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Ymchwil a Datblygu
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Ymateb gan: Dr Dylan Henderson, Canolfan Ymchwil Polisi Arloesedd

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Scoping the future of Innovation Policy in Wales

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Executive summary

Even though the Sixth Senedd will have its hands full with the legacies of Covid, the challenges of Brexit and the imperatives of Climate Change, it will see that the innovation proposals presented here are integral to the twin tasks of recovery and reconstruction and to the longer term goals of the Well-being of Future Generations Act.

Today innovation is about so much more than just science and technology. Among other things it is about social innovation to address societal challenges; public service innovation to highlight the catalytic role of the public sector; and ecological innovation to counter the noxious effects of climate change. Wales needs and deserves an innovation policy in this larger, more capacious sense of the term and this is the kind of innovation policy agenda that informs our scoping report.

All the international evidence suggests that innovation is a path-dependent as well as a place-dependent process, which means that what a country can do in the future is partly conditioned by what it has done in the past and indeed by what it can learn from the past.

For this reason, the report begins in Chapter 2 with an overview of the current state of innovation in Wales, presenting an analysis of why we are where we are so to speak.

Chapter 3 presents an overview of current innovation support programmes, funded from Wales, the UK and the EU, and concludes with a condensed analysis of the efficacy of the policy mix that has been used in recent years.

Chapter 4 explores the new innovation policy landscape in Wales and the UK as this furnishes the post-Brexit context in which the next Welsh innovation policy will have to be designed and delivered.

Finally, Chapter 5 distils some of the feedback we have received from our respondents and proposes a new innovation policy agenda for Wales based on six recommendations that we believe are sufficiently ambitious to meet the momentous challenges ahead. The recommendations are:

Recommendation 1: A new innovation strategy for Wales needs to be founded on a compelling and inclusive narrative that can act as a catalyst for activity, promoting the innovation agenda and the nation.

Recommendation 2: Future innovation policy should do more to encourage universities to develop their translational research activities to bridge the gap between research and innovation in Wales.

Recommendation 3: A new innovation strategy must be accompanied by investment in the skills, capabilities and resources needed to support innovation. This should include a suite of innovation support programmes for SMEs, increased availability of venture capital, and investments in unlocking data resources and enabling digital technologies.

Recommendation 4: The new innovation strategy should support the development of greater capacity for mission-orientated innovation that tackles societal challenges, thereby engaging the public, private and civic sectors, leveraging public procurement and proactively shaping markets.

Recommendation 5: The innovation policy landscape is becoming more complex, within the UK and within Wales, and Welsh Government will need to build on the Regional Investment for Wales Steering Group to coordinate place-based investment plans.

Recommendation 6: Innovation has a significant role to play in the Sixth Senedd's immediate tasks of recovery and reconstruction and in meeting the longer term goals of fashioning a greener, fairer and more innovative Wales and therefore the innovation policy agenda should be brought into the centre of Welsh Government, championed at Cabinet level and better integrated across the civil service.

As the outcome of consultations with more than 50 plus experts in the fields of research and innovation, we hope that this report will help to inform the innovation policy debate in the Sixth Senedd, as well as stimulating a wider process of engagement with as many stakeholders as possible. An inclusive and wide-ranging debate of this kind is both necessary and desirable because innovation is essentially a collective social endeavour.

1. Introduction

The Sixth Senedd will have its hands full with the legacies of COVID, the challenges of Brexit and the imperatives of Climate Change. But the new innovation agenda that we present here is not just another issue to be added to the Senedd's list of crisis management tasks. On the contrary, the innovation proposals in this report could make a significant contribution to the immediate tasks of recovery and reconstruction and to the longer term goals of fashioning a greener, fairer and more innovative Wales.

This is because innovation has shed its stereotyped image of lab-based boffins working on a narrow range of science and technology issues. Today innovation is being framed in more capacious terms. Among other things it includes social innovation to address societal challenges; public service innovation to highlight the catalytic role of the public sector; and ecological innovation to counter the noxious effects of climate change. In short, the new innovation agenda will help Wales to realise the goals of the Well-being of Future Generations Act, one of the most innovative pieces of legislation ever produced in the UK. The six recommendations in this report can help the Welsh Government to translate its good intentions into good practice.

The report was commissioned by the Innovation Advisory Council for Wales on behalf of the Welsh Government with a view to stimulating debate about how the new innovation policy should be designed and delivered.

The Centre for Innovation Policy Research (CIPR) at Cardiff University was chosen to conduct the research because of its expertise in regional innovation policy analysis. Over the course of an intensive three-month study period, the CIPR researchers used a mixed methods approach (consisting of a combination of desk-based research and consultations with 50 plus experts in the field of research and innovation) to reflect on the pros and cons of the previous innovation policy, *Innovation Wales*, which was widely considered to be antiquated given the momentous changes that have occurred since it was published in 2015. The consultations were conducted on the basis of the Chatham House Rule – where nothing is attributed to anyone, but where the information can be freely used – which aims to encourage frank and honest discussion. A full list of the names of our respondents is provided in Annex 1, all of whom listed expressly agreed to be identified.

