



Innovation after Lockdown

Using innovation to
build a more balanced,
resilient economy

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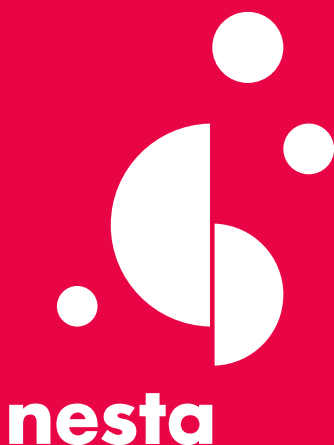
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Executive summary

Investing in innovation will be crucial as the UK looks to rebuild its economy after COVID-19. But innovation policy should not simply return to business as usual.

The UK's achievements in cultivating and supporting innovation over the past decade have failed to coincide with broadly felt prosperity. In late 2019, the UK had some of the highest levels of economic inequality in the developed world, along with some of the highest levels of regional inequality. When it came to innovation performance, some parts of the UK were among the most productive regions in Europe, while others had been overtaken by regions that were formerly part of communist East Germany.

While the pandemic will make these issues more pressing, the UK government's commitment to increase public spending on research and development (R&D) gives an opportunity to rethink. We argue that to support recovery, innovation policies must focus on creating a more balanced, resilient economy whose benefits are widely shared. In practice this means:

- 1. Creating innovation policies that serve the whole economy, not just 'frontier' sectors.** The current Industrial Strategy focuses on a narrow range of sectors, which according to one study, employ just one per cent of the UK workforce. Yet small productivity improvements in sectors that employ large numbers of people could have a big effect on overall productivity and, crucially, on the wellbeing and livelihoods of many people across the UK. More investment is needed to help innovation to diffuse across the economy and to support innovation in sectors that are not normally thought of as being at the 'technological frontier', like social care and retail.
- 2. A far greater focus on building innovation capacity across the country.** Public spending on R&D is heavily skewed towards London, Oxford and Cambridge, which receive 52 per cent of investment despite having 37 per cent of the population. Innovation policies should shift from a place-blind to a place-sensitive approach. The UK's nations, cities and regions need resources and capacity to build and develop their own innovation priorities. Institutions like UK Research and Innovation must take on new responsibilities for geographical rebalancing.
- 3. A more proactive approach to guiding innovation in the public interest.** Market forces alone do not always produce innovations that create societal value and sometimes produce innovations that are harmful. The government should develop institutional infrastructure for more proactive, democratic governance of innovation, enabling the UK's innovation system to fully embrace a mission-led approach to R&D and to take advantage of new, anticipatory approaches to regulation.

Our 15 recommendations are summarised below.

Problem	Recommendations
<p>COVID-19 has exposed the precarity of many workers and sectors</p>	<p>Building the productivity and resilience of the wider economy</p> <p>Using innovation to raise the productivity and resilience of essential sectors like care, retail and hospitality</p> <ol style="list-style-type: none"> 1. Introduce a new settlement for frontline workers and sectors, funding innovation to improve pay and resilience in those parts of the economy that have been hardest hit in the struggle against COVID-19. 2. Use testbeds both to stimulate innovation in the foundational economy and to increase the supply of innovations developed at the frontier that are readily applicable to the foundational economy. 3. Task the Economic and Social Research Council's new productivity institute to look specifically at improving work, productivity and pay in foundational sectors. 4. Invest in increased support for low productivity firms and sectors to adopt basic technologies and management practices, and in an expanded evidence base on the impacts of this kind of 'catch up' diffusion. 5. Produce guidance and resources for firms in the public and private sectors that want to start using digital tools, but are concerned about managing the legal and ethical issues. 6. Create an 'automation pioneers' programme to incentivise firms that want to introduce automated processes in their business in a manner that improves, rather than replaces, jobs.
<p>COVID-19 threatens to worsen regional inequality</p>	<p>Addressing regional inequality</p> <p>Using investment in innovation as a tool for regional development</p> <ol style="list-style-type: none"> 7. Devolve a significant proportion of public R&D funding to the nations, regions and cities of the UK as part of new Deals for Innovation-Led Recovery. 8. Accompany investment in innovation hubs with measures to ensure that the benefits they create are widely felt. 9. Create regional offices of UK Research and Innovation (UKRI). 10. Create greater latitude for decision makers, both at a national and a regional level, to prioritise equity. 11. Invest in innovation mapping tools to provide a better understanding of what innovation is happening and where. 12. Make public R&D investment more transparent, in particular by making available more data on the regional and sectoral spread of existing support.
<p>Innovation will be essential to recovery, but will only be acceptable if its value is clear to the public</p>	<p>Steering innovation for the public benefit</p> <p>Guiding and regulating innovation to deliver maximum public benefit and minimise potential harms</p> <ol style="list-style-type: none"> 13. Maintain commitment to mission-led innovation policy and expand funding for innovation that is directed to tackling societal problems. 14. Continue to support regulators to take a more anticipatory approach. 15. Configure the regulatory system to be anticipatory 'by design'.

Introduction

Innovation will be vital to Britain's economic recovery. But unless we change the way innovation is funded and supported, recovery will leave too many people and places behind.

The UK's innovation performance is well above the EU average, and has increased steadily over the past decade.¹ But the UK's recent achievements in cultivating and supporting innovation have failed to coincide with broadly felt prosperity.

Despite record low unemployment rates,² the British economy in 2019 was not one that unequivocally worked for most people. Productivity was low and stagnant by European standards and, despite some recent growth, wages were still lower in real terms than before the 2008 financial crisis.³ The UK also had some of the highest levels of economic inequality in the developed world,⁴ along with some of the highest levels of regional inequality.⁵

In addition to weak and uneven economic performance, anxiety was mounting about the broader consequences of technological innovation, from its potential to increase inequality⁶ and its impacts on marginalised groups, to the undermining of democracy and the reduction of human agency. And while the public had a clear appetite for new technologies to be managed to mitigate such risks and harms,⁷ less than a third were confident politicians were doing enough.⁸

The COVID-19 pandemic stands to make these problems more acute. As the UK reels from an economic shock likely to be far worse than that of 2008, attention will inevitably turn back to regional inequality, low pay and stagnant productivity – all of which will have been exacerbated by the downturn and a lockdown that has affected various sectors very differently.

Likewise, as governments look to technological innovations to help deal with the outbreak (and prepare for future shocks), the need to secure public trust in the management and value of new technologies will become far more important. More than ever, innovation policymakers will have to show how scarce public resources invested in innovation are delivering for ordinary people, and how innovations can be guided and controlled to work in the public benefit.

This report argues that innovation policy in the UK has helped create some of the problems we now see in the UK's innovation performance. Insufficient attention to the kind, location and direction of innovation has helped create an economy in which innovative practice – while world-leading in many areas – is concentrated in a small handful of places and sectors, benefiting far fewer people than it could and worsening economic inequality.

Rebuilding the economy in the wake of the COVID-19 pandemic requires a new approach to innovation. To use the UK's technical and creative ingenuity to build the fairer, more resilient and more balanced economy that many will come to expect, policymakers will need to take a broader, more inclusive view of the aims and scope of innovation policy. Innovation must be directed for the common good.

2

Key challenges for the UK innovation system

It is widely recognised that the UK under-invests in innovation compared to other leading economies. While increasing the country's R&D intensity should remain a priority, there are also other key challenges that post-pandemic innovation policies should address. Each of these is longstanding, but made more pressing as a result of COVID-19.

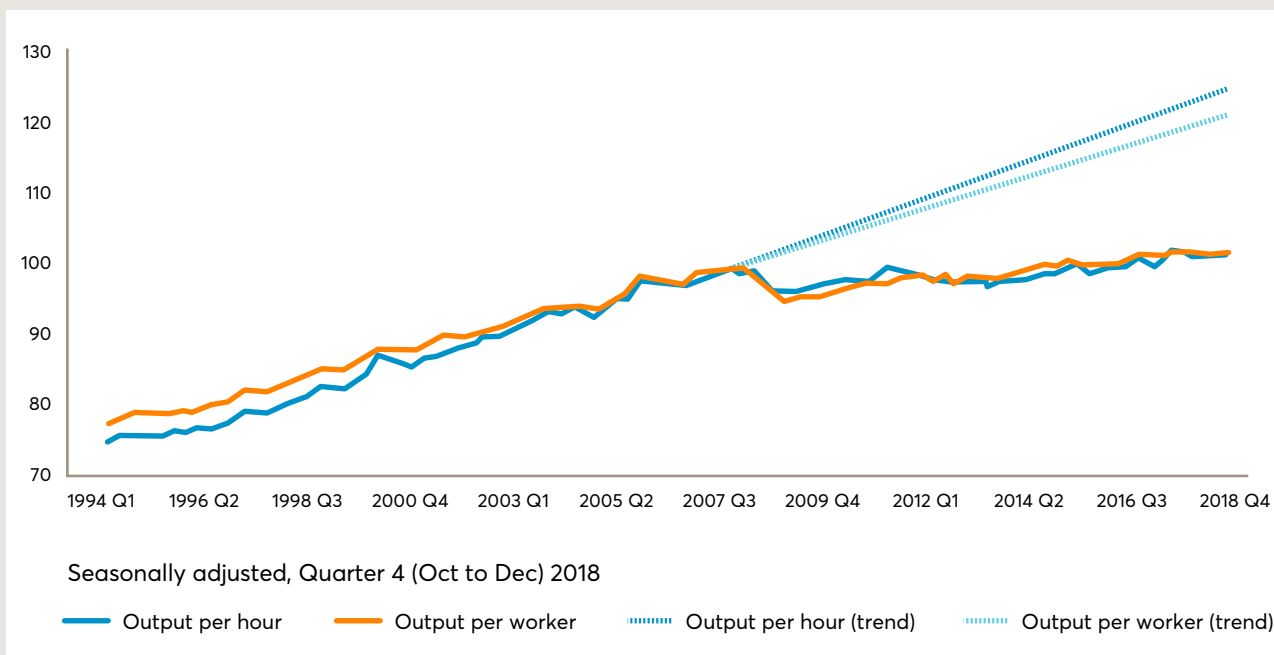
These challenges include: addressing low productivity and pay; spreading the innovation economy across the country; directing innovation towards big societal challenges while building economic and social resilience; and building public support for a high-tech economy.

