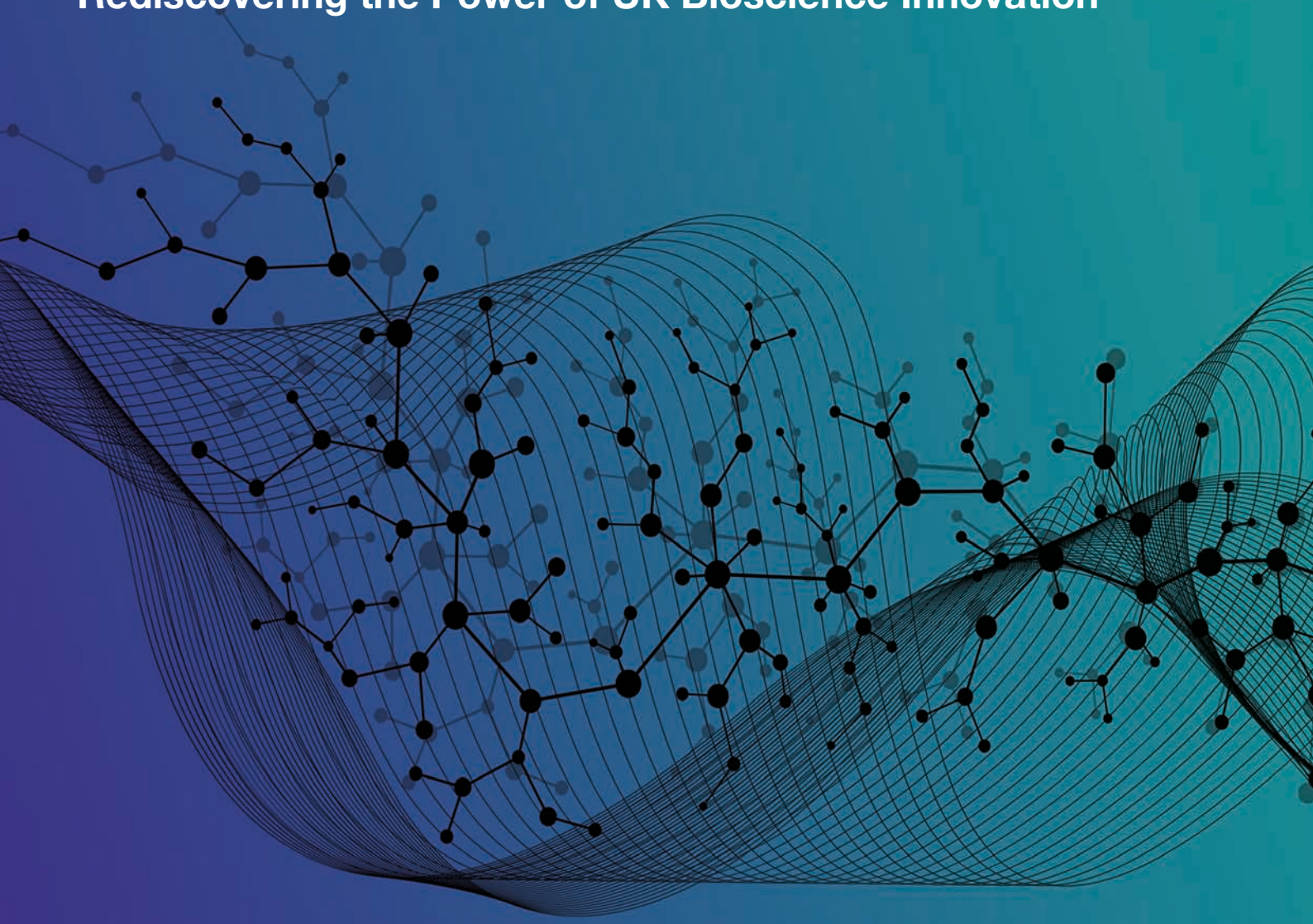
Innovation Caucus

BIOSCIENCE: LOST IN TRANSLATION?

Rediscovering the Power of UK Bioscience Innovation



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In partnership with:

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Data used in this publication have been taken from two reports prepared by the Innovation Caucus titled *Understanding and articulating the nature of innovation and commercialisation in bioscience Mapping the biotechnology and bioscience industry in the UK.* These reports are available on request from the Innovation Caucus.

