities has led to a range of regeneration initiatives, often with a cultural, intellectual or government element at the heart. These include: Media City in Salford; a City of Culture and waterside development in Hull; the Titanic initiative in Belfast; the Cardiff Bay development; the Victoria and Albert Museum in Dundee; and the development of the Queen Elizabeth Olympic Park in East London.

There is less evidence of investment in the wider regions in which these initiatives are located, risking growing divisions between cities and their surrounding regions.

The UK's research strength already supports local and regional economies across the country. According to a report commissioned by the 2010 to 2015 Coalition Government, every £1 million of public R&D spent leverages £1.4 million of private R&D funding, resulting in £7 million of net economic benefit to the UK.[6] High-quality research and innovation create jobs and enable improvements in areas such as transport, healthcare, food safety, business competitiveness and the quality of the natural environment. Reports on regional inequalities have also highlighted the importance of investing in research to address regional inequalities.[7]

Given the evidence of substantial economic benefits associated with research, it seems reasonable that research should have a key role in the post-COVID economic recovery and levelling up.[8] The high media profile of science during the COVID-19 pandemic may well raise the political appeal of R&D investment as an instrument of economic and social development.

Nevertheless, the 'deep-rooted spatial inequalities' persist, as described by the 2070 Commission, an independent inquiry into city and regional inequalities in the UK.[9] While there have been many successes by individual institutes or initiatives, collectively these efforts have not yet demonstrated big changes in the regional distribution of wealth and opportunity across the UK.

The 2070 Commission has described:

> *The lack of genuine opportunities [in blighted neighbourhoods], in terms of access to good-quality education, jobs, health services or housing, perpetuates structural inequalities. Local levels of deprivation are reinforced by regional imbalances in economic development and structure across the UK. These limit the growth in wage levels and job opportunities as well as available resources for investment in services and infrastructure. As a result, inequalities in the UK are concentrated and persist in particular regions.*[10]

Against that background, it is less clear how R&D investment alone is going to deliver its promise for regional development. Is R&D investment a magic potion for economic growth? Or is it part of a complicated relationship between a high-level Government vision and the daily experience of individuals across the UK?

Regional concentration of R&D

This growing focus on regional inequality has re-opened long-standing questions about the geographic distribution of R&D investment, and in particular whether R&D funding is too heavily 'concentrated' in particular regions of the UK. Tom Forth and Richard Jones explored this issue in a report for Nesta in 2020.[11]

Meanwhile, the UK continues to face growing international competition for talented researchers and business R&D investment. Ambitions for regional development are inevitably tensioned against ambitions for national performance that have historically benefited from investment in the largest and most research-intensive institutions.

Successive UK governments have promised substantial growth in R&D investment. In principle, higher levels of R&D funding could address regional inequalities and support international competitiveness simultaneously. In the longer term, the UK's international standing should be enhanced by having a larger number of large institutions in diverse geographic locations. This will mean ambitions for regional equality and stronger international competitiveness will align.

1. Degrees of concentration: from global to local

As the Council for Science and Technology has recently observed, 'The approach to levelling up must be strategic and long-term in its focus' in order to ensure coherence between national and local strategies and to maximise existing and potential private R&D investment.[12] We argue that a further dimension to consider is the pattern of research funding globally.

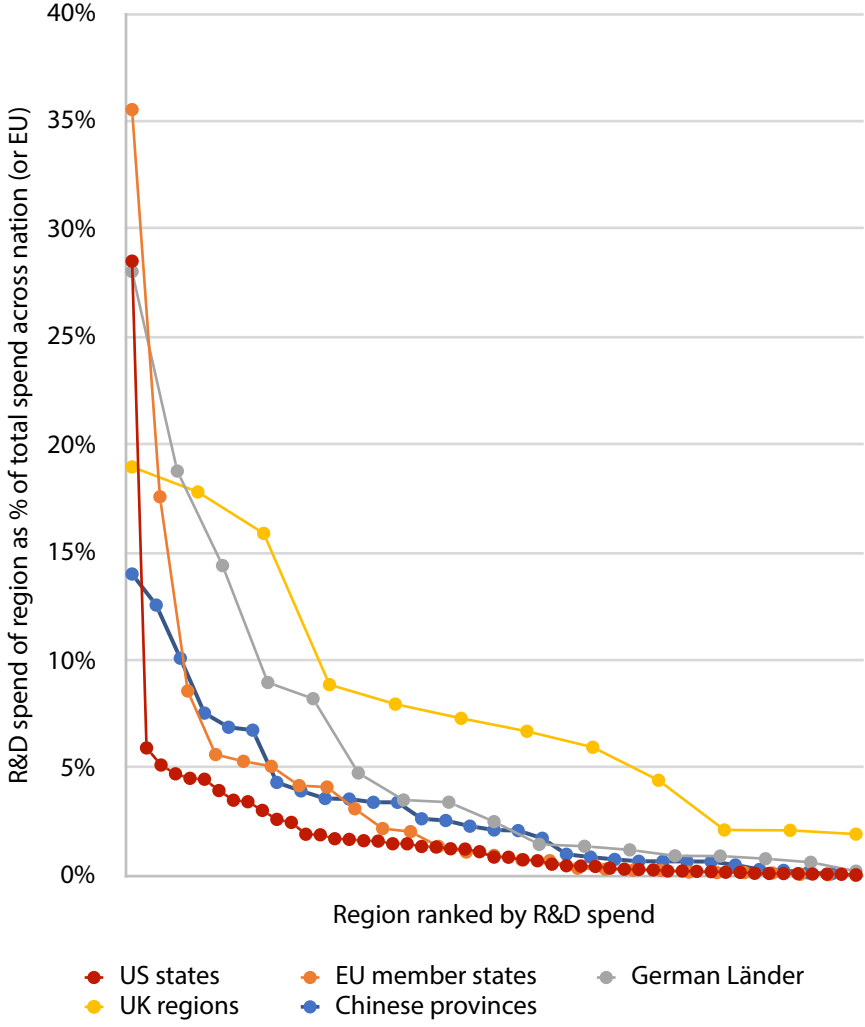
Regional inequalities are not unique to the UK. OECD data show significant disparities between cities and regions globally, across health, living standards, environmental quality and digital infrastructure, along with population growth and GDP per capita.[13]

The geographic distribution of R&D spending across administrative regions in several major research nations and the EU is shown in Figure 1.

Figure 1 shows the R&D spend of each region as a percentage of the total R&D spend across that region's nation (or EU). The left side of the graph shows the regions that receive the highest amount of R&D funding, with the data on the right reflecting the regions that receive the least R&D funding. The lines with the highest peaks on the left therefore illustrate a greater degree of concentration.

By this measure, the degree of geographic concentration in the UK and China is less than elsewhere. In both the US and Germany, the regions with the most R&D funding (California and Baden-Württemberg respectively) each attract about 28% of national R&D funding. The UK region with the largest R&D expenditure (the South East) attracts 19% of the national total.