Addressing low productivity and pay

Productivity in the UK is low and stagnant. In 2016, the average British worker produced 16 per cent less per hour than their counterparts in other members of the G7, according to the Office for National Statistics (ONS).⁹ (While the OECD has recently published an analysis suggesting that the UK's poor productivity performance relative to other countries may have been exaggerated by differences in the measurement of hours worked, the UK performs poorly on both the new and the old metrics.)¹⁰

A significant factor accounting for the UK's low productivity is its poor recovery after the 2008 financial crisis. While productivity growth levels fell across the world in the wake of the crash, other advanced economies experienced significantly greater recovery in productivity growth since. By 2017, UK productivity was 20 per cent lower than it would have been had pre-crisis growth trends continued. In light of the COVID-19 global recession, the UK's experience following 2008 should act as an important and sobering reminder that productivity growth does not necessarily or automatically return to pre-crisis levels.

Figure 1: The UK's productivity slowdown since the 2008 financial crisis



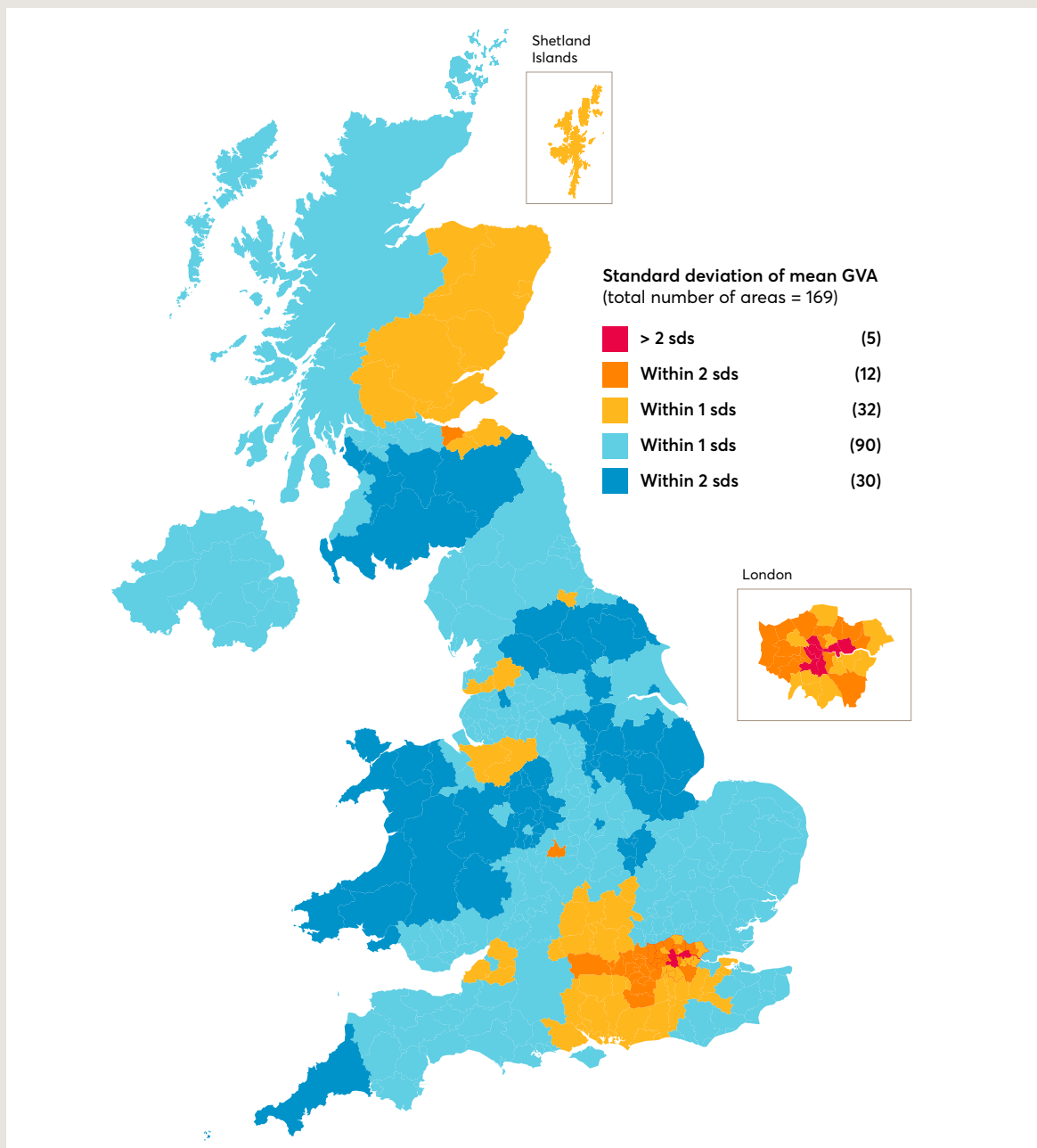
Source: The Office for National Statistics.

The UK's decade of poor productivity growth has had a marked impact on wages, with Britain having experienced the longest period of wage stagnation since the Napoleonic wars.¹¹ Before COVID-19, wages were not expected to return to their pre-crash peak until 2025 – it is likely that this date will now be pushed back further. Data from the ONS suggests that poor productivity between 2009 and 2019 has resulted in the average UK worker losing out on up to £5,000.¹²

Low productivity in a time of economic crisis might in fact be a good thing, signalling that firms are keeping staff employed and maintaining productive capacity (even if that capacity is not being fully utilised). However, the experience post 2008 shows that productivity does not always simply 'bounce back' when economic conditions improve. Several explanations have been put forward for the UK's poor productivity recovery compared to other countries. These range from the effect of low interest rates on sustaining otherwise unviable companies and the difficulty of measuring productivity gains brought about by digital technologies, to low levels of firm capital spending.¹³ With regards to the latter, it should be noted that companies' reluctance to invest in productivity-enhancing measures is likely both a cause and a product of low wages. Indeed, it has been suggested that low wages since the financial crisis (caused in part by the ready availability of cheap labour) have disincentivised companies from investing to raise the productivity of employees.¹⁴

In the longer term, improving the UK's productivity is vital to prosperity. But if the ultimate aim of increasing productivity is to raise wages and living standards broadly, innovation policy will need to pay more attention to how productivity gains are achieved, and how they are distributed across the economy.

Figure 2: Labour productivity distribution in the UK (Gross Value Added) 2017



Source: The Office for National Statistics.

In seeking to account for the UK's long-standing low-productivity levels, relative to other comparable economies, Bank of England Chief Economist Andy Haldane has emphasised the role of the UK's 'long tail' of less productive firms – pointing out that the 'long tail' in the UK is longer than in nations like France and Germany.¹⁵ By contrast, economist Patrick Schneider has drawn on firm-level data to show that the slowdown in productivity growth since 2008 is confined to the 'top tail' of the distribution of productivity across workers: "Workers at the most productive firms are failing to improve on each other at the same rate as their predecessors did."¹⁶

Cultivating and growing the innovative capacity of the 'top tail' might be the most direct way of improving aggregate productivity growth, given that this is the part of the economy responsible for the greatest recent fall in productivity. However, alongside the fact that much of the slowdown at the top was the result of exogenous factors that will be hard to reverse,¹⁷ it is unlikely that further productivity gains in this part of the economy (which employs a small fraction of the workforce in only a handful of places) would have a significant effect on median wages.¹⁸

In contrast, comparatively modest productivity gains in low-productivity sectors could have more substantial effects on median wages and living standards, because far greater numbers of people are employed in these firms and sectors. (In 2017, data from the ONS showed that 59 per cent of all employment in the UK was in low-productivity sectors.)¹⁹ There is also emerging evidence showing a correlation between more evenly distributed productivity and future productivity growth.²⁰ Should this relationship prove to be causal, it would further strengthen the case for a focus on improving the productivity of low-productivity firms and sectors.

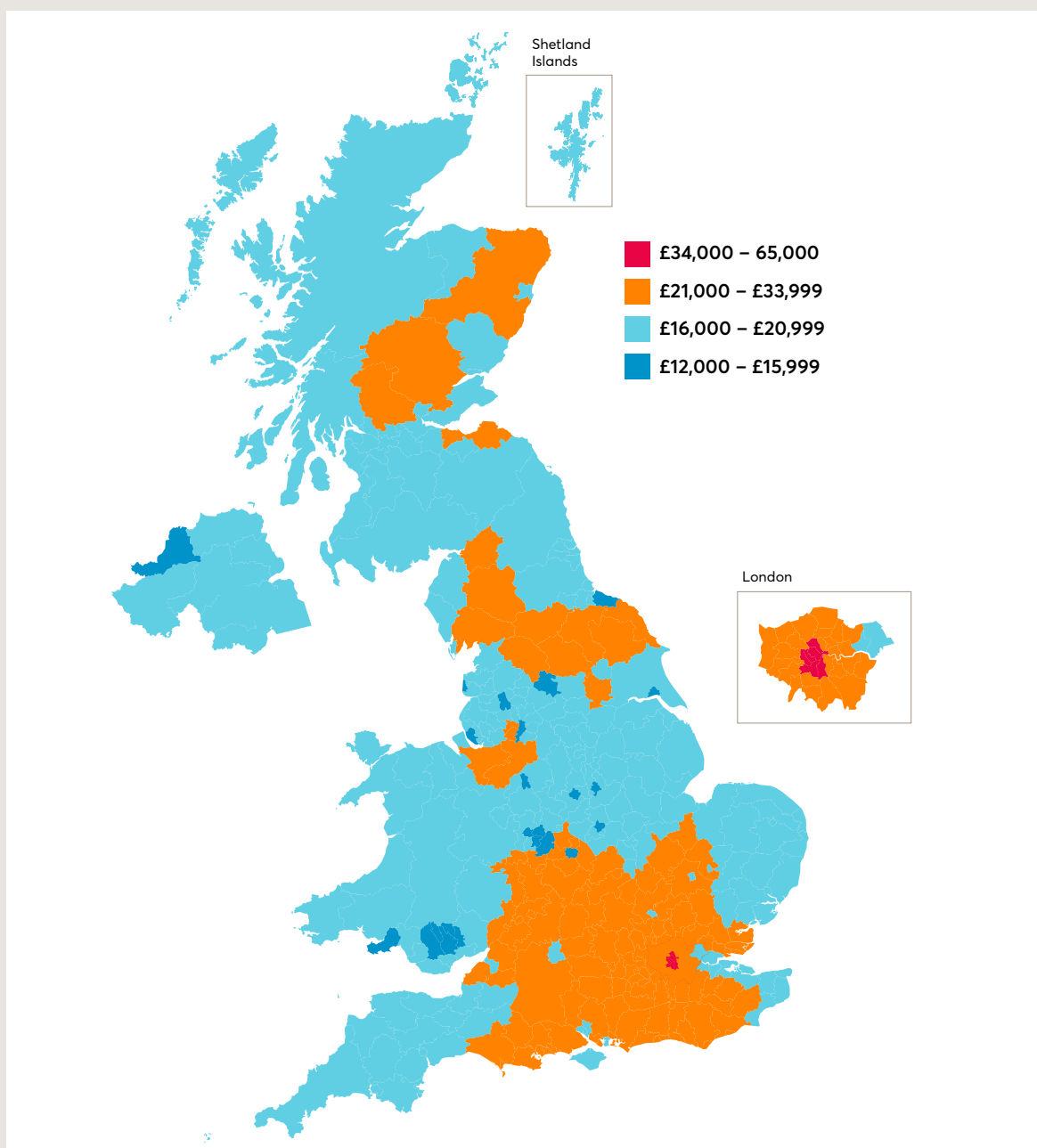
We argue that particular attention should be paid to increasing productivity in the foundational economy, which provides essentials such as housing, education, health and care, utilities, high-street banking and food. Though these sectors tend to be lower productivity, they account for over 40 per cent of the workforce, meaning that small improvements could have large effects. Moreover, as the foundational economy is to be found in all parts of the country, the productivity gains in these areas would result in more regionally balanced economic growth than equivalent gains at the high-tech frontier. It is also the foundational economy – and in particular the health and social care sectors – that will do the heavy lifting as the UK adapts to the pressures of an ageing population. The health and productivity of these sectors will be a major factor in determining whether or not the UK is able to rise to this challenge.