The geographical profile of the respondents reveals a strong weighting to the south east region and this is largely due to the concentration of R&I stakeholders in that region. But the lower number in the north was also due to the fact that a number of respondents who were approached were unable to schedule a meeting in the limited time available.

Turning from the research methods to the content of the report, it is worth explaining why the report takes a retrospective look at past policies as well as a prospective look at what future policies might look like. No matter how novel they may seem, regional development strategies are always designed in the context of powerful path dependent forces, including policy path dependence; so much so that the prospects for the future are conditioned not merely by what has been done in the past, but also by what has been learned from the past. In other words, we may get a taste of the future by having a better understanding of the past.

For this reason, the report begins in Chapter 2 with an overview of the current state of innovation in Wales, presenting an analysis of why we are where we are so to speak. Chapter 3 presents an analysis of the current innovation support programmes, concluding with a condensed analysis of the efficacy of the policy mix that has been used in recent years. Chapter 4 explores the new innovation policy landscape in Wales and the UK as this furnishes the post-Brexit context in which the next Welsh innovation policy will have to be designed and delivered. Finally, Chapter 5 distils some of the feedback we have received from our respondents and proposes a new innovation policy agenda for Wales based on six recommendations that are sufficiently ambitious to meet the momentous challenges ahead.

We hope that this report will help to inform the debate in the Sixth Senedd, and stimulate a wider process of engagement with as many stakeholders as possible, because innovation is essentially a collective social endeavour.

2. The current state of innovation in Wales

Innovation is widely seen as an important contributor to the prosperity and growth of regional and national economies. In Wales it has a particular significance given the nation's comparatively lower levels of productivity relative to other parts of the UK, but also in its role as an enabler of solutions to societal grand challenges such as the ageing population, renewable energy, and mobility. In this section we examine the characteristics of innovation in the Welsh economy, drawing on published datasets and reports. In setting out the current state of innovation in Wales we intend to provide the basis for subsequent analysis of the challenges and opportunities for supporting innovation across Wales.

R&D expenditure and employment in Wales

R&D is well established as a traditional indicator of innovation. While it says little about the translation of this activity into commercial outcomes, nor the often hidden forms of innovation that take place in some sectors, it does provide a readily available and comparable source of data on the capacity of a region's potential to innovate. Figure 1 shows that as a proportion of gross value added (GVA) Wales' expenditure on R&D (1.2 per cent of GVA) lags behind other parts of the UK, and less than 2/3 of the UK average. These data point to the uneven nature of R&D activity in the UK context and hint at the productivity challenges facing Wales.

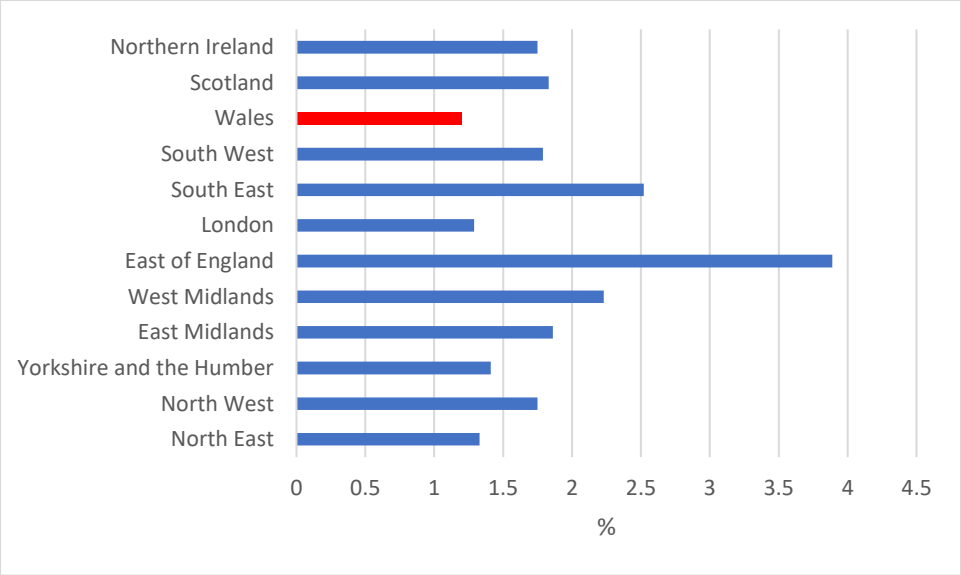


Figure 1. Expenditure on R&D as a percentage of gross value added, UK NUTS 1 regions, 2017
Source: ONS (2019)

Although Wales spends comparatively less on R&D there is some evidence that R&D expenditure has increased across its constituent parts (business, higher education, and government expenditure) over time, with overall R&D expenditure standing at £786m in 2018.