Figure 1: Distribution of total R&D spend across regions of the US, EU, Germany, China and the UK



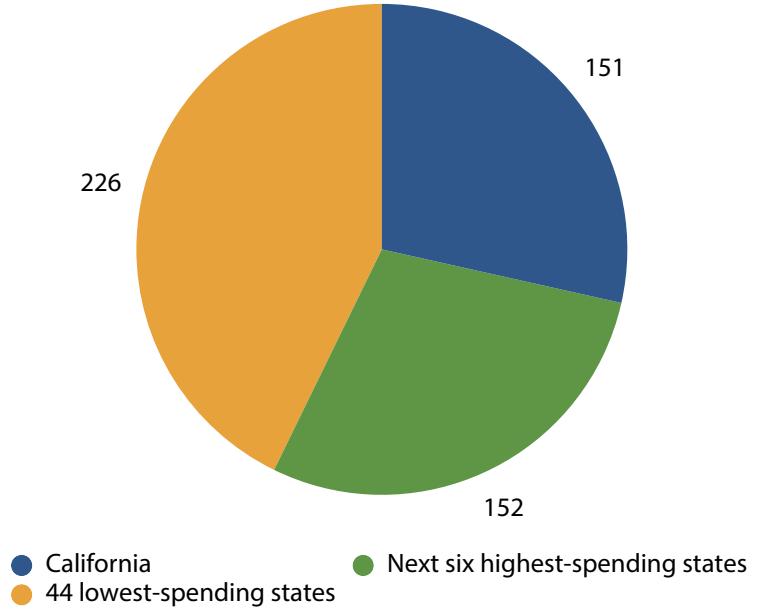
For all figures, see list of data sources at the end of this report

On average, EU member states have R&D investment of just over 2% of GDP. This figure disguises investment levels ranging from 0.5% in Latvia and Romania to 3.3% in Sweden.[14] (Further variation can be found when looking at regional differences within EU member states, as we will explore later.)

Six states account for almost half of all R&D expenditure in the USA, with the level of intensity ranging from below 0.75% of GDP (seven states) to above 4% (six states).

California's R&D spend of about US$150 billion per annum dwarfs that of other US states as shown in Figures 2 and 3. In 2017, California's R&D spend was nearly five times as much as the next highest state, Massachusetts ($31 billion).

Figure 2: R&D spend in US states ($bn, 2017)

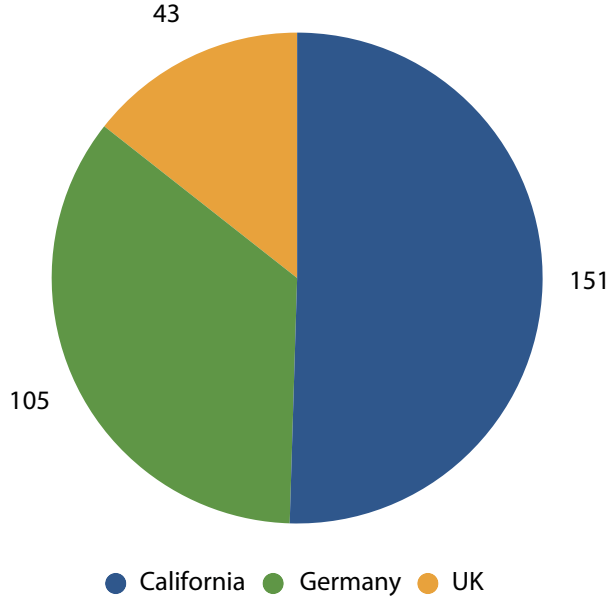


N.B. District of Columbia is included; technically it is a federal district rather than a state.

R&D expenditure in California is approximately equivalent to the combined R&D spend of the six next highest-spending US states, or the combined spend of the 39 states with the lowest R&D income. In 2017, California's R&D spend was 44% more than the R&D spend across the whole of Germany that year (€100 billion), and three and a half times the entire UK R&D spend (£35 billion).

Comparisons of UK spending on R&D against international benchmarks helped persuade Government and opposition parties that the UK should increase its overall level of investment to 2.4% of GDP from its current level of well below 2%.

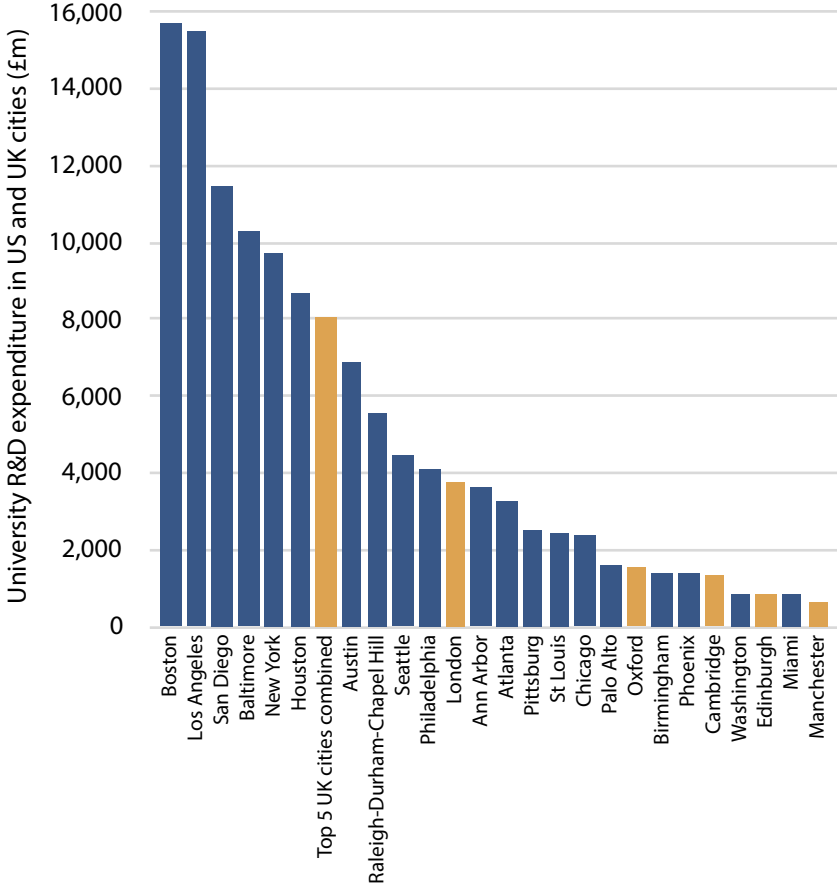
Figure 3: R&D spend in California, Germany and the UK ($bn, 2017)



International comparisons of regional concentration provide less fertile ground for developing regional R&D policy. Indeed,

persistently low levels of overall investment mean that even the UK's larger clusters of research appear modest by international comparison.

Figure 4: University R&D Expenditure in US and UK cities (total of 2016-2018)



A comparison of university research spending in UK and US cities illustrates this point. London has 59 universities and

higher education colleges.[15] It has major research centres such as the Crick, Dementia Research and Alan Turing Institutes. It has growing communities of research and innovation in White City, King's Cross and elsewhere. Surely, London must be one of the largest centres of research and innovation in the world?

A recent study by consultants SQW for Research England presents the sobering picture shown in Figure 4.[16] The combined R&D expenditure in London's universities falls behind the equivalent investment for each of the US top ten cities. Even after adding together university R&D spend in Cambridge, Edinburgh, London, Manchester and Oxford, the total is about the same as in Houston, Texas. These five great UK cities include some of the world's most famous and highly respected universities whose combined research spending is around half that in either Los Angeles or Boston.

Figure 5 shows the regional distribution of R&D intensity (R&D spend as a proportion of national GDP) within EU member states – that is, the extent to which R&D spending varies within individual member states. Germany has the greatest variation of regional R&D intensity – almost as large as the spread of R&D intensity across the whole of the EU.