The way that productivity is raised also matters. Many productivity-enhancing innovations, such as the automation of mundane or repetitive tasks, can significantly enhance workers' wellbeing, freeing them up to devote more time to more stimulating or rewarding aspects of their jobs. Others, such as the emerging practice of using digital tools to monitor and direct workers' performance in real time (see the concept of 'the precision economy'²¹ developed by the RSA) may have a detrimental effect on the wellbeing and autonomy of the workforce (and the wages they receive). As well as raising productivity in the wider economy, innovation policy should work to ensure that this change occurs through the development and proliferation of productivity-enhancing technologies and practices that are beneficial to worker-flourishing – or at the very least, do not undermine pay and conditions.

Spreading the innovation economy across the country

Perhaps one of the most visible problems facing the UK economy is its high level of inequality. In 2018, the UK was the fourth most unequal advanced economy in terms of income, behind South Africa, Chile and the US.²² Wealth in the UK is also unequally divided, with the richest 10 per cent of households holding 44 per cent of all the wealth and the poorest 50 per cent holding just 9 per cent of it.²³

Figure 3: Gross disposable household income across the UK, 2018



Source: Office for National Statistics, Regional Gross Disposable Household Income (GDHI): 1997 to 2013.

But regional inequality is the area where the UK's problems are most obvious. A recent report from IPPR North showed that regional inequality in the UK has become the worst of any comparable developed country – and is growing.²⁴ This fact is reflected across most measures of economic performance. While rates of economic productivity in London and the South East are some of the highest in the world, parts of Wales, Northern Ireland and the north of England have productivity levels worse than regional cities in Poland and Romania. Job creation is similarly lopsided, with London and the South East having accounted for 30 per cent of the jobs created since 2010, despite being home to only 25 per cent of the population.²⁵ Recent analysis suggests that many of these regional inequalities are set to be made worse by the COVID-19 pandemic, with 20 of the areas predicted to be worst hit economically by the outbreak in the Midlands and the North West and only one in the South East or London.²⁶

The consequences of such pronounced regional inequality are equally stark. Geographical variations in life expectancy are significantly higher in the UK than in the majority of developed nations. Average life expectancy at birth in Glasgow, for instance, is 73 years, a full decade lower than the average for those born in the Chilterns.²⁷

Regional inequality of this degree is not sustainable, polarising politics, undermining social mobility and, as IPPR North have described it, contributing to a 'geography of discontent',²⁸ with those living outside of the South East growing increasingly disenchanted with a status quo that seems only to work for one part of the country.

Fiscal transfers from the South East to the rest of the country can and do go some way towards ameliorating the adverse effects of such economic imbalances, but there is a limit to what they can achieve, and to how much redistribution is desirable in the long run. Though the South East subsidises the rest of the UK to the tune of just under £100 billion per year,²⁹ this arrangement cannot restore high-paying jobs, or a sense of pride and optimism, to worse-off parts of the country. Rather than resorting to ever more extreme regional redistribution, concerted efforts must be made to develop the economy outside of the South East.

The root causes of the UK's regional inequality are complex and long standing, but the uneven geographical distribution of innovative, high-productivity economic activity is a significant factor. Innovation of this kind needs to take place in a friendly ecosystem – against a backdrop of other similar firms, large 'anchor' institutions and informal knowledge networks – and as such, tends to cluster in particular places, creating localised hubs of innovation. In the UK, these hubs are predominantly located in London and the South East, with relatively few elsewhere. Richard Jones has recently argued that the UK's lack of regional hubs is a direct cause of the UK's geographically imbalanced economic performance.³⁰

Crucially, experience from other countries suggests that innovation policy, and particularly the direction of public R&D spending, can be used to address this problem. In a recent paper for Nesta, Jones and Forth outline how channelling R&D spending towards previously poor regions of east Germany has contributed to the development of innovation clusters in these places, and to their recent economic resurgence relative to comparable regions of the UK.³¹

Given this, a key challenge for innovation policy over the coming decade will be to build the innovation systems of those parts of the country beyond the south of England.

Directing innovation towards big societal challenges, while building economic and social resilience

Like many other advanced economies, the UK is set to face a series of large, society-wide challenges over the coming decades, from dealing with the effects of the climate crisis and navigating economic displacement brought about by the fourth industrial revolution, to finding ways to cope with and make best use of an ageing population.

The UK's success in responding to these challenges will depend, to a large degree, on the extent to which it can bring its innovation system to bear on them. Perhaps most obviously, the UK will need to rely on technological and scientific innovation to respond to ever more frequent and severe flooding, far hotter summers and the arrival of transmittable diseases previously unviable in the British climate. But we will also need to promote and facilitate a far greater degree of innovation and experimentation to find humane and sustainable ways to care for an older population, and to help people thrive across considerably longer, more varied and unpredictable careers and lifespans.

Crucially, we argue that innovation of this kind and scale will only be possible with state support and direction, requiring government efforts to create and shape new markets, carve out spaces for real-world testing and experimentation, set regulatory standards and provide targeted investment and tax cuts.

Although UK innovation policymakers today often frame their work in terms of directing innovation towards the pursuit of grand societal missions of this kind, more work needs to be done to ensure that this emphasis is material rather than merely cosmetic. UK innovation policy's tendency to direct money and support towards technologies of historical significance or where the UK happens to have a competitive advantage could be in tension with this objective.

As well as being far more orientated towards specific future problems and challenges, the UK's innovation system also needs to be used to foster more general economic and societal resilience in the face of future disruptions. The COVID-19 pandemic has exposed the fragility of many of our economic and social arrangements. In particular, our reliance on efficient but tenuous 'just-in-time' supply chains for food and other essential goods, our flexible labour market and our 'streamlined' public services have proven ill-equipped to deal with unforeseen pressures and prolonged deviation from business as usual.

Yet the disruption and economic damage caused by COVID-19 will pale in comparison to that caused by the climate crisis, on even the most optimistic predictions for global temperature rises.^{32, 33} It is also impossible to predict the exact nature of the disruption that the climate crisis will bring about, meaning that economic and social arrangements will need to aspire to a general resilience and adaptability, rather than being designed in response to specific, narrowly defined conceptions of future challenges.

Just as economies with a greater variety of kinds of financial institutions tend to be less exposed to (and tend to better weather) financial crises,³⁴ economies with a greater diversity of institutions tend to be better placed to adapt to crises and unforeseen changes.³⁵ The connection between innovation and resilience is also borne out at the firm level. There is evidence that greater levels of innovation are correlated with greater post-crisis profitability and demonstrate greater resilience.³⁶ Moreover, firms with a track record of innovation have been shown to better weather periods of recession.³⁷

To build this kind of resilience, innovation policy will need to expand its focus from technological innovation to fostering experimentation and innovation in organisational and institutional forms. In addition to expanding the arsenal of responses to unforeseen challenges, businesses and public-service providers who are used to experimenting with and testing out new ways of working will be far better placed to quickly adapt business and operating models in the face of exogenous shocks.

Building support for a high-tech economy

Science and technology feature heavily in the government's plans to 'level up' the economy post-Brexit.^{38, 39} Yet, for all the ambition, any concerted efforts to establish the UK as a 'science superpower' or to restructure the economy around the technologies of the 'fourth industrial revolution' stand to be highly expensive, disruptive and risky.

One immediate challenge for innovation policy is therefore to build institutional support: ensuring that the British innovation ecosystem is set up to direct and regulate the rapid development and roll-out of new technologies so that risks are managed and public benefit is maximised. As a de facto testing ground for new technologies, the UK will need a regulatory system able to consistently anticipate the challenges and trade-offs that emerging technologies present, and guide them to develop in forms that align with both the national interest, and public values and priorities. The UK already has a comparatively sophisticated approach to the regulation of emerging technologies, which constitutes a major asset and contributes to the attractiveness of the UK as a place to innovate.^{40, 41} As these techniques become more important, the regulatory system will need to be configured so that they become the default, rather than examples of best practice.

A related challenge is that of building public support. In addition to increasing the UK's capacity to manage innovation, more needs to be done to democratise decisions about how it is managed. Facing what stands to be a far worse economic downturn than that following the 2008 financial crisis, ensuring sustained public and political support for increased spending and emphasis on emerging science and technology will be critical.