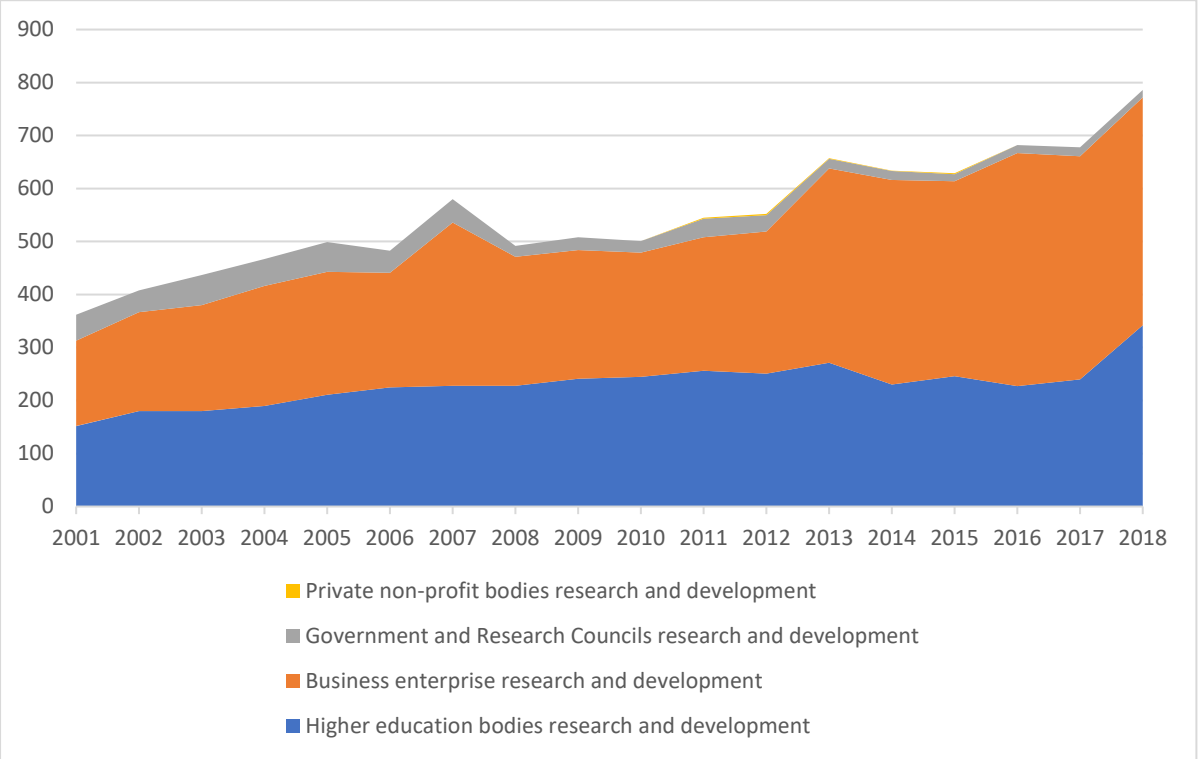


Figure 2. Research and development expenditure in Wales by expenditure type and year

Source: StatsWales (2020)

Figure 3 suggests that the largest share of R&D expenditure in the UK is accounted for by a small number of areas such as the East of England and South East. This, as research has recently shown, illustrates the challenges of supporting the levelling up agenda in Wales through R&D (Forth & Jones, 2020).