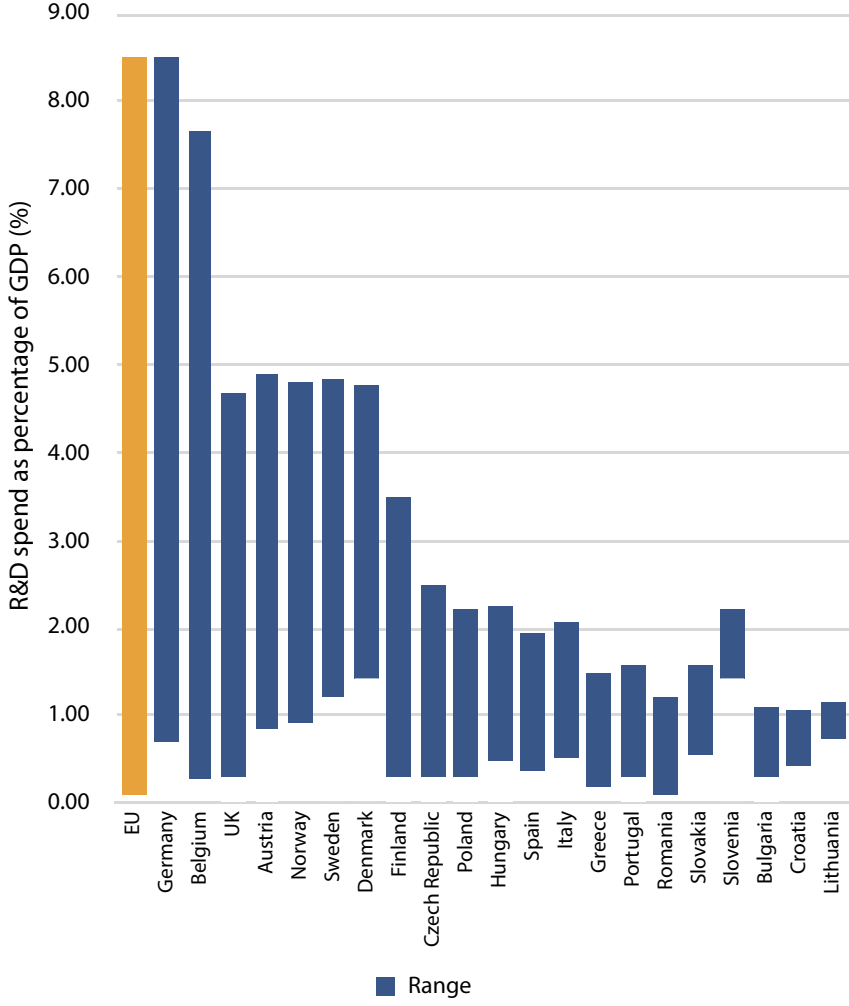
In the EU, 27 of the 266 regions account for half of R&D spending.[17]

Research concentration at a global level can also be seen in private R&D funding. According to the *EU Industrial R&D Investment Scoreboard*, 'Industrial R&D is highly concentrated. A small subset of companies, industries and countries account for a large share of the total R&D investment'.[18]

This *Scoreboard* shows that companies from three countries – the USA, Japan and Germany – account for 62% of business investment in R&D globally. Chinese investment in R&D is

growing at over 10% per annum so we can expect some jostling for seats at that top table.[19]

Figure 5: Range of R&D spend within European countries (as % of GDP), by NUTS 2 regions, 2017



The granularity effect

NUTS classifications

The NUTS classification (Nomenclature of Territorial Units for Statistics) is a hierarchical system for dividing up the economic territory of the EU and the UK.[20]

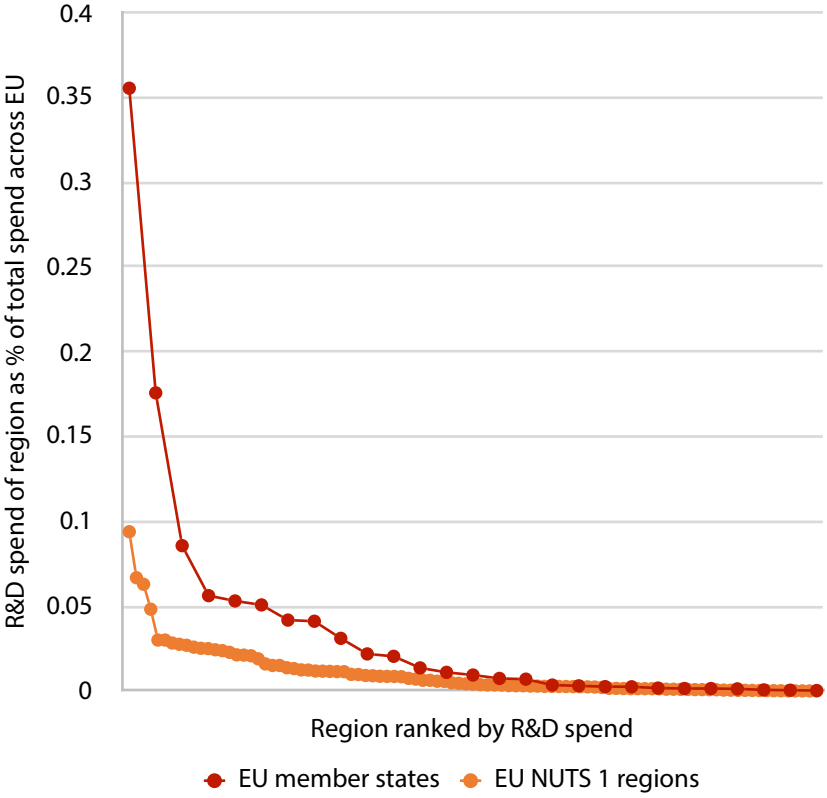
NUTS 1 classification divides countries into major socio-economic regions. NUTS 1 regions are divided further into NUTS 2 regions and further split into NUTS 3 regions.[21]

For example, Liverpool is one of four NUTS 3 regions in the NUTS 2 region of Merseyside, which in turn is one of five NUTS 2 regions that make up the NUTS 1 region of the North West of England.

Presenting R&D investment data at a more granular level of geography shows apparently lower levels of geographic concentration than in Figure 1.

Figure 6 shows the distribution of R&D funding across the EU at two levels of granularity – EU member states (as shown in Figure 1) and the smaller, more numerous NUTS 1 regions of the EU. The proportion of R&D spend in each NUTS 1 region (the blue line) is inevitably lower on average than that in each EU member state (the orange line).

Figure 6: R&D spend at different levels of granularity in the EU



Intra-regional research distributions

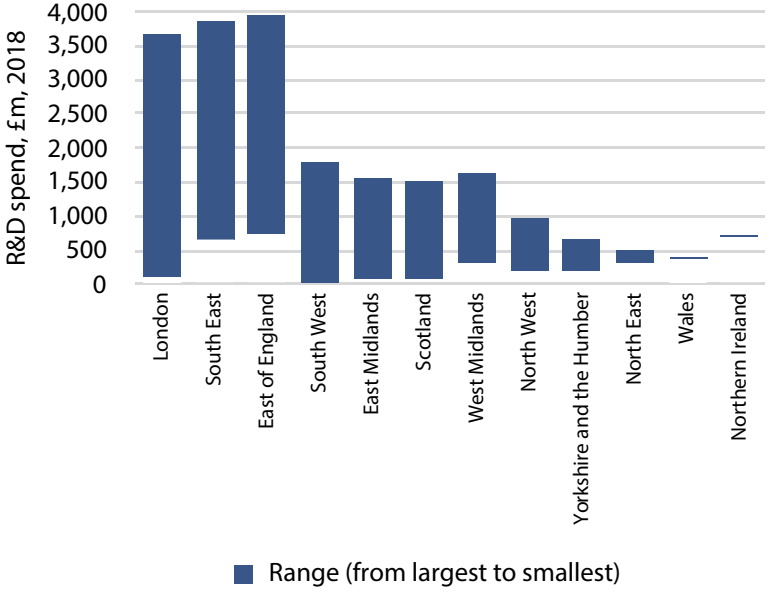
Applying similarly fine granularity to UK regions shows intra-regional variation. Comparisons at the regional level mask the – often significant – differences in funding levels within those regions.