In addition to the strong intrinsic reasons to develop and roll out transformative technologies with public consent, there are practical arguments for securing buy-in. Public backlash against a new technology or innovation can do significant and long-standing damage to a state's attempts to develop a competitive advantage in that field. Early delays or a loss of stakeholder confidence can lead to expertise and investment migrating elsewhere – a trend that can be very difficult to reverse once set in motion.⁴²

Recent Nesta research on public attitudes towards innovation shows the public to be generally in favour of investment in innovation, science and technology, and to believe that calculated risk-taking to be necessary to drive society forward.⁴³ However, there is also substantial evidence that this support is conditional. In particular, failure to convince the public that new technologies are being developed and rolled out in the public interest (understood more broadly than just GDP growth), and that the benefits and risks will be effectively and fairly managed, can result in the rapid withdrawal of support.⁴⁴

The importance of securing a 'social licence' for the roll-out of innovations is illustrated vividly by the fate of NHS England's care.data scheme for sharing patient information, which was aborted due to widespread public concerns and opposition. Importantly, care.data's abandonment was not the result of the intrinsic unacceptability of the scheme, but of its proponents' failure to meaningfully involve the public in designing it in a way that took account of and attempted to minimise its potential harms. Indeed, the Scottish Healthcare Informatics Programme, an initiative to engage the public on how the risks and benefits of NHS data sharing might be shared and managed, resulted in a blueprint for the practice that has so far avoided the opposition experienced south of the border.^{45, 46}

3

Why a new approach to innovation policy is needed

Innovation policy could play a key role in tackling high inequality and regional variations in productivity growth, building economic and social resilience, and readying the UK to tackle big societal challenges like global heating. But recent UK innovation policy exhibits tendencies that make this difficult. It has under-emphasised diffusion, given little attention to equity and been hesitant to actively guide the direction of innovation.

In this paper, we argue that this approach to innovation policy undermines the long-term health of our innovation system, because it does not sufficiently convert innovation into broadly felt economic gains, and fails to generate the most public benefit from new technologies.

Innovation policy has underemphasised diffusion

Innovation policy needs to broaden its remit, focusing not only on the technological frontier, but on how innovation can spread to, and benefit, a much wider section of the economy.

Since the 1980s, when Margaret Thatcher all but ended public support for 'near-market research',⁴⁷ the UK has invested far more public money in research than in developing, testing and commercialising innovation. In 2019, Innovate UK received just over 10 per cent of the public R&D budget, while 43 per cent went to the research councils.⁴⁸ In contrast, the ratio between research and innovation is much closer to 1:1 in other competitor nations.⁴⁹

However, the problem is not just that the UK under-invests in innovation, but that it has a narrow view of where innovation happens. The vast majority of support and funding for innovation in the UK is directed towards high-tech, frontier activity. The Industrial Strategy Challenge Fund (ISCF), for example, focuses heavily on STEM-intensive manufacturing. Our own analysis suggests that 16 out of the 22 ISCF challenges announced since 2018 are directed towards STEM-intensive industries, with just 22 per cent of funding allocated

to other sectors like construction, the creative economy and health and social care and services. This effectively limits the 'innovation economy' to a small sub-section of firms. A recent study estimated that sectors targeted by the ISCF employ just 1 per cent of people in the UK, even on a generous definition.⁵⁰

There is little support for innovation away from the frontier or for diffusion of innovation to the 'long tail' of low-productivity firms. In his widely cited 2018 speech on productivity, Andy Haldane argued that the UK in fact overlooks three 'D's – not just development, but also diffusion and dissemination.⁵¹ While Germany, for example, has a well-established 'diffusion infrastructure' to help non-frontier firms adopt innovation, the UK's is underdeveloped and under-resourced. The Catapult Network, set up to mirror Germany's Fraunhofer Institutes, which currently have a combined annual research budget of €2.8 billion,⁵² had a core budget of £237 million in 2018.⁵³ As a result, the Catapult Network in practice works mainly with leading-edge SMEs, 'leaving largely untouched the long tail of UK companies'.⁵⁴

A core problem is that diffusion has, for many years, been left to the market, under the presumption that business competition and the pursuit of greater margins would drive 'non-frontier' firms to adopt innovations that are available in the marketplace. The rationale for government intervention in 'frontier-firm' innovation – that new-to-market innovation invariably creates spillovers, which cannot be fully captured by the firm concerned and are therefore a form of public good – does not exist to the same extent in the case of diffusion.

As a consequence of this, where support for diffusion is available, it is small scale. In total, the 2018 Budget allocated £56 million to initiatives to enhance the productivity of UK businesses, of which £11 million went towards the creation of a programme to provide small businesses with leadership training, £20 million to strengthen local business improvement networks and £25 million to the Knowledge Transfer Partnerships programme, allowing a mere 200 additional businesses to take part.^{55, 56}

Efforts to better understand the barriers to technology adoption in SMEs are also relatively small scale. The Business Basics Fund, developed in partnership with Innovate UK and the Innovation Growth Lab at Nesta, is the Department for Business, Energy & Industrial Strategy's main vehicle for finding new ways to support diffusion in smaller and lower-productivity firms. It uses an experimental approach to find out more about the barriers to SMEs adopting 'tried-and-tested' technologies and management practices, and to work out how best to support them to do so. At present, however, only £9.2 million has been allocated to the fund.

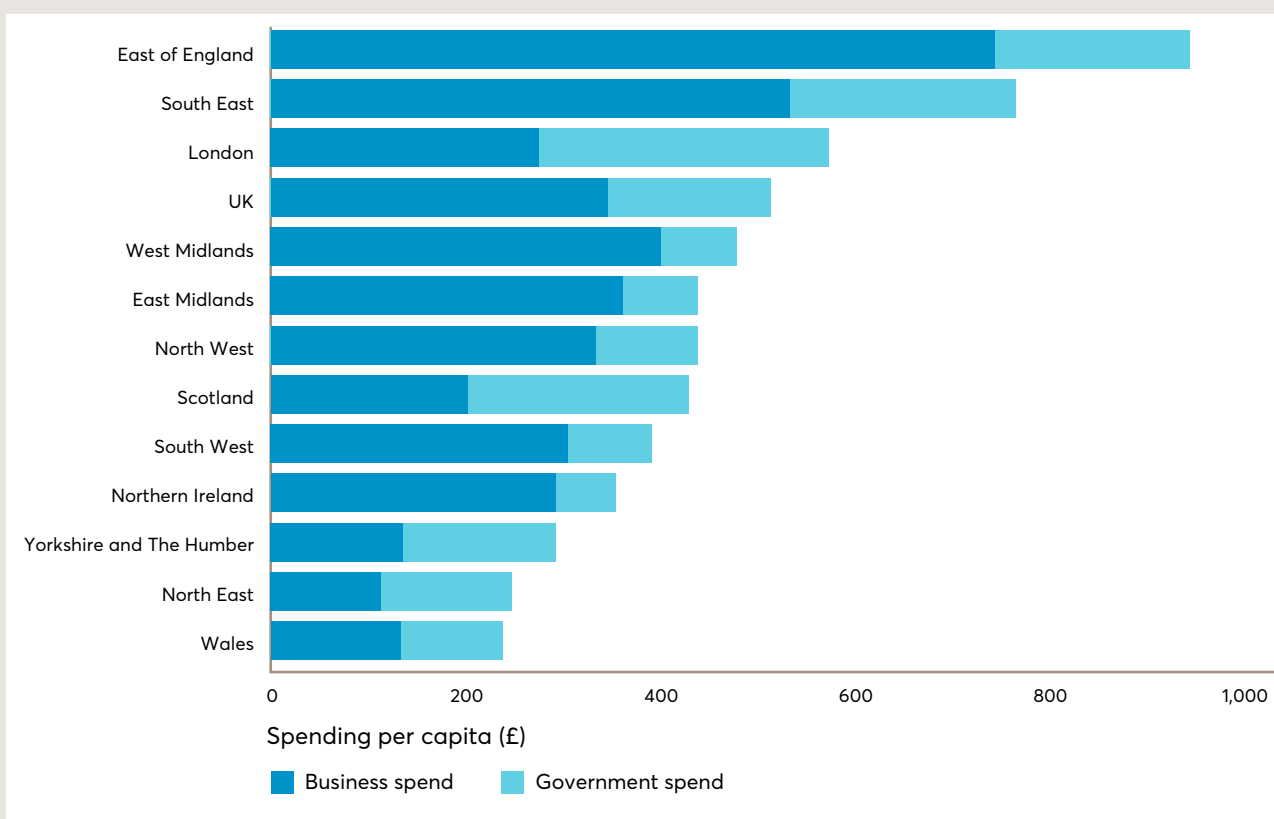
If the government wants to improve living standards across the UK, it cannot restrict itself to supporting productivity gains at the high-tech frontier. Government should acknowledge that, for reasons we do not quite yet understand, there is a market failure in terms of productive firms outcompeting the unproductive, and in terms of many firms failing to adopt innovations that should improve their productivity. In order to deliver broadly felt economic benefit, innovation policy must work for the whole economy: not just manufacturing but services; not just STEM-intensive industries but foundational and everyday sectors; not just leading-edge firms but the 'long tail'.

Innovation policy has given little attention to equity, and in doing so, has reinforced regional disparities

The principle of ‘investing in excellence wherever it is found’ has been repeated frequently in policy documents over the last two decades, from the circular announcing the Research Excellence Framework in 2007⁵⁷ to the influential Nurse review of UK research councils in 2015.⁵⁸

Emphasising that excellence will be supported ‘wherever it is found’ implies (intentionally) that excellence can be found anywhere. However, in practice, the distribution of public R&D funding would suggest that policymakers believe excellence is found mainly in one particular corner of the UK. In 2017, 42 per cent of government and research council expenditure on R&D took place in London, the South East and the East of England (regions which only account for around 36 per cent of the UK population).

Figure 4: Public and private spending on R&D across regions of the UK, 2016



Source: Eurostat, Office for National Statistics and Nesta.