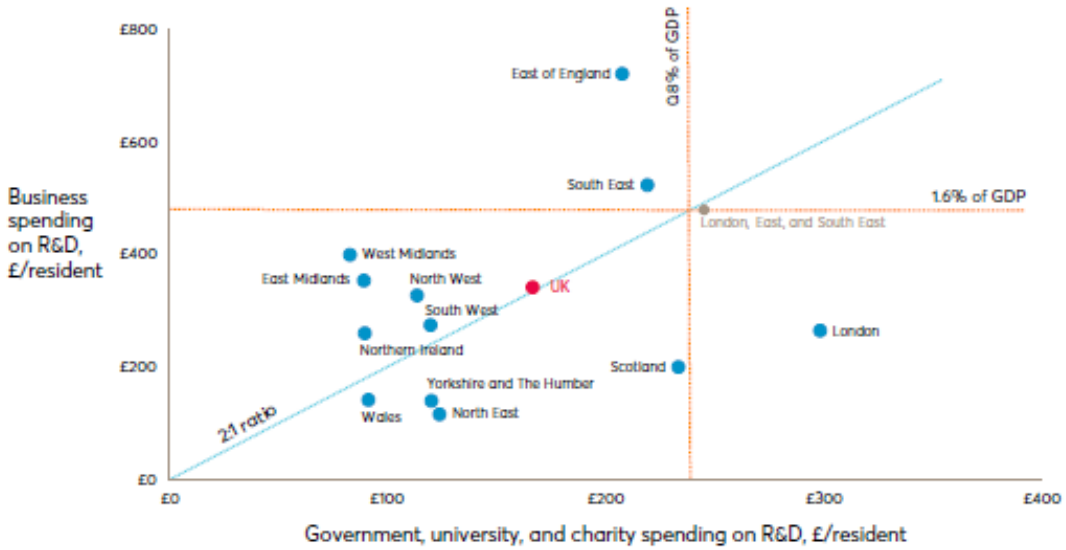


Figure 3. Spending on R&D by NUTS1 region within the UK, 2016 (split by business and non-market-led
Source: Forth & Jones (2020)

Note: Non-market led spending includes government, university and charity

R&D employment provides a further measure of innovation capability (see Figure 4). Like R&D expenditure, this represents a narrow indicator of innovation, with skills development both driving and supporting innovation in businesses more widely. It does, however, provide a picture of the sectoral focus of this employment in the UK context, showing that Wales' employment in services R&D is comparatively lower than all other regions of the UK.

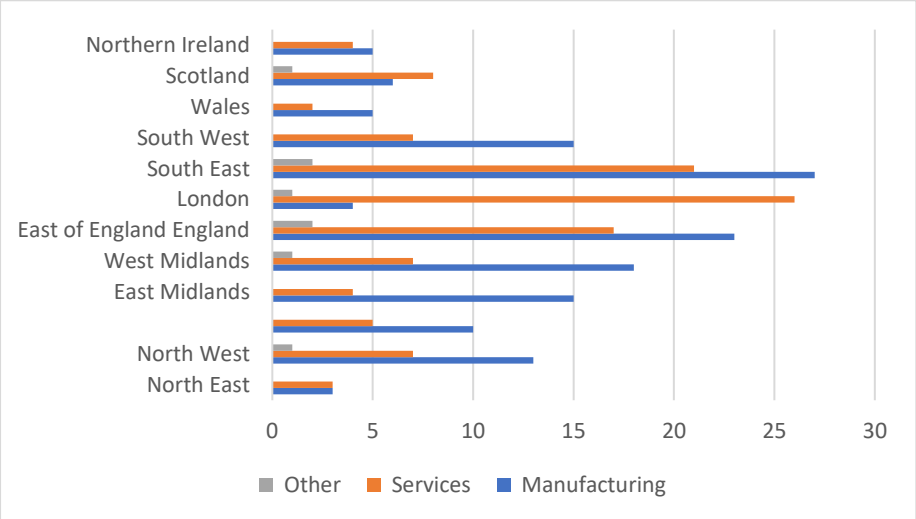


Figure 4. Business R&D employment per sector in UK regions, 2020
Source: ONS (2020c)

Research from the UK Innovation Survey suggests that science, technology, engineering, and maths (STEM) graduates represent a larger share of the workforce in highly innovative businesses (BEIS, 2020). Figure 5 below suggests that Wales performs comparatively well in relation to STEM degrees.