The range of distribution within UK regions is shown in Figure 7. Each of the bars shows the range of R&D investment across the NUTS 2 sub-regions within each NUTS 1 region.

In the North West, the sub-region with the largest expenditure receives about three times that of the sub-region with the smaller expenditure. In Scotland, this ratio is approximately 8:1 and in London approximately 12:1.

NUTS 1 regions with higher levels of overall R&D investment tend to have higher levels of intra-regional variation. For instance, two of London's five sub-regions (both in Outer London) receive lower R&D investment than any of the sub-regions within the North East, North West and Yorkshire & the Humber. One explanation for this pattern is that a small number of exceptionally high-performing research institutions or clusters in research intensive regions stand out from the overall level of investment in those regions.

Figure 7: Range of R&D investment within NUTS 1 Regions



Northern Ireland is shown as a line because it consists of just one NUTS 2 region, synonymous with its NUTS 1 region. Wales consists of two NUTS 2 regions, with similar values; therefore the range of distribution is small.

If that is the case (and the location of larger research universities and institutes would support the hypothesis) then it raises questions about how analysis of regional R&D investment can adequately reflect the broader regional picture, beyond these exceptional institutions. To separate out these institutions from the broader picture in regional analysis would, of course, raise further policy dilemmas that are beyond the scope of this report.

Research clusters within regions

Regional clusters of investment can be found around the world. This reflects the behaviour of scientists and researchers who frequently build careers in large geographic clusters. These clusters allow researchers to form social and professional networks, move jobs without moving home and share expensive scientific infrastructure. However clusters do require concentrations of research funding and clusters of sufficient scale to compete globally. This poses a policy dilemma: clusters are often admired by politicians while research concentration is often perceived as a problem.

Eurostat, the European Commission's statistics arm, describes the development of R&D concentration as follows:

> *This geographical concentration of R&D activities is a common phenomenon. R&D clusters often develop around academic institutions or specific high-technology industrial activities and knowledge-based services, where they can benefit from a favourable environment and knowledge sharing. Regions in these clusters tend to attract new start-ups and highly qualified personnel and develop a competitive advantage in specialised activities.*[22]

The origins of research clusters vary. Some, such as Silicon Valley or Singapore, can be traced to specific decisions or

events. Others – in Edinburgh, Oxford or Cambridge, for example – are the products of long histories. Analysis by the Royal Society shows that these clusters combine specific research strengths, highly qualified researchers, access to public and private funding, a skilled workforce, business capabilities and appropriate infrastructure.[23]

In the UK, some clusters of business and academic research – Cambridge or Sheffield, for example – have emerged around one or two universities. More federated regional partnerships have emerged: the GW4, Midlands Innovation, N8, Science and Engineering South and others. The pervasive use of video-conferencing and remote working during the COVID-19 pandemic may create additional types of cluster. In Wales, for example, universities are exploring new approaches to collaborations.[24]

In the UK, research clusters are magnets for business investment in R&D, not least from companies headquartered overseas, choosing the UK as the place to do R&D. Around half of business R&D investment in this country now comes from firms headquartered overseas.[25] It is difficult to imagine how the Government's plan to raise overall R&D investment to 2.4% of GDP could be delivered without attracting more investment from overseas. If the UK does not maintain research clusters that compete with the largest and best in the world, then over time it will struggle to hold its place against global competitors. Indeed, a recent report from the National Centre for Universities and Business said:

> *The UK must start behaving as a competitor in the global market for R&D investment to retain existing business investment and attract higher levels of globally mobile business research.*[26]

Policymakers face the challenge of balancing the allocation of resources for the further growth of existing, high-performing clusters against resources for smaller clusters with high potential for the future.

That challenge is less stark if an entirely new research facility is created, with entirely new funding. In that case, there is a winning location but no losing locations from which resources are transferred. The Government's Advanced Research and Invention Agency (ARIA) is one example. Professor Emma Flynn from Queen's University Belfast was quick to set out persuasive arguments for locating this agency in Northern Ireland.[27] Other locations have also been proposed. At the time of writing, the Government has not yet confirmed how the location of ARIA will be decided.

2. Dilemma of the denominators: measuring the geographic distribution of R&D funding

So far, we have presented R&D volumes either as cash expenditure or as a proportion of GDP. Arguably, cash expenditure is the most straightforward measure while expenditure as a proportion of GDP is favoured by governments and economists making international comparisons. For example, the UK Government's target for overall R&D investment is expressed as a percentage (2.4%) of GDP (chosen because it is the average R&D spend across the OECD).

In cash terms, the South East, East of England and London between them account for much of the research investment in the UK.[28] But is the overall level of funding the best metric for describing regional distribution of R&D funding? Should the measure of R&D investment reflect the characteristics of the region in which the measure is made?

Let us consider two NUTS 3 regions in the South East: Oxfordshire and the Isle of Wight. The level of R&D investment in the Isle of Wight is low in cash terms compared to Oxfordshire, which has many research institutes, one of the world's top research universities and a correspondingly high level of R&D investment. That does not mean we should level up R&D investment on the Isle of Wight to the scale found in Oxfordshire. The Isle of Wight has no research-intensive universities and no obvious capacity to absorb large increases in R&D investment. It would be absurd to compare R&D investment levels in Oxfordshire and the Isle of Wight without allowing for their different characteristics.

There is no uniquely authoritative measure of R&D investment. Figure 8 shows the regional distribution of R&D spend in the UK according to four measures:

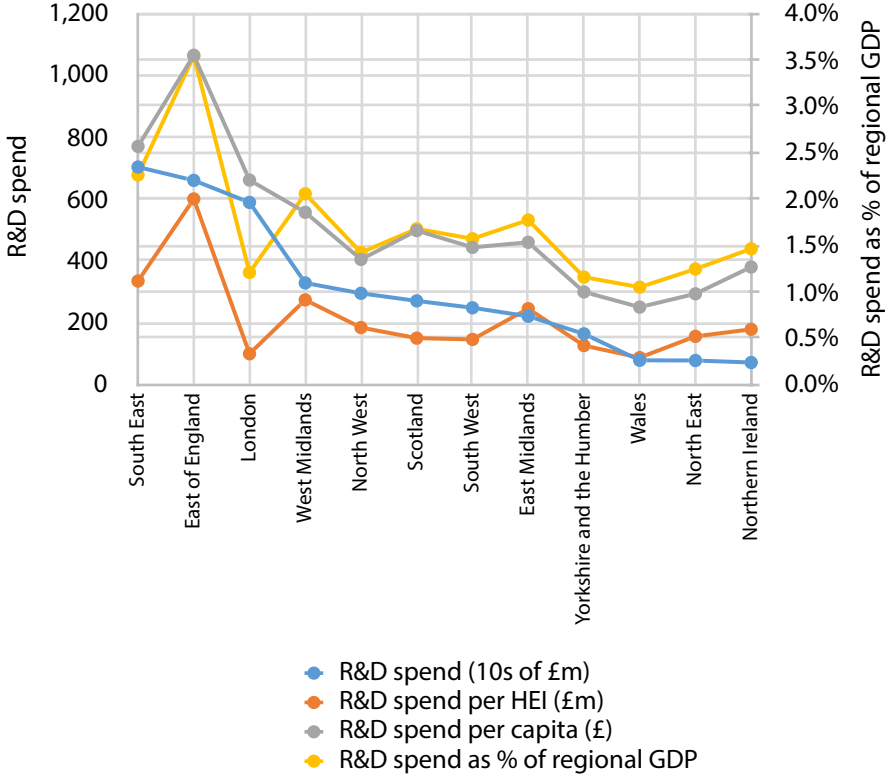
i. overall R&D spend;

ii. per number of Higher Education Institutions;

iii. per capita; and

iv. as a percentage of regional GDP.