The excellence-led funding approach has helped to create the regional disparities in innovation performance discussed in the previous section of this report. In practice, regions with more resources – those that are already ‘excellent’ – are better placed to attract further investment, further shoring up their advantages.⁶⁰ As the OECD notes, innovation policies can ‘unintentionally favour leading regions by rewarding excellence’.⁶¹

UK policymakers have long recognised these regional imbalances, but have remained committed to the principle of distributing public R&D funding based on excellence, arguing that to do otherwise would risk damaging UK strengths,⁶² and that growth in the most innovative companies and places will eventually benefit the whole country.

However, there is in fact little to suggest that the gains generated by high-tech innovation have translated into better wages in the rest of the economy. Though there is some evidence that increased productivity in leading firms raises wages at a sectoral level and acts as a job multiplier, it does not seem to have had an upward effect on wages in the wider economy – where the majority of people work.^{63, 64} Based on a review of the evidence around inequality, wellbeing and inclusive growth, the Productivity Insights Network concludes that ‘there is no evidence that higher levels of growth and productivity in certain sectors are shared across the population as a whole’.⁶⁵

Contrary to policymakers’ worries about damaging UK strengths, a more balanced economy might be stronger overall, as a recent report by think tank Onward points out.⁶⁶ Regional disparities suggest that productive resources are not being utilised efficiently. For instance, a 2018 report from the Chartered Institute of Personnel and Development found that over one third (37 per cent) of workers have the skills to cope with more demanding duties than they currently have.⁶⁷ Nor is it clear that directing resources to create a more balanced economy would threaten areas of UK strength. Areas that are already excellent are better positioned to attract private investment, so may not need such a high level of public funds. Meanwhile, rewarding established excellence while ignoring areas of emerging excellence could, in the long term, lead to the UK falling behind.

In the last few years, ‘place’ has started to feature more strongly in UK innovation policies and this tendency has intensified since the election of the Johnson government in 2019, with the introduction of a narrative of ‘levelling up’. A speech by the then-Science Minister, Chris Skidmore, in January 2020 appeared to go further than previous policy statements by committing to ‘ensure that more public R&D funding is being driven to places where, despite historic under-investment from the state, private investment has been flowing freely, and where it is ready to flow even faster.’ With more money on the table, it was implied that both excellence and equity could be supported.

Yet as things stand there is still very little funding that is geographically targeted. Devolved governments and regions have instead mainly relied on EU funds to support initiatives to promote research and innovation. Between 2014 and 2019, the European Regional Development Fund (ERDF) provided £426.5 million of investment in research and innovation across the UK. While the government has announced a new Shared Prosperity Fund⁶⁸ to replace the ERDF post-Brexit, it has not yet confirmed details of how this will work.

The one UK government initiative aimed at directing R&D funding specifically towards the regions is the Strength in Places Fund.⁶⁹ However, at just £236 million in total, Strength in Places formed less than 0.5 per cent of the government R&D budget in 2019/20,⁷⁰ far '...too modest to drive any significant rebalancing of investment'.⁷¹ As a competitive scheme, it is also poorly configured to distribute funding and support to places with innovative potential, but which are starting from a low base. Those places that could most benefit from the funding it provides are therefore least able to draw on its resources.⁷²

As the long-term economic impacts of COVID-19 start to bite, the government's commitment to 'levelling up' less prosperous regions of the UK – many of which are set to be the hardest hit – will become all the more relevant. If the government is to hold on to its broad coalition of support, it will be vital to do everything possible to prevent the gap between the most and least prosperous parts of the country growing rapidly wider. If innovation policy is to have any hope of doing this, it cannot continue to focus exclusively on excellence. Instead, policymakers will have to recognise the deep distributional ramifications of R&D spending decisions, and be far more prepared to allocate resources with a view to helping some regions catch up with others.

Innovation policy has been hesitant to actively guide innovation

While the previous two sections have focused on innovation's economic effects, another question to consider is the influence of policy on the broader impacts of innovation.

In the years following the Thatcher government, UK innovation policy took a decidedly laissez-faire turn, underpinned by the twin beliefs that the market was better placed than the state to select and support promising innovations and that,⁷³ under healthy market conditions, most innovations would deliver broad public benefit in the long run.⁷⁴

Since the late 2000s, however, there has been a gradual but marked move away from the former view, with policymakers having become increasingly open to investing public money in innovation and directing it towards certain sectors and industrial challenges.

This development has been spurred on by a mounting body of evidence showing how public spending on innovation does not necessarily crowd out private investment – and that in fact the opposite is often true. A 2015 report commissioned by the Department for Business, Innovation and Skills estimated that a one per cent increase in public expenditure on R&D would lead to between a 0.48 per cent and 0.68 per cent increase in private expenditure on R&D – or between £1.13 to £1.60 for every pound spent.⁷⁵

Likewise, Mariana Mazzucato has made a strong – and very influential – case for the direction of innovation, arguing that states have a role not just in fixing markets, but in shaping them. According to Mazzucato, the emergence and diffusion of new, transformative technologies is often dependent on a shift in technological and economic paradigms that market actors have neither the power nor the incentives to bring about. Instead, such changes, such as the wide-scale adoption of the car, have relied on government efforts to create and shape new markets, set regulatory standards (for instance, technical standards to ensure interoperability, and consumer protection standards to encourage adoption) and provide targeted investment and tax cuts.⁷⁶

Notably, Mazzucato's work has helped create interest in 'mission-oriented' innovation policy, which is reflected in the four 'grand challenges' set out in the 2017 Industrial Strategy white paper and the challenge-driven approach of the ISCF.

However, while policymakers have become increasingly comfortable with the idea of more interventionist innovation policy, the scale of such interventions has remained small, with the ISCF representing around five per cent of total government R&D investment.⁷⁷

Moreover, the scope and motivation for such intervention has largely focused on developing competitive advantages in the industries of the future (such as AI and drones) and overcoming technical challenges with economic relevance. For instance, though the Industrial Strategy grand challenges are couched in terms of overcoming broad societal threats, such as the climate crisis and the ageing population, the underlying motivation is explicitly around fostering world-leading innovation in particular areas where the UK has pre-existing strengths.⁷⁸

A lack of measures aimed at addressing the broader impacts of innovation 'upstream' – in particular through directed funding and proactive regulation – is problematic for at least two reasons.

Firstly, the underlying assumption that, under healthy market conditions, most innovations deliver public benefit in the long run has always been questionable: in the absence of countervailing forces, new technologies often take forms or are commercialised in ways that deliver little social or economic benefit, or that actively distort the economy and work against the public interest.⁷⁹ For example, some technologies make huge amounts of money for small numbers of people, but deliver little to no wider economic or social value. Perhaps the epitome of this is high-frequency trading, which uses algorithms and significant amounts of computing power to make large numbers of trades in fractions of a second. Thomas Peterffy, one of the originators of the practice, has recently argued that it has 'absolutely no social value'.⁸⁰

In other cases, technologies are commercialised in ways that have significant economic and social ill effects. The emergence of what Shoshana Zuboff has termed 'surveillance capitalism' is a good example of how a set of innovations have been deployed in a manner that tends towards monopolisation and the reduction of human agency.⁸¹

Secondly, it is not at all clear, as has been historically supposed,⁸² that the ethical and social effects of innovation and innovation policies can be addressed effectively after the fact through regulation.

The biggest obstacle to the post hoc regulation of new technologies has become known as the Collingridge dilemma: when new technologies and business models do present clear harms that require regulation, these often only become apparent to regulators well after they have become commonplace. By this time, the innovations in question have often become so integrated into economic life that post hoc regulation is extremely difficult. Uber provides a recent example of this phenomenon: concerns have been raised about

the ride sharing service's impact on workers' rights, market competition, environmental considerations and passenger safety. But, as Uber is now a relied-upon part of the transport infrastructure and source of income for drivers in many cities, addressing these problems systematically is hard.⁸³

The difficulty of dealing with the broader societal and distributional consequences of innovations after the fact underscores the case for innovation policymakers to take steps to address them as early as possible. As early funding and regulatory standards have significant power to affect the development of emerging technologies and their societal impacts,⁸⁴ there is a strong case for newly interventionist innovation policy to broaden its remit to consider these wider, vitally important factors.

Fortunately, there is a growing body of regulatory practice that could be used to direct innovation to have better societal outcomes. In recent years, the difficulty of reactive approaches to the regulation of innovations has been an important driver of the emergence of a new set of proactive regulatory practices, focused on enabling regulators and governments to identify and address thorny regulatory challenges as early as possible, to understand public views on challenges raised by them and to actively guide innovations in benign directions. These techniques, collectively known as 'anticipatory regulation', stand to be invaluable in enabling governments to effectively direct and manage the consequences of innovations.

The next wave of UK innovation policy needs to place far greater emphasis on harnessing and directing innovation for public benefit, especially in light of government ambitions to make science and technology increasingly important to the UK economy. This will mean not just building on the steps already taken to shift to a more mission-oriented approach, but broadening the motivations for these missions beyond the economic. It will also entail actively using the regulatory system to shape innovation so that its value to the public – and their support for greater levels of innovation – is maximised. In the long run, far more will need to be done to build on the UK's existing regulatory strengths, creating a regulatory system able to consistently anticipate the challenges and trade-offs presented by new technologies, and capable of guiding them to develop in forms that align with the national interest, and public values and priorities.

4

Innovation policies for sustainable, inclusive economic recovery

There will be many pressing calls on public budgets as the UK attempts to recover from the impact of COVID-19. Investment in innovation should continue to be a priority. But innovation policy needs a far stronger focus on creating prosperity that is broadly felt. We argue that the government should:

1. **Create innovation policies that serve the whole economy, not just 'frontier' sectors.** More investment is needed to help innovation to diffuse across the economy and to support innovation in sectors that are not normally thought of as being at the technological frontier, like social care and retail.
2. **Shift from a place-blind to a place-sensitive approach to innovation policy.** A significant proportion of the public R&D budget should be devolved to the UK's nations, cities and regions. Institutions like UK Research and Innovation should take on new responsibilities for geographical rebalancing.
3. **Develop institutional infrastructure for more proactive, democratic governance of innovation,** enabling the UK's innovation system to fully embrace a mission-led approach to R&D and to take advantage of new, anticipatory approaches to regulation.