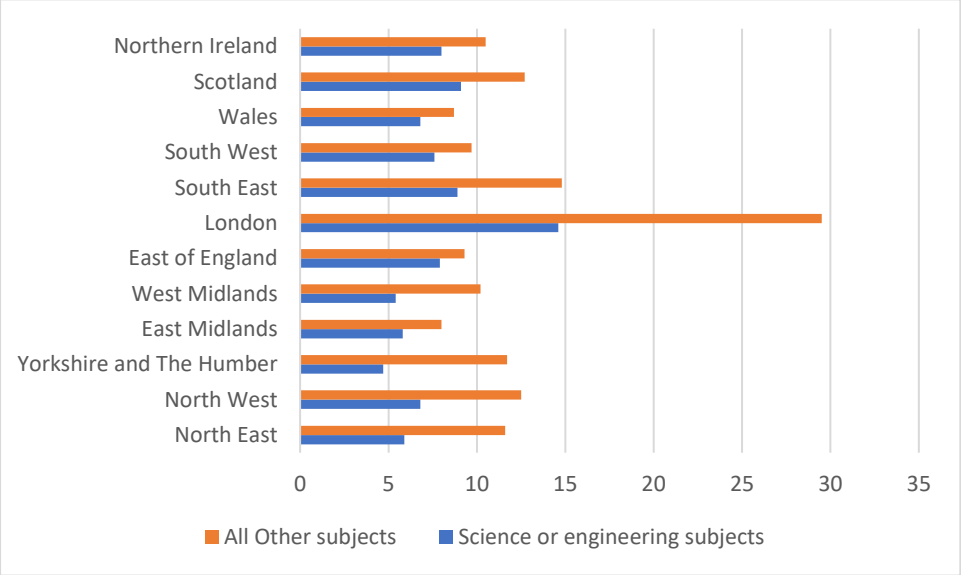


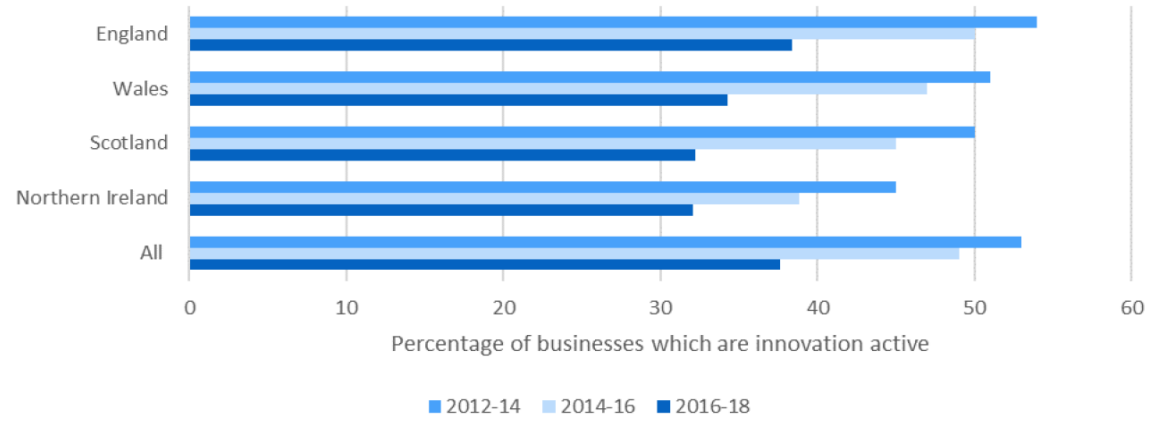
Figure 5. Skills - Average proportion (%) of employees that hold a degree or higher

Source: ONS (2020d)

Innovation activity in Wales

Innovation activity is a measure of whether an organisation undertakes any form of innovation. Figure 6

indicates that rates of innovation active businesses in most parts of the UK have declined in the 2014-2018 period, Wales declining by 12.2 percentage points, against a UK fall of 11.4 percentage points.



Unweighted base = 15,091 for 2012-14, 13,194 for 2014-16, 14,040 for 2016-18

Figure 6. Percentage of innovation active businesses by UK nation, 2012-2018

Source: BEIS (2020)

Sources of information for innovation provide an insight into a key process of innovation activity, namely acquisition of knowledge. Here data from the UK Innovation survey suggests that Welsh businesses draw ideas primarily from their supply chain (customer base). In contrast, comparatively few report either government research or higher education institutes as highly important.

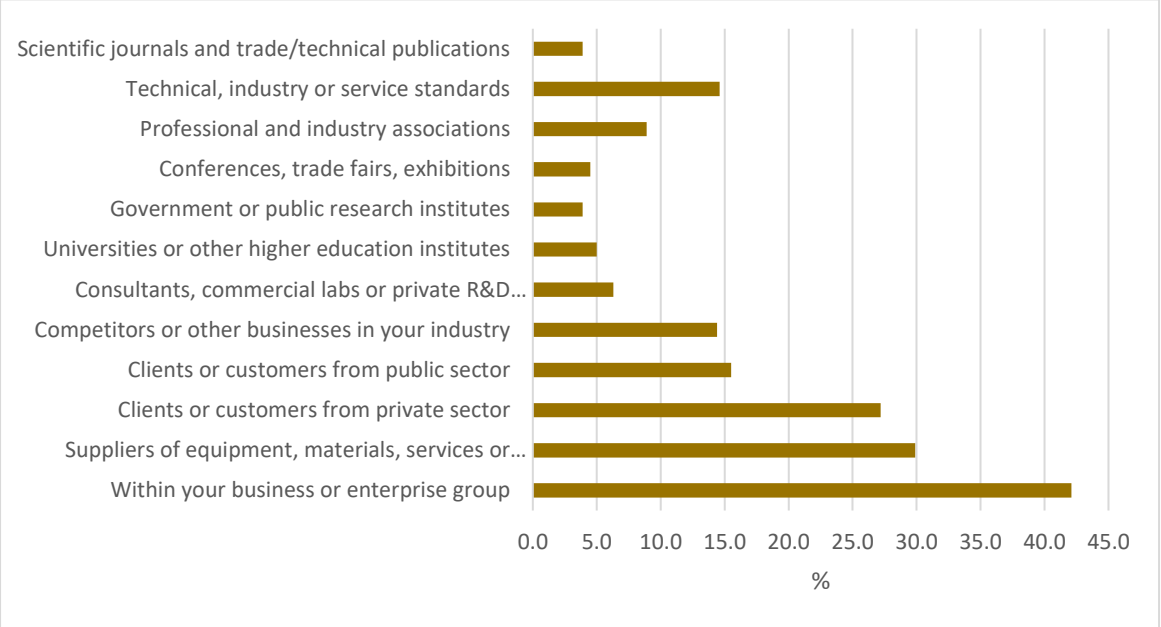


Figure 7. Sources of information used by Welsh firms (% of broader innovators rating listed information sources as "highly important"), 2016-18