Figure 8: Regional distribution of UK R&D spend, 2018: comparing metrics



Regions listed in order of overall R&D spend (blue line)

The picture changes according to the denominator. The East of England secures a high proportion of funding on all measures while the North East, Wales, and Yorkshire and the Humber consistently secure low levels. The pattern of distribution across other regions of the UK varies from one measure to another.

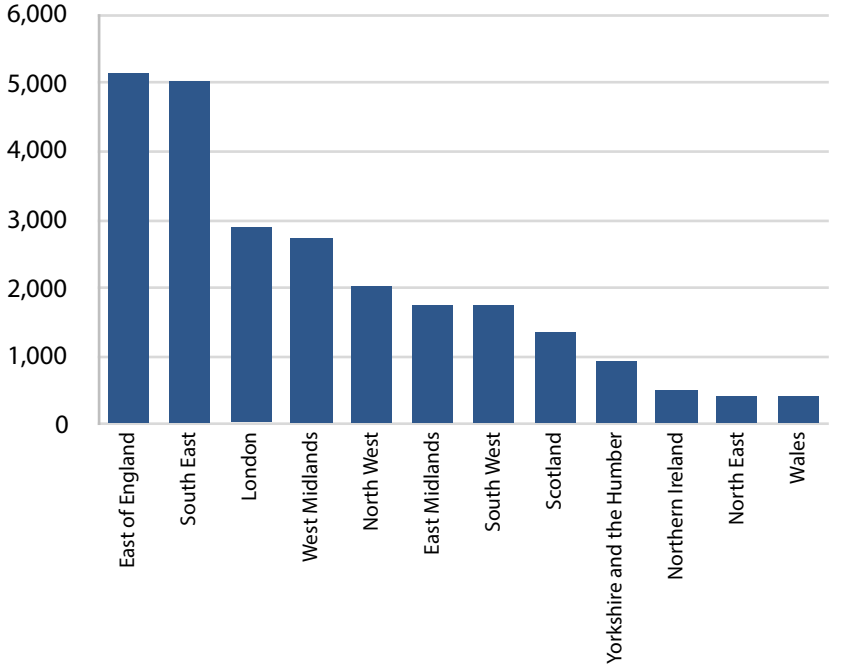
For example, London's ranking in terms of R&D spending depends heavily on the metric:

- on overall R&D spend and R&D spend per capita, London ranks 3rd;
- on R&D spend as a percentage of regional GDP London ranks 10th;
- on R&D spend per Higher Education Institution, London ranks 11th.

The distribution of business R&D expenditure in Figure 9 shows a similar pattern to that of overall R&D spend regionally. The East of England, South East and London attract the highest amounts of business investment, while Northern Ireland, the North East and Wales attract the least.

Ambiguous geographic distributions may well be mirrored within regions, possibly because of the research clusters described earlier. For example, the East of England attracts high levels of R&D investment under all of our methods of calculation. However, King's Lynn (which hosts a campus of the University Centre of West Anglia), Norwich (home to the University of East Anglia and the Norwich Research Park), Colchester (home of the University of Essex) and Cambridge (home of the University of Cambridge, large amounts of business investment and Anglia Ruskin University) each have distinct characteristics that are masked by aggregation into a NUTS 1 region.

Figure 9: Regional distribution of business R&D spend, £m, 2018



Furthermore, East Anglia contains some of the most deprived areas within the UK, alongside more prosperous ones. The map of the Government's Indices of Multiple Deprivation shows the distribution of the most and least deprived areas is scattered across England.[29]

This has important implications for the Government's commitment to, as promised in the March 2020 Budget, 'examine how R&D funding as a whole can best be distributed across the country to help level up every region and nation of the country'.[30]

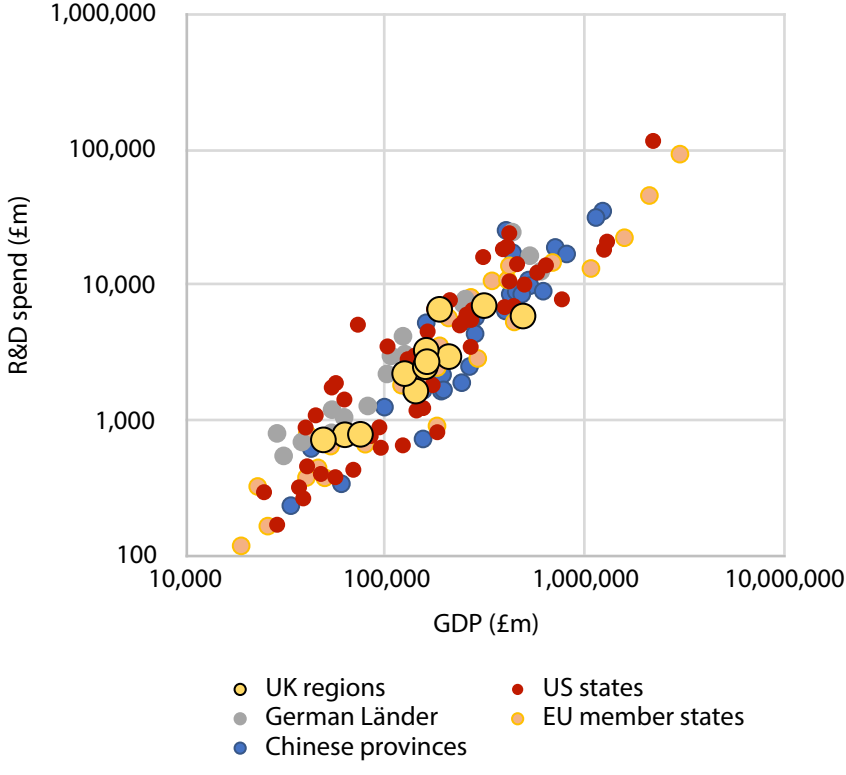
Defining the 'best' distribution of R&D funding to support levelling up will be a matter of political judgement rather than objective calculation.

We shall now explore some of the factors that may be factored into such judgements, taking account of – but going beyond – the historic distribution of funding.

3. R&D redistribution and economic 'levelling up'

Figure 10 shows a clear correlation between R&D spending and GDP across regions of the UK, US, Germany, China and the EU. Since the balance of evidence suggests that investment in R&D promotes economic growth, there may well be a causal link as well as correlation. Against that background, why not redistribute R&D activity to stimulate a similar redistribution of economic activity?

Figure 10: Relationship between GDP and R&D spend - UK, Germany, USA, EU, China



At least two factors complicate this quick fix.

i. Unless R&D budgets are rising, the geographic redistribution of R&D investment implies that resources are taken from areas of proven success (and, presumably, political influence on matters relating to R&D) and redeployed in less successful (and, perhaps, less influential) areas on the untested hypothesis that this redeployment will generate economic benefit.

ii. The existing geographic distribution of R&D investment evolved as part of a complicated mix of market behaviours and policy choices in domains such as housing, transport, business investment and skills. Unsuccessful attempts to use R&D for regional development often seem to make R&D choices in isolation from these other factors.