Priority 1: Spreading innovation beyond the high-tech frontier

Government efforts to stimulate innovative, high-skilled economic activity outside of London and the South East must go hand in hand with measures to improve productivity, pay and conditions in the less innovative sectors and firms that employ the majority of the UK workforce.

As argued above, improving low levels of productivity in foundational and everyday sectors of the economy, such as care, retail and hospitality, and in smaller less productive firms, is key to raising wages and living standards for the majority of the UK workforce.

This requires investment to support the diffusion and adoption of technology. The COVID-19 crisis is both forcing firms of all sizes to digitise,⁸⁵ and highlighting the challenges they face in doing so.⁸⁶

The need to improve the diffusion of new technologies is particularly acute in the case of automation. It is predicted that three-quarters of the productivity gains from automation will come from the broader adoption of existing technologies, rather than advances at the frontier.⁸⁷

But as argued above, the means by which firms automate will make a significant difference in how the impacts of automation are felt in society. The IPPR have argued that, to avoid drastic increases in inequalities of wealth, wages and power, attempts to accelerate the diffusion of automation through the UK economy should be accompanied by measures to regulate and manage the roll-out of the technology, such as the formation of a regulator covering the use of robotics and AI.⁸⁸ In the shorter term, we believe that more could be done within existing institutional structures to equip and encourage businesses and public sector organisations to adopt such technologies in a manner that is more conducive to the mitigation of these risks.

The provision of authoritative guidance for businesses is one example of a useful measure that could be made relatively quickly. There are already some signs of uncertainty among firms and public sector organisations about how to automate parts of their businesses in an ethical manner, and of demand for clear practical guidance on this. In sectors like HR, where AI already has several clear applications, research has shown that these worries constitute a barrier to adoption.⁸⁹ Businesses responding to a consultation by the Centre for Data Ethics and Innovation expressed a desire for the body to provide guidance for companies using data and associated technologies.⁹⁰ While organisations like the Confederation of British Industry have been quick to respond to this demand, publishing a practical guide on ethical automation for its members,⁹¹ this support needs to be universally available.

Finally, foundational sectors can also be sources, not just adopters, of innovation. For example, in social care, a growing number of 'age-tech' ventures are emerging, using technology to improve older people's quality of life. However, as a review of the ageing innovation system by the Centre for Ageing Better points out, successful innovation in sectors like these does not only revolve around technology. In foundational sectors, technological innovations will often need to be accompanied by social or organisational innovations, for which there is currently little support. Social care is a particularly good example of this: new technologies can help transform the way that society looks after the elderly for the better, but only if new social and organisational arrangements are also put in place to make best use of new technological capabilities.

Recommendation 1: Introduce a new settlement for frontline workers and sectors, funding innovation to improve pay and resilience in those parts of the economy that have been hardest hit in the struggle against COVID-19.

One way of achieving this using existing institutions would be by allocating funding and support for innovation in the foundational economy through future waves of the Industrial Strategy Challenge Fund (ISCF). Like the ISCF's Healthy Ageing Challenge, these funds should support technological and non-technological innovations, products, services and business models, and should be explicitly open to charities and social enterprises, as well as commercial innovators. The design of these funds should reflect lessons learnt from the Welsh Foundational Economy Challenge Fund. In particular, it should include greater focus on raising awareness of the programme to ensure a deep and diverse pool of applications, greater provision of non-monetary support and guidance, and clearer commitments to scaling up or testing successful innovations further.⁹²

Recommendation 2: Use testbeds both to stimulate innovation in the foundational economy and to increase the supply of innovations developed at the frontier that are readily applicable to the foundational economy.

For instance, the government could provide support for testbeds (initiatives that provide a controlled or bounded space for testing innovation in real-world, or close to real-world, conditions⁹³) that focus on working out how to make best use of emerging technologies, and organisational and social innovations, to improve productivity in particular sectors of the foundational economy. In cases such as social care, this could enable technological innovators and service providers to experiment together to establish if and how new technologies:

- Can be developed to enhance current operating models and models of service delivery.
- Offer the potential to fundamentally redesign services in a better way and consider what such new organisational models might look like.

Recommendation 3: Task the Economic and Social Research Council's new productivity institute to look specifically at improving work, productivity and pay in foundational sectors.

The formation of this new productivity institute is an opportunity to investigate how to address the poor productivity performance of the UK's foundational sectors. In order to develop a body of evidence on how best to support such sectors and firms to successfully adopt innovations and new ways of working, the new entity should have a greater focus on undertaking practice-oriented research and pilots in close conjunction with firms and workers' representatives.

Recommendation 4: Invest in increased support for catch-up diffusion and an expanded evidence base.

The government should consider expanding the size of the Business Basics Fund, allowing it to run more pilots and collect more evidence about the best ways to encourage SMEs to adopt new technologies and management practices, and should develop a strategy to roll out its findings more widely. In the longer term, the government could consider expanding the fund into a larger entity with a wider remit that could extend to:

- Running pilots on SMEs' adoption of basic management and technologies, and on adoption of more advanced technologies, such as automation.
- Collecting evidence on the impact of adopting different technologies and practices on productivity and worker satisfaction.

Recommendation 5: Produce guidance and resources for firms in the public and private sectors that want to start using digital tools, but are concerned about managing the legal and ethical issues.

In order to help SMEs and organisations in the foundational economy to adopt data-based technologies confidently and ethically, a trusted government body such as the Centre for Data Ethics and Innovation could be tasked with providing resources on how to navigate these challenges. This could include granular and practical guidance on common issues firms might face in considering if and how to adopt such technologies. Such guidance could build on the principles laid out in the Data Ethics Framework developed by the Department for Digital, Culture, Media and Sport,⁹⁴ but could also be more specific and explicit, and may include sector-specific guidance.

Recommendation 6: Create an 'automation pioneers' programme to incentivise firms that want to introduce automated processes in their business in a manner that augments, rather than replaces jobs.

The government could explore ways of supporting and incentivising firms looking to automate to do so in collaboration with their employees and other relevant stakeholders. One potential way to do this would be to set up a voluntary scheme that would help employers work closely with employees, union representatives and other relevant stakeholders to agree on the best way to implement automation in the workplace. The design of such a programme could draw on lessons from the Danish Union HK's Innovation Lab, an initiative set up to enable union members and employers to co-design the automation of workplaces and the shape of future jobs.⁹⁵

Priority 2: Spreading high-tech innovation and its benefits more broadly

Innovation policy should shift from a 'place-blind' to a 'place-sensitive' approach. Imbalances in R&D funding between regions should be addressed, and a significant proportion of the public R&D budget should be devolved to the UK's nations, cities and regions. This should be accompanied by efforts to ensure that clusters of high-tech innovation do not only benefit high-skilled workers, but improve living standards for the wider communities that host them.

As argued above, UK innovation policy has paid little attention to addressing equity, and as a result, has reinforced pre-existing regional disparities. To address this imbalance, the government should act to increase research intensity in places outside London, the South East and the East of England. This will need to involve changing funding allocations and addressing the fact that currently, decision-making tends to take place far from the places affected.

Policymakers also need to pay more attention to innovation's role as a driver of inequality within places, and how this might be addressed. Hubs of high-tech innovation do not have a good track record of improving work and living standards for all those who live near them, with higher levels of high-tech employment corresponding only to modest increases in wages in local non-tradable sectors once rises in the cost of living are taken into account.⁹⁶ A 2017 study of American cities has shown that cities become more unequal the more innovative they become.⁹⁷ This analysis almost certainly applies to places like Cambridge, Oxford and London: poster children for dynamic, innovation-led growth and the UK's three most unequal cities respectively.⁹⁸ As Maria Savona has shown, 'innovation, in the form of R&D spending, is a mixed blessing, depending on the initial industrial structure' - while improving competitiveness, it can also contribute to polarisation within regions and increase the shares of lower quality, 'routinised' jobs.⁹⁹ As well as spreading innovation more broadly between regions, national and local policymakers should explore how they can spread its benefits better within regions.

Recommendation 7: Devolve a significant proportion of public R&D funding to the nations, regions and cities of the UK as part of new Deals for Innovation-Led Recovery.

As they look to rebuild after COVID-19, the UK's nations, cities and regions need tailored strategies for innovation recovery that respond to their specific industrial and employment structures and take account of differing needs and strengths (such as the existing balance of public to private investment in R&D). To build and develop their own innovation priorities, they need resources and capacity. The Strength in Places fund, the only geographically targeted R&D fund, is far too small scale for this purpose and the status of Shared Prosperity Fund, first announced in 2016 as a replacement for European Regional Development Fund (ERDF) and European Social Fund (ESF), is still unclear.

To address this, a substantial proportion of the annual public R&D budget should be devolved. Richard Jones and Tom Forth propose that 25 per cent of the uplift to R&D spending announced in the March 2020 Budget be devolved. If the uplift goes ahead as planned, this would put up to £2.5 billion per year by 2027 in the hands of the UK's nations, cities and regions. We believe this amount would be of a sufficient scale to drive a rebalancing of investment, if allocated on a needs-based formula. Devolution, however, should be a priority even if the uplift to R&D funding is revised given the budgetary pressures caused by the pandemic. Jones and Forth point out that in France, around €1 billion per year is spent by regional and city-region governments on R&D. This would seem a reasonable minimum.

Any significant devolution of R&D funding would only be successful if devolved decision-makers have sufficient capacity and expertise to spend it judiciously.¹⁰⁰ As noted by Jones and Forth, the devolved nations and several large city regions, such as Greater Manchester, Liverpool and the West Midlands already have significant analytical and institutional capacity. Other regions may need more support to develop their capacity to spend devolved funds.

This could point towards the use of a City-Deal-style model, with regions required to demonstrate capacity and provide credible plans before funds are devolved. Building on Jones and Forth's recommendations, we suggest that Deals for Innovation-Led Recovery should also include skills funding, with part of the new National Skills Fund also devolved. This would enable local decision makers to create holistic recovery plans that combine investment in R&D, business support and skills.

Devolved R&D budgets would also likely have to be ringfenced to ensure that funds were not redirected towards other priorities.

Recommendation 8: Accompany investment in innovation hubs with measures to ensure that the benefits they create are widely felt.