1. THE CONTEXT

The subject of bioscience innovation is not a new idea. In 2018 the Bio Economy Strategy sought to emphasis the power of bioscience, and set out the UK as a global biotech partner of choice. While the strategy has been withdrawn, and despite the challenges of Brexit and Covid-19, the significance and strength of UK bioscience remains internationally leading. The commercial application of bioscience extends far beyond pharmaceuticals and other health-related applications, into everything from sports and beauty products to transportation and hospitality. Bio-based products and processes increasingly contribute to sustainable and resource-efficient solutions in vital areas like agriculture, energy, health, and environmental protection. **However, the full potential of bioscience tends to be obscured by structural factors in policy, research, investment, and routes to market.**

In this context, the Biotechnology and Biological Sciences Research Council (BBSRC) commissioned the Innovation Caucus to conduct an independent, investigation into bioscience innovation and commercialisation in the UK, comprising two separate but interrelated studies:

1. *Understanding and articulating the nature of innovation and commercialisation in bioscience* reviews bioscience ecosystem using a combination of desk research and in-depth interviews with UK bioscience stakeholders. The interviewees were drawn from businesses; 'intermediaries' such as universities and industry organisations; the financial community, regulatory, standards and policy bodies; and 'critical friends' in NGOs and campaign groups.

2. *Mapping the biotechnology and bioscience industry in the UK: A knowledge space analysis* identifies knowledge spaces in the biotechnology and bioscience industry by mapping spatial and sectoral data on a sample of 10,809 start-ups in the UK. In doing so, it reveals important patterns of agglomeration; that is, the 'clustering' effect well-known in other industries as a driver of entrepreneurial activity, business growth and job creation. The study also maps the coalescence between market sectors.

The overall aim of the investigation is to understand bioscience in the UK as an ecosystem, while outlining the profile and perception of bioscience among influential stakeholder communities and identifying bioscience innovation pathways, focusing on commercialisation of academic research.

For the purposes of brevity, 'bioscience innovation' is used in this summary to stand for biotechnology and bioscience innovation and commercialisation.

The main findings of the investigation are twofold**. First, bioscience is not consistently understood among different stakeholder groups**, whether internal or external to bioscience. While bioscience can be perceived positively (e.g., natural history, vaccines, non-GM agriculture, the exploitation of bioscience can be often viewed negatively (e.g., GM, stem cells). Those working in and with bioscience have a responsibility to acknowledge this, and to prioritise public understanding of research and innovation. There are long-standing and sometimes difficult ethical debates and communication challenges. On the other hand, failing to realise the public and commercial value of bioscience research carries social and economic risks for the UK.

Second, **if UK bioscience is to achieve its full potential it needs to be understood in its entirety**. The first study draws on entrepreneurial ecosystem literature, which is itself inspired by ecological models. The ecosystem analogy emphasises not just the presence of specific characteristics, factors, or conditions, but also the importance of their interdependence. Thus, the health of the UK bioscience ecosystem can be tested by observing its enabling social, cultural and economic forces. The second study, which draws on knowledge space analysis, illustrates the UK bioscience innovation ecosystem is fractured and disaggregated. The clustering effect of UK bioscience risks fragmentation in pools of resources, disparity in availability of networks to bioscience, sub-sectors, and unequal funding prioritisation by the public and private sectors. The disparate nature of the UK bioscience innovation system leads to wasted potential.

Examples from other countries suggest there is much to be gained from rethinking ecosystem elements, such as the right infrastructure to support bioscience innovation specifically, better regulation, and narratives around bioscience that involve as well as influence the public. The research highlights the prospect that greater awareness of existing and potential knowledge spaces in bioscience innovation, in terms of locations and networks, can increase the value and impact of public investment, as well as creating private sector opportunity.

2. THE UK BIOSCIENCE INNOVATION ECOSYSTEM

We employ an ecosystem lens in our analysis of Bioscience Innovation in the UK. Here the ecosystem can be understood as a series of interdependent elements, comprising systemic conditions (networks, intermediaries, talent, knowledge, and leadership) and framework conditions (formal institutions, culture, physical infrastructure, and demand). In Figure 1 we liken the ecosystem to an iceberg, distinguishing between those aspects that are visible above the surface, and those that exist beneath the surface.