Source: ONS (2020d)

Strengths assessment

Identifying strengths in a regional economy represents a way for policy and funding to be targeted. Such strengths can be assessed in a number of ways, reflecting both established economic and innovation activities, but also emergent areas of development. Three such approaches, drawing on secondary data sources, are adopted in this report:

1. Sector strengths, based on productivity
2. Business-university interactions
3. City/Growth Deals priority strengths

Sector productivity

Figure 8 below seeks to identify the comparative strengths of Wales' sectors according to their contribution to the economy based on multifactor productivity over the period 2008-2018 (and adjusted for its comparative strength). This highlights both the contribution and number of firms in each 'bubble'. A number of comparative strengths emerge from this analysis – namely sectors that perform strongly and face the challenge of continuing to innovate:

- Public administration and defence
- Manufacturing
- Electricity, gas, water; sewerage and waste management
- Human health and social work activities
- Accommodation and food service activities

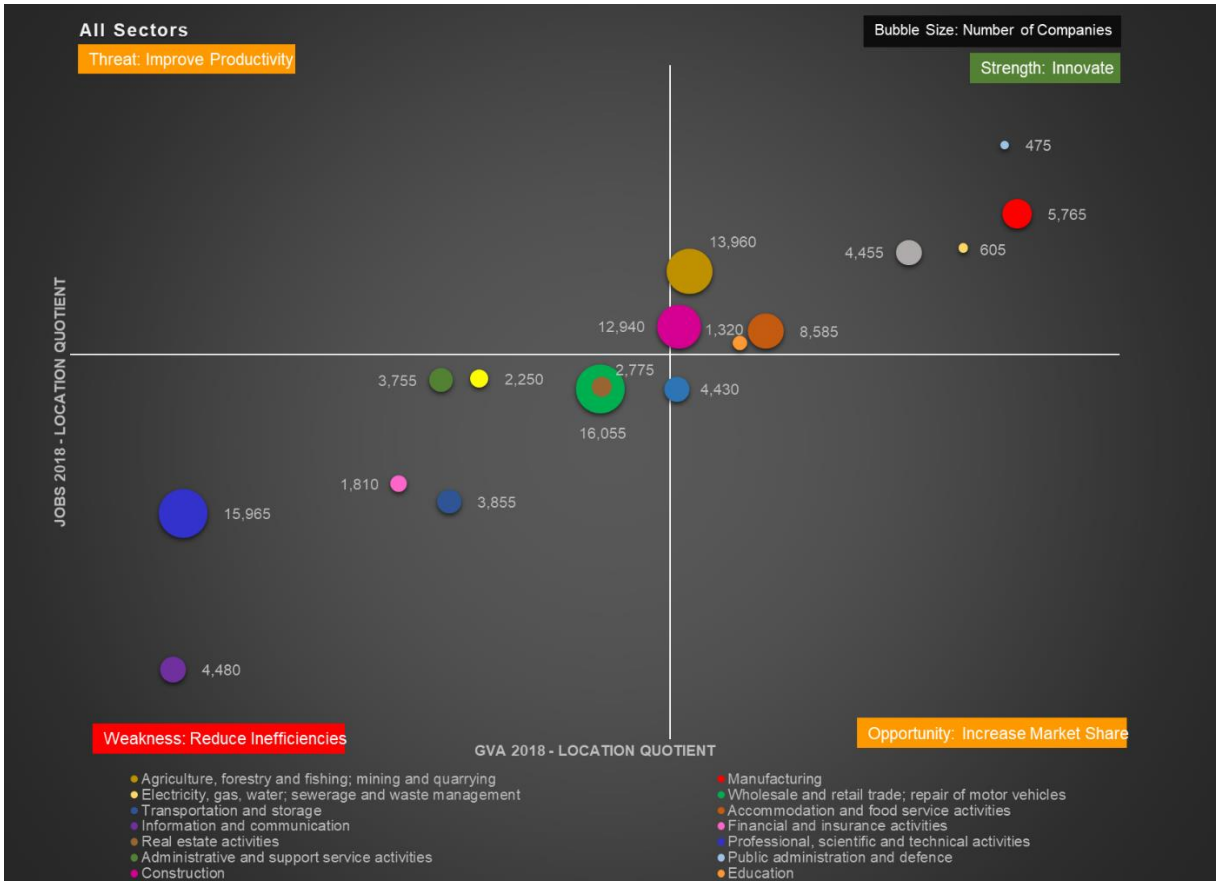


Figure 8. Wales economic sectors, mapped by their contribution to the economy and historical total multi productivity growth 2008-2018 and number of jobs