These confounding considerations are recognised by the Council for Science and Technology (CST), which notes two points of principle in its advice to the Prime Minister on the role of science and technology in addressing regional disparities:

i. not to 'diminish the success of the outstanding knowledge based economies…in some parts of the UK'; and

ii. the 'inter-connected factors' on which the success of R&D investment depends.

The CST rightly emphasises that long lead-in times and coordinated policy actions, rather than quick fixes, are needed to deliver levelled up prosperity and productivity.

4. Retrofitting regional policy

Policy development for regional R&D investment is often based on retrofitting regional interventions to the national research funding system. The devolved administrations in Scotland, Wales and Northern Ireland have scope to create distinctive policy interventions but even they do not always integrate R&D investment with other areas of social and economic policy.

Weak connections between policy domains leaves regional R&D policy without a powerful voice in central government or funding agencies. Without strong political advocacy – and in the absence of predictable outcomes from investment – the regional R&D agenda seems to lack power in contests for public spending.

Detailed proposals struggle to survive changes in political leadership, even if the overall ambition of regional economic parity remains intact. A regional dimension for R&D has been on the agenda of most UK governments but its detailed articulation varies from minister to minister. The effort of re-inventing ideas for regional R&D policy comes at the expense of actually delivering them.

Initiatives since the 2015 general election

Science and Innovation Audits, first announced by the then Science Minister in 2015, set out to 'help local and regional areas to map their research and innovation strengths and identify areas of potential global competitive advantage'.[31] However, there was no sizeable funding explicitly aimed at seizing opportunities identified in the Audits. The lasting impact of the Audits remains unclear.

The Higher Education and Research Act 2017 makes no explicit provision for regional R&D policy, although there are

specific provisions relating to devolved administrations.[32] Nor does any regional policy appear in the Nurse Review, which provided the stimulus for the creation of UKRI.[33]

The BEIS *UK Research and Development Roadmap*, published in July 2020, states:

> *We have already committed to developing a comprehensive and ambitious UK R&D* Place Strategy together with the devolved administrations over the coming months. Our goal in developing the Place Strategy will be to drive place-based outcomes from our *R&D system – accelerating our economic recovery, levelling up across the UK*.[34]

The place agenda has been signposted in UKRI's *Corporate Plan*, published in October 2020, which states:

> *Applying a place-based lens to what we do, we will:*
>
> - *work with the government to develop the UK Research and Development Place Strategy by building on strengths across the UK, and evolving our Strength in Places fund*
> - *improve our reporting on the regional distribution of our funding, progressing from our initial publication in January 2020*.[35]

So far UKRI's Strength in Places Fund is the only funding dedicated to R&D investment for levelling up. It aims to 'invest in research and innovation projects that aim to drive economic growth in specific areas of the UK'.[36]

The description of the forthcoming Shared Prosperity Fund – the replacement for EU Structural and Investment Funding – in the Government's November 2020 *Spending Review* makes no mention of R&D.[37]

Full economic costing and regional funding

Alongside the challenge of maintaining a stable policy for regional R&D, poor connections between regional and national R&D policy create obstacles and risks to the levelling up agenda. This is clear, for example, in the relationship between the full economic cost of research and regional funding.

Research in universities is currently funded at levels below the full cost of performing the research. According to the Office for Students, UK research funders (such as UKRI, charities and business) on average provide 71% of cost of the research in universities.[38] Universities must find the remaining 29% – often from fees paid by overseas students and taught postgraduate students – to get the research done. The idea is that project grants cover the 'direct' costs of the project: things like researchers' salaries and lab materials. They do not cover all of the overhead costs – infrastructure, facilities, office administration and so on.

What percentage of full economic cost does each funder cover?

Some funders cover more research costs than others. Research Councils provide 74% of the funds needed for a research project in a university. The equivalent figures are 77% for industry, 69% for EU funders and 60% for UK charities.

In the US, five of the wealthiest grant-giving foundations last year pledged to cover more of projects' overhead costs. These foundations concluded that their own funding policies 'provide just a sliver of the money they [recipients of grants] need to operate and run projects'.[39] So they changed their policies. For example, 29% of every grant from the MacArthur Foundation now goes towards overheads.[40]

This has resulted in a growing research funding deficit, which reached £4.5 billion across UK Higher Education Institutions in 2018/19.[41] As a previous HEPI report noted, this 'demonstrates the systemic underfunding of research, which requires universities to cross-subsidise from other income to fund research'.[42]

This funding model now appears unsustainable. COVID-19 has shaken confidence in overseas student fees as a secure source of income to meet the cost of research overheads to the extent that the Government provided an emergency funding package at short notice.[43]

However, under the current funding model, what does it mean to level up research funding when that funding only covers part of the costs of the research? If research funding in a region expands then the funding gap in that region also expands – putting greater financial pressure on those parts of the country the Government is trying to help. To quote a more recent HEPI report, 'expanding loss-making activity merely increases any losses'.[44]

The ability of universities to support loss-making research varies across the UK. Scotland and London are particularly dependent on international student fee income (which makes up 39% and 31% of student fee income in those regions respectively), while London and the East of England receive a quarter (25% and 24% respectively) of their research income from UK charities, and a quarter (27%) of Wales' research income comes from the EU.[45]

Consideration of full economic costing is usually missing from regional development initiatives.

Government and funders are hesitant to cover a higher proportion of research costs because this would reduce the

number of research projects they could fund with a given pot of money. In other words, it would give them less bang for their buck.

We pose two considerations to counter this view.

First, we would challenge the assumption that quantity is more important than quality when funding research. Funding a greater number of research projects in a system with scarce resources exacerbates career instability and unhealthy cultures in research.

Secondly, we note that the current plans to increase substantially research funding provide a unique opportunity to increase *both* the number of research projects funded *and* raise the proportion of fEC (full economic costs) covered. At the time of writing, the Government remains committed to an unprecedented increase in public R&D investment, from around £13 billion in 2019/20 to £22 billion by 2024/25.

5. Making research policy work for levelling up

The former Chief Executive of UKRI, Sir Mark Walport, remarked that successful regional R&D investment came with four requirements:

- academic strength;
- business strength;
- local government support; and
- good leadership.[46]

Redistributing R&D funding may address the first of these but it is unlikely by itself to do much to enhance the others.

What specific issues should be addressed to try to break the cycle of new regional initiatives that are not followed through with long-term investment at scale?

Obvious but difficult questions remain unanswered. Without direct and persuasive responses, these questions can return again and again during Spending Reviews and other stages in the allocation of public funds. Each time the questions go unanswered, the case for a powerful regional R&D agenda slips down the list of government priorities.

For example:

i. What is the overall aim of levelling up: improving personal wealth, employment, productivity or economic growth? What measures should be used and at what level of regional granularity should measurements be made?

ii. To what extent should the goal of any regional R&D agenda align with that of the overall levelling up agenda? Or should regional R&D policy have distinct aims?

iii. In R&D investment, what is the optimal balance between national performance and regional parity?

iv. What are we trying to level up: regions or localities or both? What is the optimal distribution of research funding within regions? Assuming we are not aiming for complete uniformity of R&D investment across UK localities (for example, achieving uniformity of investment at the level of NUTS 3 regions seems unrealistic and probably not the desired outcome), to what degree do we want to level up? How much variation is optimal?

v. Which metrics should be used when levelling up the regional distribution of research funding? The amount of R&D investment in each locality, R&D per capita, R&D per GDP, international comparisons or something else? Should the same denominator be used for all regions and localities?

vi. By what mechanism can distinctive local strengths, opportunities and capacity be recognised and exploited?[47]

vii. Who should be accountable for the effectiveness of public spending on regional R&D – and to whom should they be accountable? Without putting local or regional bodies into the accountability chain, how can R&D investment be integrated into local priorities for investment?