At the top, visible above the surface, are systemic conditions; networks, intermediaries, talent, knowledge and leadership. At the bottom of the iceberg, out of view, are framework conditions; formal institutions, culture, physical infrastructure and demand. The visible systemic conditions act as fundamental causes which, when driven by framework conditions, can create a successful ecosystem. Meanwhile, the more taken-for-granted framework conditions which are affected by social structures, are integral in enabling and/or constraining the competitiveness of the bioscience ecosystem. The interdependencies of systemic and framework conditions are critical to the health of bioscience innovation in the UK.

The research shows that while the UK has successful stories to tell about systemic conditions, much more could be done to improve framework conditions. The first study revealed a range of strengths within the UK bioscience innovation systemic conditions, however interviewees were less able to identify positive framework conditions. While they readily discussed the importance of intermediaries, the usefulness of role models for peer learning and the need for talent and funding, they were less clear about the function of framework conditions or their impact as challenges to innovation and commercialisation. When the value of bioscience is not well recognised in this way, the consequences permeate all ecosystem conditions. Thus, a lack of understanding of bioscience's value may lead to reduced demand for innovation and commercialisation.

SYSTEMIC CONDITIONS

Networks: Meetups, collaboration spaces, skill training programmes, incubators, networks of mentors and angel investors

Intermediaries: Inclusivity, diversity and transparency of regulatory and policy making aspects need to be explored

Talent: Diversity in education and research background, training and education capacity

Knowledge: Actors with knowledge of bioscience potential to provide appropriate funding and investment

Leadership: Diversity of businesses and sectors, availability of knowledge and translation for R&D in universities

FRAMEWORK CONDITIONS

Formal Institution: Anticipatory and conducted in collaboration with multiple stakeholders

Culture: Having a coherent understanding of the value of bioscience and bioeconomy, tolerance for risk and failure of bioscience innovation

Physical Infrastructure: Access to basic entrepreneurial infrastructures

Demand: Private & public institutions' investment commitment; public perception on value of bioscience and its influences on formal institutions

Figure 1:
The Bioscience Innovation Ecosystem

The interviews also showed that some sectors, notably pharmaceuticals and medical biotech, have wider networks, more resources and better support than others. For example, an interviewee described how a comparative lack of funding and interest restricted innovation and commercialisation in farming. When commercialisation is the objective, investment decisions will always tend to be linked to potential returns, which are likely to be greater in some areas than in others (at least, in the short term).

An important lesson from high-profile controversies, such as arguments in the 1990s over food containing genetically modified (GM) ingredients, is that careful presentation of the true value of bioscience can avoid the damage caused by inaccurate perceptions. Interviewees described that investment was also linked to the way policy focus and, therefore, public funding, shifted away from agriculture because of the genetically modified (GM) foods controversy. As one interviewee noted, "if you turn the money off you can't just turn the expertise back on again". If actors within the bioscience innovation ecosystem themselves are not sufficiently aware of this, persuading the public is always going to be problematic.

Directing support for bioscience innovation through a narrow lens can be damaging to the clustering effect, which has been shown to promote economic growth, job creation and increased public and private sector demand for innovation. By highlighting both the market and geographical positioning of companies applying bio-based products and processes in the UK, the investigation revealed the outlines of current and nascent sectors and sub-sectors within bioscience. With the right support, these clusters represent significant opportunities for creating sustainable social and economic value.

The UK regulatory environment was another area of concern for interviewees, with some expressing the view that it potentially discourages bioscience innovation. One interviewee compared the UK and EU regimes unfavourably with the US, where, in their opinion, regulation is "more scientific, risk-based... less impacted by political interest". There is no question that regulation is needed to protect the public (and public investment), but the suggestion here is that active discussion with wider stakeholder groups could inform a more balanced regulatory approach.

Similarly, since policy is influenced by public opinion, improving public communication and messaging about the value of bioscience innovation could help address the sensitivities attached biological modification and augmentation, which often extend to all biotechnology and bioscience activity. It would also help to expand the 'bird's eye' view of the iceberg that consumers typically experience, which leaves them largely unaware of the true depth and breadth of the contribution made by bioscience to consumer products and services. In France, the Bioeconomy Action Plan introduced in 2018 puts public opinion at the centre of the programme. By conducting public consultation and stakeholder convergence ahead of regulation, the French approach supports public recognition of the value of bioscience to the national economy. In the UK, bringing the public into the conversation earlier – including, potentially, at research design phase – might mitigate the problem of the topic being avoided out of fear that public opinion will deter research commercialisation. For example, as the first study showed, while activists are well versed in effective public communication, their concern is often about the system of commercialisation rather than the science itself. Therefore, the onus is on all actors in the bioscience innovation ecosystem to communicate proactively before valuable technologies become demonised and the opportunity for positive societal and economic impact is lost.