Jones and Forth make several recommendations about creating new science and technology institutions outside London, the South East and the East of England. These include establishing new translational research centres that can become 'poles' for innovation (like the Catapult Quarters proposed by CBI);¹⁰¹ investing in City Centre Innovation Districts; and investing in Advanced Manufacturing Innovation Districts on the edges of cities and towns.

These investments should be accompanied by measures to ensure that the activities these institutions carry out create as much direct benefit as possible to local communities. Interventions could include:

- Initiatives to incentivise innovative firms to offer apprenticeships and paid work experience placements to young people in the local area (as explored by Citizens UK in East London).¹⁰²
- Targeted skills programmes to enable local people to access jobs in innovation hubs, such as North Carolina's BioWork course, which trains residents for jobs in the state's rapidly growing biotechnology industry and is specifically designed to be accessible to at-risk or displaced workers from more traditional manufacturing subsectors¹⁰³ and the Assured Skills Programme in Northern Ireland, which develops short term training programmes for young people to meet the skills needs of local businesses.¹⁰⁴
- Support for participatory projects that bring together local authorities, businesses and local residents to co-design the layout and composition of new tech hubs, ensuring spatial design and amenities work for local residents on low incomes, as well as for the tech companies and their employees.
- Greater support for, research into and trials of mechanisms to address rising housing costs associated with places hosting hubs of innovation, such as community land trusts¹⁰⁵ and the use of a version of the Community Infrastructure Levy to strategically generate money for affordable housing from land value uplift.¹⁰⁶

Recommendation 9: Create regional offices of UK Research and Innovation (UKRI).

A regional structure for UKRI could act as a source of expertise for regional decision-makers. This would help ensure that local R&D funding allocation decisions are made with the best possible evidence and expertise, and that local decisions are joined up with national innovation and industrial strategy.

Building on and strengthening the role played by Innovate UK's network of regional engagement managers, who focus on representing Innovate UK in the regions, representatives from UKRI regional offices could act as advocates for their respective regions at a central-government level. They could advise the UKRI Committee for the Regions and Nations proposed by Jones and Forth, which would report directly to the UKRI main board and which would also include figures from devolved governments, key combined authorities and elected mayoralties.¹⁰⁷ In order to contribute to building the capacity of local institutions in the longer term, these regional offices could be embedded in combined authorities and would be expected to provide advice on the use of devolved R&D budgets.

Recommendation 10: Create greater latitude for decision makers, both at a national and a regional level, to make innovation policy decisions that prioritise equity.

It is often argued that there is a trade-off between equity and growth, and that innovation policymakers should therefore only pursue equity if it does not compromise growth.¹⁰⁸ We are not convinced this trade-off exists. There is good evidence to suggest that inequality is a drag on growth,¹⁰⁹ so in the longer term, promoting growth and equity should be seen as twin challenges, rather than trade-offs.

Even if it does, however, there is a case to favour equity at least some of the time. Nesta's research on attitudes to innovation in the UK has found that 67 per cent of the public prioritise making everywhere in the country more prosperous - even if this means progress in better-off areas is slower than it might have been otherwise - over improving the country's economy overall, even if some places do better than others.¹¹⁰

One way of creating greater scope to approach funding allocation differently within UKRI would be to add 'levelling up the regions and nations of the UK' into UKRI's missions and objectives, alongside creating economic, social and cultural impact.¹¹¹

Another mechanism would be to introduce a 'place test' for new investment in R&D infrastructure, with the default being that it is located in regions with low public sector R&D intensity.

Recommendation 11: Invest in innovation mapping tools to provide a better understanding of what innovation is happening and where.

Innovation mapping is a technique that uses data science methods and visualisation tools to help policymakers navigate and understand complex innovation systems. This could dramatically enhance the ability of local and regional governments to direct resources in a manner that fosters emerging innovative strengths and opportunities.

To avoid duplication of effort, we suggest that datasets and mapping tools should be created centrally and made openly available. Regional capacity for data analysis could be boosted by creating data analytics teams in regional UKRI offices.

Recommendation 12: Make public R&D investment more transparent.

Greater openness in data on use of public funds and tax credits would allow for analysis and improve understanding of the extent to which efforts to take a place-sensitive approach to innovation funding are working. For instance:

- UKRI should consider publishing the success rates of applicants from different regions and disciplines to enable greater analysis of which regions are doing well and which could be doing better.
- HMRC should consider publishing data on the firms that benefit from the R&D tax credit (including location, sector and size of company). While this data alone may be insufficient to clearly highlight regional imbalances, it would be useful in helping identify the kinds of firms and sectors that derive most and least benefit from the tax credit, and could potentially be used to identify individual innovative companies or pockets of innovation that could be further supported.

Priority 3: Developing more proactive, democratic governance of innovation

In order to better translate innovation into public benefit, mechanisms for governing innovation and emerging technologies should be more proactive and democratic, seeking to guide innovation to take forms that result in widely felt public benefits, addressing potential harms as early as possible and giving the public a meaningful say on the direction that innovation takes.

Industrial policymakers have considerable power to guide innovation in a direction that promotes public benefit. As we argue above, market forces alone do not always produce innovations that create societal value and sometimes produce innovations that are harmful. The public, too, is keen to see innovation address important social challenges, like making the UK's population healthier, as well as strengthen the UK's economy. This extends to prioritising social over economic benefit. In Nesta's research on public attitudes to innovation, 65 per cent of survey respondents said that the government should invest in innovations which solve social problems even if there is no economic benefit, while only 35 per cent agreed that the government should only invest in innovations where there will be an economic benefit to the country.¹¹²

One mechanism to achieve this is mission-oriented innovation policy, which aims to "galvanise different actors and sectors across the economy to work together to solve problems", by setting clear, measurable goals.¹¹³ As we note above, the UK has adopted a mission orientation through the inclusion of 'grand challenges' in the 2017 Industrial Strategy white paper. The government's more recent commitment to bring all greenhouse gas emissions to net zero by 2050 is also a mission-oriented policy, which is likely to guide innovation investments.

Yet at present, it is still unclear how the innovation missions already identified will be delivered. The Industrial Strategy Challenge Fund, which is UKRI's main mission-oriented funding instrument, is not strictly linked to the Industrial Strategy missions (its funding has been spread across 22 'challenges' so far, which are quite broad ranging in focus) and at around five per cent of total government R&D investment in 2019/20, is relatively small.¹¹⁴ We argue that missions of the scale of achieving net-zero emissions require substantial investment in both research and innovation and complementary investment to build capabilities, strengthen relevant parts of the innovation ecosystems and engage the public.

Another significant factor influencing the shape taken by new technologies is regulation. In its current form, however, the UK's regulatory system is not well configured to deal with the challenges presented by emerging technologies, undermining its ability to guide technologies to develop in beneficial ways.

One problem is that regulators struggle to keep pace with emerging technologies. In addition to exposing the public to potential harm in the short term, this can make long-term regulation difficult, due to the fact that technologies and business models can be very difficult to meaningfully regulate once they have become commonplace.

Another is that emerging technologies often present regulators with tough, value-laden questions, where different regulatory approaches will amount to choosing between different priorities and values. These are questions that regulators – who are set up to find ways to achieve outcomes specified by the government – have neither the capacity nor the mandate to answer on their own.

This can put regulators faced with such questions in a very exposed position. On the one hand, they can wait for guidance from politicians (which can be slow to materialise, if it materialises at all), while regulating the new technology according to the letter of the law as it stands – even if it may be obviously inadequate. On the other hand, they can choose to act without mandate, trying to mitigate some of the potential harm of the technology as they see it, but exposing themselves to challenge should something go wrong.

This problem is made harder by the fact that emerging technologies do not fit neatly into current regulatory categories. While some technologies are multi-purpose and therefore potentially fall under the remit of several regulators, others are so novel that no regulator seems especially well placed to take responsibility. This leads to a risk of inconsistent regulatory responses to the same technology, or to technologies going unregulated because every regulator assumes doing so is someone else's job.

In response to these challenges, the past few years have seen the emergence of techniques and principles aimed at helping regulators to be more proactive, coordinated and democratic in their approach to new technologies. In 2017, Nesta coined the term 'anticipatory regulation' to describe this emerging approach to regulation. Anticipatory approaches imply a more proactive, future-facing stance to regulation, developing regulatory frameworks alongside new technologies; greater emphasis on coordination and intelligence-sharing between different regulators and other stakeholders; and the use of public engagement to provide a short-term mandate for an initial regulatory response while regulators wait for more conclusive answers from elected representatives. Nesta's report 'A working model for anticipatory regulation', sets out the case for these techniques, along with a framework by which they can be understood.¹¹⁵

There is a growing acknowledgement of the need for these kinds of approaches within the UK regulatory system, along with some tentative but promising steps in this direction, including the establishment of the Regulators' Pioneer Fund (which provides grant funding for regulators to develop capacity to better regulate emerging technologies) and the Centre for Data Ethics and Innovation (tasked with providing advice and intelligence for government on the governance of AI and other data-driven technologies). More recently, the Department for Business, Energy and Industrial Strategy has begun setting up a new Regulatory Horizons Council to undertake horizon scanning of technologies presenting regulatory challenges and advise government accordingly. However, to truly allow for the effective, legitimate regulation of emerging technologies, the techniques of anticipatory regulation will need to be supported by institutional and legal infrastructure.

Recommendation 13: Maintain commitment to mission-led support and expand funding for innovation that is directed to tackling societal problems.