Source: Tony Guile - Sector Strengths Analysis

Business interaction and collaborative research strengths

A number of 'hotspots' have been identified in university-business interactions, reflecting strengths in strategic sectors and technology disciplines (Morgan et al., 2017). These hotspots are based on university perceptions and are, in the majority of cases, found across a number of institutions (Figure 9).

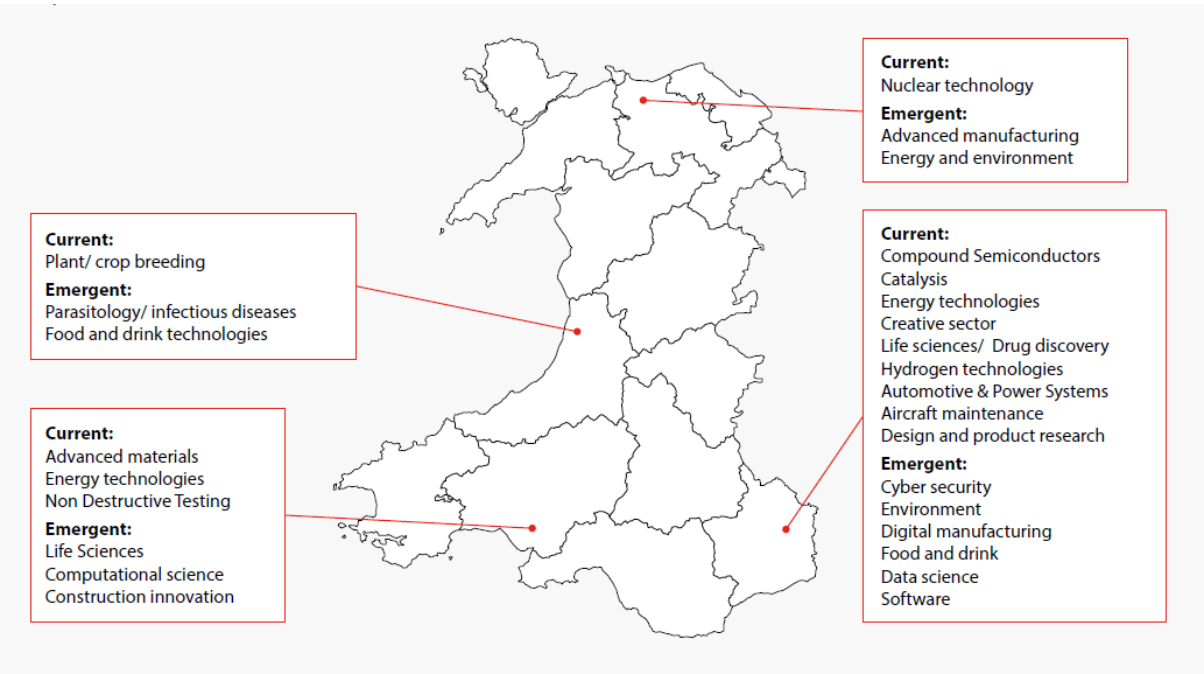


Figure 9. 'Hot spots' of university-business collaboration

Source: Morgan et al. (2017)

City / Region Deal strength priorities

While it can be difficult to objectively identify sectoral strengths, it is informative to review those sectors identified by regional actors as their priorities. At a sub-national level, four regions have published strategy and vision documents that identify specialisms and themes that form an important part of the innovation landscape. These are the Cardiff Capital Region City Deal, Swansea Bay City Deal, the North Wales Growth Deal and the Mid Wales Growth Deal. The main strengths identified in these Deals are summarised in the table below.

Cardiff Capital Region	Swansea Bay	North Wales Growth Deal	Mid Wales Growth Deal
• Compound semiconductors • FinTech • Cyber Security Analytics • Artificial intelligence • Creative economy • Life sciences • Transport engineering • Energy and environment	• Creative and digital • Low carbon energy and marine • Lifesciences, wellbeing and sport	• Low carbon and nuclear energy • Advanced "smart" manufacturing • Digital and creative sectors	• High value manufacturing • Agriculture, food and drink • Defence and security • Tourism

Table 1. City and Growth Deal sector and technology priorities

Sources: Cardiff Capital Region (2019), North Wales Economic Ambition Board (2018), Growing Mid Wales (2020) https://www.swanseabaycitydeal.wales/about/

The sector and technological strengths and priorities identified in the interviews and sources reviewed can be summarised as follows.