3. DIVING BELOW THE SURFACE

To extend the iceberg analogy, the findings show that there is much to be discovered beneath the surface; even those immersed in the waters of bioscience may not have a full view of the diversity of sectors in which bioscience is now a cornerstone of innovation. Academia and the market seem to view the iceberg from opposite sides, missing out on the benefits of mutual recognition. For instance, academics who have successfully commercialised research in the UK made comparisons to the academic culture in the US, where, as an interviewee said, "[t]here is an expectation that you will found a company or two or three and it's not even questioned, it's just something that everybody does."

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On the other hand, as noted above, markets often focus on short-term returns on investment and find it harder to see the potential of research-based innovation, particularly in emerging sectors. At the same time, consumers don't have sight of the contribution of bioscience to products and services. All these factors lead to the full potential value of bioscience being lost by its disaggregation, spread across multiple sectors and only partially visible from each stakeholder group's perspective. By using knowledge space analysis, the BBSRC research makes it possible to understand and visualise industry specialisations, spot potential gaps in the technological composition of a cluster and identify new technological niches where innovation can thrive. Moreover, examining regional knowledge and skills capabilities in conjunction with sectoral composition enables an assessment of which sectors are coalescing and which technologies are converging.

The research revealed significant clustering among 10,809 UK start-ups selected from a mix of publicly available data sources, investment tracking and filtered by industry. Ten sectoral clusters representing 'where the action is' in UK bioscience demonstrate that bioscience underpins a huge range of markets and sectors (Figures 2 and 3). This illustrates the breadth of untapped potential for bioscientists to increase their role in providing market solutions in a variety of areas. Given their potential economic value, this is useful for national and regional policy planning. Bringing more of the iceberg into view in this way enables a holistic perspective of the bioscience value chain, rather than a cluster-centric view, which can reduce its potential impact. The opportunity here lies in improving framework conditions that support the social and economic benefits of clustering and also drive systemic conditions, making the interdependence of ecosystem elements more apparent and thus more amenable to strategic intervention.

At sectoral level, most of the start-ups are grouped around three major sectors: Health, Food and Energy. Start-ups can be characterised through categories related to these sectors, providing evidence of how UK bioscience is understood. Emergent sectors such as Innovative Foods, Transportation and Sustainability show promise as areas for innovation and further cluster development, while Agri-Tech, Wellness and Beauty, Cleaning/Hosting and Sports show the presence of niche start-ups or nascent sub-sectors. At geographical level, London and South East England, particularly metropolitan London, claim the lion's share of start-ups. Oxford and Cambridge also appear as significant bioclusters, with other cities such as Manchester, Leeds, Birmingham, Edinburgh, and Glasgow hosting an important number of companies in some of the main sectors. However, this is necessarily a snapshot of a moving picture, with changes driven by the varying status of systemic and framework conditions, along with global political and economic factors.

What this demonstrates is the diversity of spaces in which bioscience makes its contribution, and what is clear from the iceberg analogy is the danger of maintaining a fragmented view. The ecosystem, with its focus on the interdependence of elements, similarly highlights the importance of a holistic view. As one of the interviewees put it, "when the value of bioscience is not well recognised, its effect on the innovation and commercialisation ecosystem permeates all conditions." The current appetite within the financial community for 'life sciences' is a case in point, as it obscures the returns to be made from investing in emerging bioscience sub-sectors and clusters. That's not to diminish the risks, such as lengthy R&D and approval processes, which interviewees from the financial community stakeholder group clearly articulated. But it speaks to the importance of the physical infrastructure conditions within the bioscience innovation ecosystem and the need to make it, and other framework conditions, more visible.