Excellence and impact

Perhaps the primary purpose of regional R&D investment is to enable regions to capture the impact of research, leaving national funding to support the research itself.

In a speech in December 2020 on the Government's R&D Places Strategy, the Science, Research and Innovation Minister, Amanda Solloway, said:

> *This [the Government's Place Strategy] is not simply about how much money we are spending in each place. Levelling up the United Kingdom is about outcomes, so our focus must be on the impact that our R&D system can have in different places across the country, tackling the constraints which limit the contribution that research and development can make.*[48]

A distinction between research excellence and research impact might appear attractive, but in practice the relationship is complicated and indistinct. Harvesting the impact of research at the frontiers of knowledge may only be possible by working with those close to the frontiers: people with specialised understanding of the research field.

That said, how can we increase the capacity to benefit from the UK's research performance in regions or parts of regions that have not traditionally been research-intensive? The CBI's work on regional productivity has echoed the importance of factors such as education, housing and the quality of local transport, as much as R&D spend, in boosting productivity.[49] They join others in presenting persuasive arguments for regional R&D funding decisions to be undertaken alongside investments in education and skills, human capital, infrastructure and connectivity.

Bolting on or bedding in?

The CBI highlights significant variations between and within regions in terms of levels of productivity, observing that 'There is almost as much variation in productivity within the regions and devolved nations as between them'.[50]

There is not one dominant cause of regional disparities and there is unlikely to be a single policy prescription that can be bolted on to existing regional economies to reduce disparities.

This prompts the question as to whether 'levelling up' should be done to regions, or done by them? If more emphasis were placed on levelling up by regions themselves, then civic authorities in cities and regions would take on substantial new responsibilities. In that case, further considerations arise:

- Should a proportion of research funding be devolved to regions themselves, rather than allocated from London or Swindon [the geographical home of the UK Research Councils]?
- For example, should the UK distribute a proportion of research funding according to local R&D strategies or local industrial strategies?
- If so, against what objectives, in what proportions and with what implications for national research policy?

This agenda would require profound reforms to administration of R&D funding across the UK. Tom Forth and Richard Jones, in their 2020 report for Nesta, set out a case for regional authorities in England to play stronger roles in R&D funding, as part of their wider range of recommendations. They also point to 'two serious objections to such devolution that need to be confronted':

> *the question of whether the existing regional bodies have the analytical capacity to be able to make good decisions about how to spend the money, without being captured by special interests … in the absence of such capacity, it needs to be built up. …*
>
> *the risk of there being many duplicated subscale initiatives … This can be avoided through a combination of development of analytical capacity and some degree of central oversight.*[51]

Neither of these issues appear insurmountable. Rising levels of public spending on R&D create opportunities for change, giving regional authorities greater responsibility – and accountability – for the health and scale of R&D. However, in the context of other challenges and priorities, it remains unclear whether the Government has the capacity and political will for such reform.

6. Future directions: islands, archipelagos and land masses

The Government's commitment to raise R&D investment, if delivered, provides unprecedented opportunities. For the first time in several decades, Government could then expand research capacity across the UK while enhancing our most research-intensive institutions.

Time-limited funding for specific projects and research institutes has been central to earlier attempts at regional development. These funding models opened promising opportunities that have proved unsustainable financially. Tom Forth and Richard Jones propose a regional weighting to UKRI's performance-driven Quality-Related (QR) funding.[52] The *Review of Government Funded Research and Innovation in Wales* proposed that additional QR funding should be used to incentivise and reward institutions that win larger volumes of grant funding.[53] Both of these proposals recognise the key role of QR funding in creating sustainable new research capacity, not least in less research-intensive areas of the UK.

Recent reports from the Campaign for Science and Engineering (CaSE) and the Royal Society have noted the challenge of creating new clusters of research excellence.[54] With these reports in mind, sustaining and enhancing research excellence across the UK in the future is likely to require:

- longer-term investment in factors necessary to support emerging clusters, from education and skills to physical and digital infrastructure;
- the empowerment of local actors and leaders in decisions on research investment in order to ensure that it addresses local need; and

- investment in existing centres of excellence to maintain research performance across the UK.

Every region of the UK already has at least one research-intensive university. Yet there are many areas – even those in close proximity to research clusters – that may not be particularly engaged with R&D activity.

London has 59 higher education institutions, including a number of globally leading research-intensive universities, but the London Borough of Waltham Forest contains no such institution. The University of Manchester is driving the Northern Powerhouse, but how familiar is its work to people living in Oldham?

Increasing the number of large research centres in the UK while neglecting the areas around them will not automatically change the lives of people locally. So what else could be done?

Investment in regional research could be accompanied by support for collaboration between institutions in different regions. Established research capabilities could then be better connected to local needs. Islands of research excellence could be brought together in larger archipelagos that have the critical mass to compete globally.

Perhaps we need a suite of experiments in research funding that can be assessed, refined and expanded according to their efficacy and impact.

Research England has already made a promising start with the introduction of the Expanding Excellence in England, Connecting Capability and Strength in Places Funds. Further initiatives could build additional research capabilities in geographic areas identified through the UK's Science and Innovation Audits and local industrial strategies, for example to better connect research 'hot' and 'cold' spots within

regions. These initiatives are distinct from the established mission groups and regional networks or research-intensive institutions, some of which are mentioned earlier in this paper.

- Yorkshire Universities includes 11 universities and 'works to maximise the contribution of higher education to the region, and beyond, through collaboration, where this generates greater impact and public benefit'.[55]
- London Higher helps its diverse membership 'to address the opportunities and challenges that arise from our shared location in London'.[56]
- With a wider geographic span and narrower goals, the Capabilities in Academic Policy Engagement (CAPE) initiative combines the expertise of five universities – Northumbria, Nottingham, Cambridge, Manchester and UCL – and organisations in Parliament and Government 'to support effective and sustained engagement between academics and policy professionals' with financial support from Research England and the partner universities.[57] This partnership supports policy development in levels of Government that would be difficult for universities to reach individually.

Universities in Wales are already exploring how to use their diverse characteristics as a collective strength.[58] They recognise that, individually, they have distinct strengths and relationships with local businesses and communities. Streamlined arrangements for collaboration between universities would allow the pooling of expertise and more effective translation of that expertise to localities across Wales.

It would not be surprising to find similar initiatives already exist at local and regional levels elsewhere in the UK. Perhaps they need a higher profile. Perhaps too, research funders need

to signal greater support for such multi-institutional, cross-regional collaborations, particularly given the importance that the Prime Minister's Council for Science and Technology has noted 'for structurally weaker regions to link to partners outside the region with complementary strengths'.[59]

7. Policy principles for regional R&D

This report has set out some of the complexities and ambiguities in regional R&D policy. These are more than inconvenient obstacles to progress. They may well help to explain why so many previous attempts to deploy R&D for regional economic development have not met initial expectations and have ended prematurely.

We offer the following principles for the development of future initiatives in the hope that they provide starting points for the development of successful R&D initiatives at regional and local levels.

In some respects the principles are ambitious, perhaps even idealistic. They are certainly challenging. However, it is only by rising to these challenges that regional interventions can become longer lasting, more effective and better integrated into regional and national policy.

A. Set out measurable objectives

The specific target for R&D funding in the UK to reach 2.4% of GDP by 2027 created a clear focal point for R&D policy and highlighted the challenges of policy delivery.