The government's commitment to mission-oriented innovation policy has not yet translated into significant shifts in investment priorities and implementation plans are not yet published. Meanwhile, discussions about a possible 'UK Advanced Projects Research Agency' have used the language of missions to mean a different approach, focusing on advancing breakthrough technologies. We argue that the government should:

- **Reconfirm its commitment to innovation missions that tackle societal challenges** rather than technical problems. This avoids the presupposition that the solution to a specific problem lies in developing a particular technology, or that we want that technology for its own sake. To deliver societally-focused missions, and ensure new technological solutions can reach scale, the government should be willing to support all forms of innovation that could help achieve the breakthroughs required, including business model innovation and innovations to change social behaviours. Tackling climate change, for example, will require investment both in technology and in new ways of organising society.
- **Adopt a portfolio approach to mission-oriented funding, with funding approaches and criteria differentiated appropriately.** As the Commission on Mission-Oriented Innovation and Industrial Strategy set out, innovation missions require cross-sector action and to implement them effectively, the government will need to invest in a wide portfolio of programmes that add up to a bigger whole.¹¹⁶ Funding instruments should be flexible to support different types of projects with different goals and stakeholders. For example, levels of match funding expected might be lower for programmes that aim to support emerging sectors or bring forward new business models, compared with programmes aimed at helping existing industries to transform.
- **Use an experimental, iterative approach to implementing missions.** It is difficult to predict the societal and distributional consequences of innovations in advance, so the government should provide early support for a variety of potential solutions to identified problems, enabling informed decisions about which to prioritise later. Challenge prizes are a good mechanism for this as they allow government to support a greater number

of early stage solutions, with fewer strings attached. These are particularly useful where new, genuinely disruptive ideas are sought. Rather than picking one team and providing a subsidy based on the most credible proposal (the traditional R&D grants model), challenge prizes incentivise multiple teams to compete to provide the most impactful solution. The result is a greater number and variety of innovators working on a topic, and hence an ability to support more radical or unproven technologies as well as the safer bets typically funded through grant mechanisms.

- **Take opportunities to link mission-oriented investments to a place-based agenda.**
This could be achieved through directing mission-orientated investments focused on particular challenges or technologies in regions where latent innovative potential in such fields has been identified. For example, or by locating new translational research institutes that can drive forward R&D in a mission area in parts of the country with below-average public R&D investment.
- **Involve a wide range of voices in defining missions and the programmes within them.**
Selecting and defining innovation missions shouldn't just be a technocratic or expert-led process. The public should be meaningfully involved. Nesta launched the Longitude Prize in partnership with BBC Horizon, giving the public an opportunity to vote for the prize theme from six options, each championed by a celebrity expert. This experience shows that getting the public to take part in selecting missions can create momentum, excitement and visibility, and that public engagement can be combined with expert judgement to define missions. The government should explore how to use deliberative public engagement to better understand public views and preferences on the selection of missions and on the principles that determine how money is allocated within them. Public engagement should also be used to help government and policymakers better understand the potential societal consequences of particular forms of innovation.

Recommendation 14: Continue to support regulators to take a more anticipatory approach.

In the short term, the government should continue to support individual regulators to take a more anticipatory approach to the regulation of emerging technologies – and expand this support where possible. Specifically, we recommend that the government:

- **Continues to provide (and expand) funding and support for building anticipatory capacity within individual regulators,** enabling regulators to build the necessary skills and capabilities to effectively regulate the current wave of disruptive technologies and related business models. In the short term, the continuation of the Regulators' Pioneer Fund is welcome news.
- **Considers transitioning away from a grant funding model for building anticipatory capacity, to longer-term or semi-permanent sources of funding,** providing regulators with the ability to plan in the long term, and avoiding the need to resort to funding methods that might compromise regulatory impartiality.

While a vital source of early support, the time-bounded nature of grant funding for the development of anticipatory capacity limits its ability to drive lasting, positive change in regulators. Reliance on year on year funding is not conducive to driving long term changes to organisational culture and ways of working. Moreover, it means that most regulators will have to consider alternative sources of funding if they are planning to maintain new approaches in the long term. This can present regulators with difficult choices. Funding anticipatory regulatory activity from existing income itself can divert resources away from core regulatory activities. Likewise, many external sources of long-term funding can risk compromising regulatory independence.

To build on the progress made by the Regulators' Pioneer Fund, government should consider introducing permanent sources of funding for regulators looking to transition to more anticipatory ways of working, which could cover at least some of the cost of 1) specific regulatory innovations and experiments 2) building capacity (skills, culture change and external support) for new ways of working and 3) evaluation of the impacts of different regulatory approaches.

- **Exploits existing UK strengths in innovation enabling approaches to regulation, rather than moving towards a deregulatory agenda.** While the need to develop innovative solutions to the challenges raised by COVID-19 has led to calls to relax regulatory oversight of new technologies, such moves should be resisted. Reducing oversight would exacerbate the very real risk of premature technologies and business models being rushed into service without sufficient consideration of potential harms and unintended consequences. Moreover, a lack of early regulatory scrutiny can often hinder the development or roll out of promising but disruptive technologies in the long term due to public and stakeholder backlash. Rather than pursuing a deregulatory agenda, government should therefore build on the UK's existing strengths with innovation enabling approaches to regulation, which are far better placed to reconcile the need for the fast deployment of new technologies with the need to minimise potential harms.

Recommendation 15: Configure the regulatory system to be anticipatory 'by design'.

In the longer term, the government should develop the institutional and legal infrastructure to enable far more effective and democratic anticipatory regulation of emerging technologies. To this end, the government may want to consider:

- **Ensuring that the Regulatory Horizons Council draws on all the resources of the regulatory system, including innovation mapping and the intelligence collected by regulatory sandboxes.** The formation of a centralised entity to engage in horizon scanning with a specific focus on the regulatory implications of new technologies is a positive development, reducing the chances of the regulatory system failing to identify regulatory challenges until it is too late, and avoiding the need for all UK regulators to sustain parallel foresight capacity. In order to enhance its effectiveness, the new body should consider making use of innovation mapping¹⁷ – which uses data science methods and visualisation tools to help policymakers navigate complex innovation systems – and should be given access to data produced by individual regulators, particularly that produced by regulatory sandboxes.

- **Creating a single regulatory gateway**, which any innovator looking for regulatory approval for a new technology or business model would have to approach. In addition to streamlining the process by which innovators seek regulatory approval, this could further improve the capacity of the regulatory system to spot regulatory challenges early. This gateway service would not be expected to mediate ongoing interactions between innovators and regulators, but instead would direct innovations to the appropriate regulatory authorities.
- **Founding a new public body responsible for short-term policy development, coordination across regulators and public engagement relating to challenges presented by emerging technologies**, rather than expecting regulators to be able to rapidly develop coordinated and consistent regulatory rules across multiple industries.

When technologies straddle regulatory remits, the regulatory system can often struggle to apply consistent principles to the technology across different applications.¹¹⁸ Greater coordination and conversation between regulators can help to a degree, but there are limits to how quickly unified regulatory responses can be developed.¹¹⁹ Delegating the development of short-term policy frameworks to a dedicated third party, which could engage with all affected regulators before dictating the principles to be followed by each, could enable coordinated responses to be developed quickly.¹²⁰

- **Establishing a formal process to trigger parliamentary consideration of value-laden regulatory questions raised by emerging technologies**, thereby ensuring that long-term responses to such questions are ultimately set by elected representatives.

Public engagement offers a means of developing legitimate, short-term responses to value-laden questions posed by emerging technologies. However, if public engagement is to act as an alternative source of democratic legitimacy for regulators in the long run, it will need to be formalised and standardised to enable it to take on such a role. To play a significant role in setting early regulatory standards – potentially determining how transformative technologies develop and impact society – it will not be enough for public engagement to be an optional source of extra data for innovation policymakers. Instead, there will need to be clear criteria for when to use it and how the results of such exercises should relate to regulatory decisions.

Critically, there will also need to be an established process by which short-term regulatory responses provided by public engagement give way to longer-term solutions provided by parliament and the executive. For instance, the government may want to consider developing a set of criteria for when a value-laden regulatory question should be considered by a select committee. The introduction of such a process could help address the risk of important but low-profile regulatory issues missing out on parliamentary scrutiny.

5

Towards an inclusive approach to innovation

As the COVID-19 crisis places ever greater strain on the economy and on public finances, it will be tempting to view greater investment in innovation as a luxury, to be abandoned in favour of addressing more immediate concerns.

Such a reaction would be misguided. Innovation is now more important than ever, both in building societal and economic resilience to future shocks and disruptions, and in developing the technologies and organising models that will be needed to cope with a heating planet, an ageing, growing population and an unpredictable economic outlook. Critically, these innovations will not emerge – and will not get where they are needed – without concerted government funding and support.

As it moves from focusing on crisis response to rebuilding, it is important that government continues to invest in innovation and does not lose sight of its ambition to use it as a way to 'level up' underperforming regions of the country.

But at the same time, hopes of innovating our way out of crises or using innovation to kick start a wavering economy will be limited without changes to our approach to innovation policy. If it is to drive substantial change, our innovation system will need to be more place-sensitive, support a greater variety of kinds of innovation, and become better able to direct innovation towards the realisation of specific, societally important challenges. Otherwise, government support for innovation is unlikely to be effective or to enjoy enough public support to be sustainable.

The ideas and policy proposals outlined in this report represent a fraction of the actions policymakers could take to achieve these goals. The aim has not been to be comprehensive, but rather to draw attention to things that government and policymakers can do now, and that will have material implications in the short to medium term. Nesta's wider research shows that governments around the world, from North America to South East Asia, are beginning to explore ways in which they could design more 'inclusive' innovation policies. We define these as policies that are:

Directed towards ensuring that the benefits and the risks of innovation are more equally shared; actively consider whose needs are met by innovation and how excluded social groups could be better served; focus on initiatives that promote broad participation in innovation; and take a democratic and participatory approach to priority-setting and the governance of innovation.¹²¹

Inclusive innovation policies can play an important role in ensuring that places and people across the UK benefit from innovation activities and productivity gains, but to have a transformative effect they need to be accompanied by broader reforms in policy areas such as work, welfare and education. Improving young people's 'exposure to innovation' at an early age, for example, may help to address the large disparities between demographic groups in participation in innovation (in 2015, for example, just 8 per cent of UK patent applicants were women).¹²² In doing so, it might be possible both to increase the number of innovators in the UK and the quality of innovation, opening it up to more diverse perspectives. Research in the United States estimated that if under-represented groups' potential was harnessed, the rate of innovation in America would quadruple.¹²³ Such reforms need to be matched by stronger rights to improve and update skills throughout life, combining rights to learn, systems to help people navigate opportunities, and widely accessible provision. Likewise, more will need to be said about new models for expanding access to and exploring new models of ownership that would allow more people to have a stake in productive resources such as firms, data, the internet and intellectual property.¹²⁴

The UK's innovation system is an enormous asset, but its potential is squandered as long as it remains undirected and confined to a handful of sectors and parts of the country. Now, more than ever, we need a more inclusive approach to innovation.

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