Figure 2: UK Bioscience and Biotechnology Knowledge Space

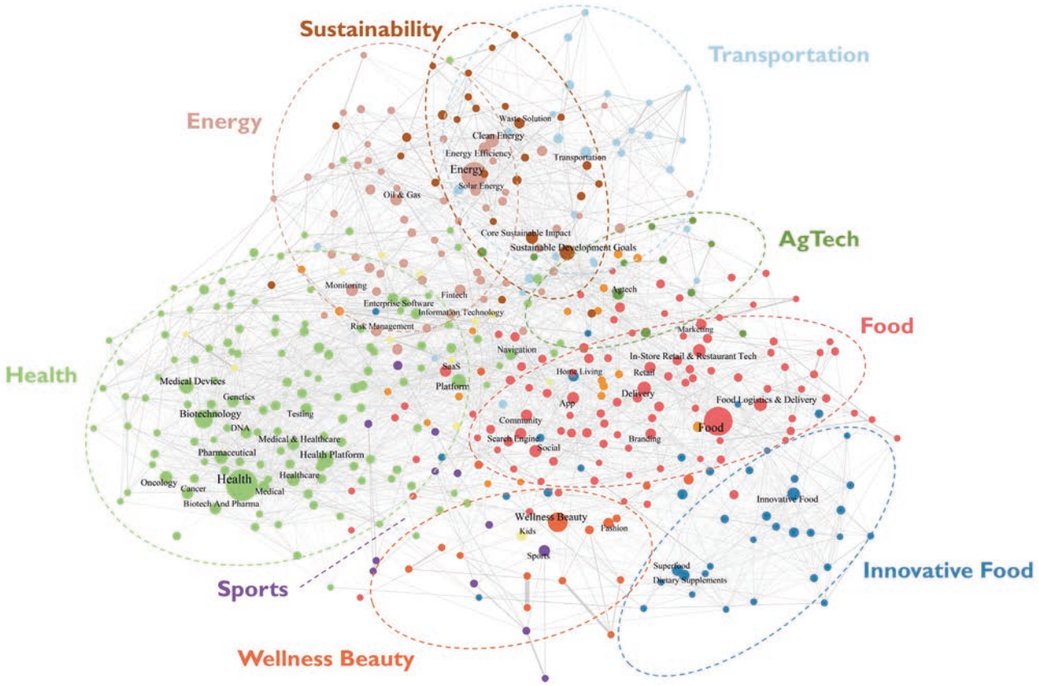
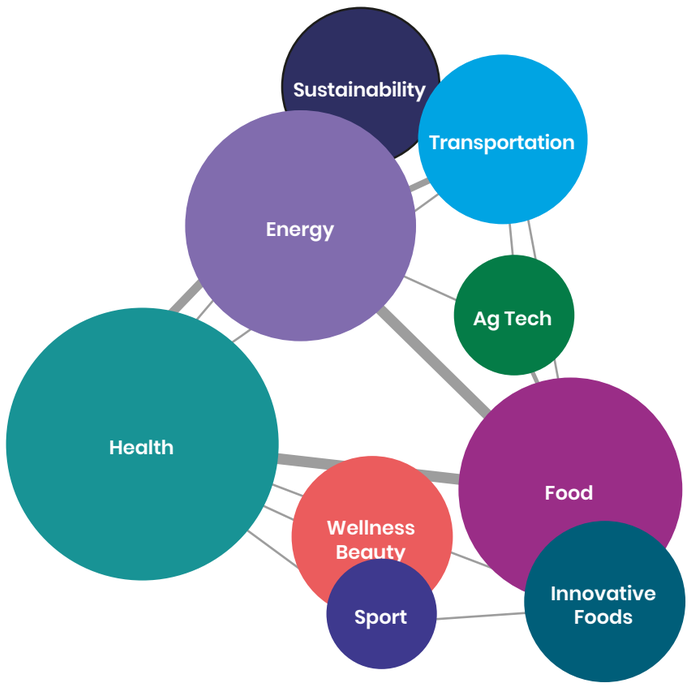


Figure 3: Full Knowledge space representation for all the bio-related start-ups in the UK (N = 10,809).



Given that most people will at least consider the balance of risk and reward in relation to health outcomes, information and education efforts could extend that consideration from food security and equitable prosperity to the mitigation of global heating. In turn, this could increase consumer demand for bioscience innovation outside pharma and medical and thus lead to more demand from public funders and private investors. Indeed, if bioscience stakeholders are not aware of the value that bioscience innovation can bring to markets beyond those with which it is commonly associated, they cannot expect consumers, investors, and policy makers to recognise or facilitate demand for bio-based products and services.