Similarly, **a clear vision and regional metrics for success** – for both the levelling up agenda and the role of R&D within it – could advance the regional R&D agenda. Government and stakeholders should have measurable goals, region by region, for the changes they expect to deliver through regional R&D.

B. Focus on impact

Regional metrics should focus on the impact of research. While research investment (the input) is easy to measure, it is a poor proxy for the impacts that successful R&D investment have on economies and societies at regional and local levels.

C. Build greater strengths through partnerships

There is substantial scope to raise the impact of research by joining up capacity both within and across regions, to level up research impact at intra- and inter-regional levels. For example, funders could provide additional support for **collaborations between established centres of research and strong institutions in less research-intensive regions**.

This would have the compound effect of i) incentivising funding bids from less research-intensive regions and ii) connecting research from across the UK more closely to local needs in less research-intensive regions.

D. Create strong civic partners at regional and local levels

The very purpose of regional policy is to better reflect the interests of regions. R&D initiatives should be no exception.

This requires **R&D initiatives that are led regionally** rather than delivered to regions by central government. That in turn requires regional and local bodies to acquire the capacity to lead R&D initiatives and to become politically and financially accountable for their outcomes within a framework that is set at a national level.

E. Integrate regional, national and global interests

However, **strong relationships between national and regional R&D** are essential to avoid needless duplication of capabilities between regions and to ensure that regional interventions are held to the same global standards of performance as national funding schemes.

F. Ensure financial sustainability for university research

In the current financial model for research in UK universities, research funding covers 71% of the cost of research with universities providing the remaining 29%.

Increasing the level of funding also increases the amount of money universities must contribute themselves to research. This would put greater financial pressure on the regions that the Government wishes to support thorough additional R&D investment. Conversely, **improving the sustainability of funding – by funders increasing fEC rates and UKRI shifting the balance in favour of QR funding – would enable stronger regional R&D**.

Closing thoughts

We hope that this report will add to the renewed focus on regional development in the UK.

Under successive governments, there has been a sequence of previous attempts to use R&D investment for regional economic development. These have had mixed results. Individual successes have not added up to a sustainable shift in the regional distribution of wealth and opportunity. All too often, R&D initiatives have started with big ambitions but have been cut short before they had time to deliver results.

The Government's commitment to further increases in R&D investment creates new opportunities to use this country's outstanding research capabilities to help tackle unacceptable economic and social disparities.

Concentration is a characteristic of research globally rather than an idiosyncrasy of the UK. The geographic distribution of R&D investment in the UK is concentrated in the south and east of the country. The degree of concentration in this country is not particularly strong by international comparison and, in itself, does not present an obvious reason for redistributing public spending on research. However, the case for a wider geographic diversity of strong research capabilities can – and should – be made, not least by developing robust evidence and persuasive responses to persistent questions about the relationship between public spending on research and the economic performance of geographic regions.

Unanswered questions about the returns on regional R&D investment and the balance between national performance and regional parity can all too easily stand in the way of a persuasive case for public sector investment in regional initiatives. If fresh approaches are to have more persistent

success then they need to build on previous experience. That includes realistic assessments of the scale, duration and connections between policy domains that are needed if R&D funding for regional development is to make a lasting difference.

Ultimately, such funding inputs are only a means to an end. What really matters are the outputs: what the funding achieves, both directly (research findings, new products and services, improvements to health) and indirectly (attracting business investment, boosting employment, driving up skills and more).

How can the benefits of research be acquired by wider populations, not only in the geographical location where the research takes place, but across the country?

Frustration and impatience in governments, funding agencies and universities can tempt them to pursue quick fixes. But the experience of decades shows that these approaches often fail to live up to longer term expectations. Difficult questions need more attention if realistic, financially sustainable and effective solutions to regional inequality are to be developed. The promise of increased government spending on R&D makes this a particularly fertile time for growing additional capacity and new networks that have lasting impacts on research and economic development across the UK.

List of image sources

Figure 1

EU data:

Eurostat, https://ec.europa.eu/eurostat/databrowser/view/RD_E_GERDREG__custom_188631/bookmark/table?lang=en&bookmarkId=9dbdc64f-41eb-49a6-9e1c-d49d1245f654

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German data reflect 16 German Länder plus one Extra-Regio NUTS 1 region.

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China data:

China National Bureau of Statistics

Figure 2

National Science Foundation, http://www.statsamerica.org/sip/rank_list.aspx?rank_label=rnd1_a&item_in=2017&ct=S09

Figure 3

Germany data:

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Figure 4

SQW. Adapted from Figure 3-2: University R&D Expenditure (£000s, total of 2016-2018), p.11, Entrepreneurial University Ecosystems, www.ncub.co.uk/index.php?option=com_docman&view=download&alias=470-entrepreneurial-university-ecosystems-us-uk-framework-report&category_slug=reports&Itemid=2728

Figure 5

Eurostat (online data code: rd_e_gerdreg), https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=rd_e_gerdreg&lang=en

- Figure based on data for NUTS 2 regions only.
- The 'EU' bar is based on all current EU countries excluding France, Ireland and the Netherlands, since data for these countries was unavailable.
- The other bars show the UK, Norway and all EU countries, except:
    - Countries for which data was unavailable (France, Ireland and the Netherlands)
    - Countries consisting of only one NUTS 2 region or data point (Cyprus, Estonia, Latvia, Luxembourg, Malta) because one data point cannot show a range. The data for these countries was, however, included in the 'EU' bar calculation.

Figure 6

EU member states: Eurostat, https://ec.europa.eu/eurostat/databrowser/bookmark/9dbdc64f-41eb-49a6-9e1c-d49d1245f654?lang=en

NUTS 1 regions of EU member states: Eurostat, https://ec.europa.eu/eurostat/databrowser/bookmark/16e37040-0f1f-4f4f-abfe-f92f022c39f4?lang=en

Figure 7

Figure shows range of NUTS 2 data points within each UK NUTS 1 region

Eurostat, https://ec.europa.eu/eurostat/databrowser/bookmark/69a4255f-2d74-405d-bef4-7cafda77f77d?lang=en

Figure 8

R&D data: ONS https://www.ons.gov.uk/economy/governmentpublicsectorandtaxes/researchanddevelopmentexpenditure/datasets/ukgrossdomesticexpenditureonresearchanddevelopmentregionaltables

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Figure 9

ONS, 2018 data, https://www.ons.gov.uk/economy/governmentpublicsectorandtaxes/researchanddevelopmentexpenditure/datasets/ukgrossdomesticexpenditureonresearchanddevelopmentregionaltables

Figure 10

UK

GDP Data source: https://www.ons.gov.uk/economy/grossdomesticproductgdp/bulletins/regionaleconomicactivitybygrossdomesticproductuk/1998to2018;

R&D spend data source: https://www.ons.gov.uk/economy/governmentpublicsectorandtaxes/researchanddevelopmentexpenditure/datasets/ukgrossdomesticexpenditureonresearchanddevelopmentregionaltables

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Too many earlier attempts to use R&D investment for 'levelling up' have started with big ambitions but not survived long enough to deliver economic benefit. The purpose of regional R&D investment needs greater clarity.

This report unpicks assumptions about the spread of research funding across the UK and finds them wanting. Comparable countries appear to have higher levels of research concentration than the UK. Variations within regions can be greater than between regions.

Proposals for more resilient regional R&D initiatives include: adopting a clear vision and metrics for success; ensuring regional metrics capture the impact of research; supporting partnerships between diverse universities; stronger local leadership and accountability within a national framework; and ensuring financial sustainability for university research.

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