4. UNDERSTANDING THE FULL DEPTH OF BIOSCIENCE INNOVATION

Seeking a better understanding of the full depth of bioscience innovation requires us to focus on the unseen. This includes understanding the different pathways for innovation and commercialisation in bioscience and the hurdles that may come along the journey. Pathways for the commercialisation of academic research in the UK today include direct sales of products and services, creation of start-up and spinout companies, joint ventures, intellectual property (IP) licensing, assignment or sale, and commercial use of in-house IP. UK higher education institutions (HEIs) hold a pivotal position as ‘anchor’ institutions and are central to the success or failure of bioscience innovation. All the bioscientists interviewed for the BBSRC research noted that their journey to commercialisation began at HEI level. Thus, HEIs can be viewed as a microcosm of the wider innovation and commercialisation ecosystem, operating with a degree of autonomy but restricted in terms of resources and scale. To extend the ecosystem analogy, a microcosm sustains life for a much smaller group of organisms than does the wider ecosystem. In the bioscience innovation ecosystem, this creates a ‘microcosm effect’, with several consequences for commercialisation activities.

For historical and cultural reasons, different HEIs have different preferences for commercialisation pathways. For instance, those with fewer resources (budget, expertise, infrastructure) prioritise licensing IP because risks and costs associated with spinouts are too great. Retaining IP rights allows for greater control but can make IP commercialisation less attractive to external actors. At the same time, the crucial role of HEI technology transfer offices (TTOs) raises further challenges for resource-poor institutions. TTOs need to be able to identify the application of research in solutions for ‘real world’ industry problems. This drives competition for staff with industry experience and entrepreneurial skills, including legal and contractual knowledge. These attributes are relatively scarce and expensive to hire, which in turn deters bioscience academics from commercialising their research, since they typically only do so through the HEI microcosm.

One possible solution is to enlarge the microcosm beyond single HEIs by centralising resources in clusters. Focusing on regional clusters could allow HEI microcosms to both imitate and, potentially, integrate with government, private sector, entrepreneurial and civil society clusters already operating at regional level. In addition, that could help increase the visibility of promising areas currently lacking development conditions. These include providing initial investment, supporting innovation-based start-ups and spinouts through the proof-of-concept stage, sustaining further research with the rewards of commercialisation, and supporting spinouts towards maturity and growth after successfully going to market. It is important here not to lose sight of the value and impact of public investment, whilst recognising potential private sector gains. For instance, skills and labour market benefits of regional clusters are particularly robust where partnerships can use their strengths to create more and better jobs and, ultimately, drive regional economic growth.

One of the most significant lessons from looking at other countries is that a combination of public investment with a compelling strategic narrative can make innovation and commercialisation pathways more attractive and effective. Cross-departmental mandates are prominent in the national bioeconomy strategies of the US and Germany, and both encourage consortia and partnership approaches among stakeholders. While historically placing great emphasis on private investment, US government funding plays its part in the national bioeconomy's current $1 trillion valuation. The German government also commits significant funding to bioeconomy development, including €2.4 billion in the period 2010 to 2016 alone, while explicitly tying outcomes to the UN Sustainable Development Goals. However, it is hard for any country to match the scale of public and private investment, growth in education and skills provision, or complexity of inter-agency R&D coordination that has arisen in China. Nor, of course, is it necessarily desirable to match the level of centralised control through which this has been achieved.

Nevertheless, there is an urgent need to address the UK's competitive positioning in relation to bioscience innovation. The now withdrawn BioEconomy Strategy assumed a largely top-down holistic perspective of bioscience has been supplanted by the Innovation Strategy which assumes a more inclusive perspective. Assuming a more inclusive perspective on the ecosystem enables a focus on the conditions that affect the development of technology through growing companies.

5. CONCLUSION

This summary, and the accompanying reports, provide insights as to the state of the UK bioscience innovation and commercialisation ecosystem. Using the iceberg analogy shows that systemic conditions are more visible to stakeholders than framework conditions, although it is the latter that exert significant influence on the former and on the ecosystem as a whole. More ambitious, cross-departmental, and transformational policy initiatives are necessary to tackle structural and systemic challenges. Greater collaborations among HEIs, academics, investors and research scientists are necessary to develop better commercialisation pathways.

More incentives, as well as better regulation, are necessary to unleash the commercial potential of bioscientists and entrepreneurs, allowing them to build on the UK's global reputation as a pioneer in bioscience and biotechnology. Furthermore, better communication in the early stages of innovation and commercialisation is necessary to tackle damaging public misconceptions.

This report questions whether the power of bioscience is potentially lost, diminished by its lack of visibility. Moving forward, to realise the value of bioscience, we must decode and dismantle mistranslations of what bioscience can truly offer. The benefits of a healthier bioscience ecosystem in the UK are within reach if the whole stakeholder community engages positively.

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