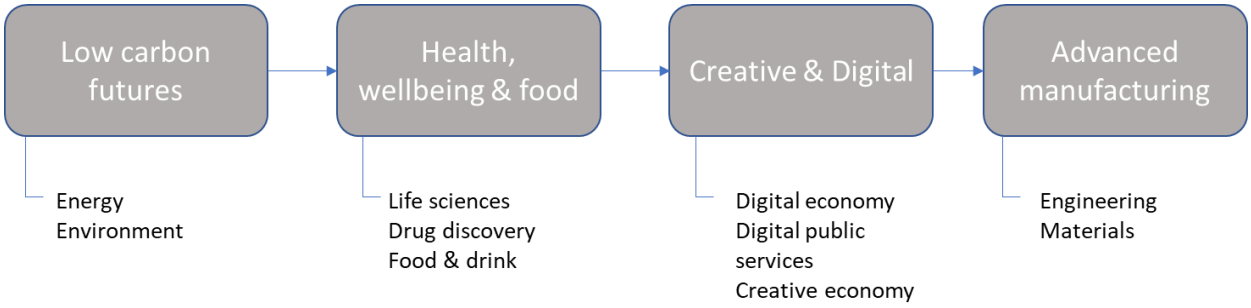


Figure 10. Summary of priority strengths identified in Wales

Source: Authors

These sector and technological strengths are clustered in nature, with significant interactions between technology areas and their supply chains across Wales (and beyond). It includes strengths that have the potential to drive competitiveness in successful businesses, and to do so across business sectors. In this respect, strengths do not always fall within the neat boundaries of general statistical classifications. Colleagues at Clwstwr have usefully mapped the creative economy in Wales in a way that demonstrates its diversity and richness (https://datahubclub.co.uk/map/Creative-Economy-Atlas-Cymru/). The merging of creative and digital reflects the perspectives of our interviewees. We note, however, that both creative and digital represent enablers across most other sectors.

While most of the strengths analysis discussed above falls within manufacturing and traded services, there is also evidence of emerging prioritisation of health and wellbeing and of low carbon and alternative energy sectors. This reflects the potential for innovation not only to contribute towards growth and competitiveness, but also the range of social, economic and environmental challenges in Wales. This has been evident in the COVID-19 period, where health sector innovation has played an important role in the UK's response to the COVID-19 pandemic (Institute of Welsh Affairs, 2021). Low carbon is a further area where Wales is well placed to innovate in the exploitation of its natural assets in wind and waves, renewable energy and support the Future Generations of Wales Act (Welsh Government, 2015b) and the wider challenge of decarbonisation.

Although the identification of strengths and priorities represents a common approach to regional strategy development, it tends to raise concerns about 'picking winners'. In

particular, focusing on areas of strength might inadvertently lead to investment in declining aspects of the economy, or miss emergent sectors that have not yet established themselves.

A number of respondents highlighted the risks of making investments in this fashion, but they also recognised the need for Wales to present strengths clearly when making the case for investment. It has recently been argued that innovation represents a cross-cutting thematic area that has the potential to support multiple clusters. That views the key ingredients of innovation as a common asset that can ultimately support the capability of a wide range of firms to innovate (Potts, 2019).

3. Support available for research and innovation in Wales

Innovation has long been supported by public policy and funding in and beyond Wales. It has sought to address many of the innovation challenges identified in the previous section, as part of efforts to improve productivity across Wales. Innovation is also supported by the UK government, with additional funds from EU (e.g. the Framework Programmes for research and innovation), with the increasing role of sub-national City and Growth Deals. The following section examines the different sources of support available in Wales and concludes by assessing the policy mix of instruments.

WG support for innovation

SMART Suite

The Smart Suite of innovation programmes represents Welsh Government's core 'backbone' research and innovation support instruments targeting business and research institutions. The programmes have their origins in the early 2000s and are managed and delivered by a Welsh Government team, with support from contractors. Funding for the Smart Suite (and its predecessors) has been provided by ERDF, Welsh Government and match funding from business and universities.

The SMART Suite comprises three integrated operations:

- **SMART Innovation**: Expert advice and support for Welsh businesses seeking to undertake innovation activity and R&D (Budget: £18.5m, including £11m ERDF. Due to end in 2023).
- **SMART Cymru**: Financial support to Welsh Businesses to grow their investment in Research, Development and Innovation (Budget £63.4m, including £23.4m ERDF. Due to end in 2021)
- **SMART Expertise**: Financial support provided to research institutions to raise the level of excellence in RD&I in Wales (Budget: £51.25m, including £30.3m ERDF, Due to end in 2021)

Together, the Smart Suite instruments support different stages and aspects of the innovation process, ranging from initial advice and support for projects, through to finance and HEI engagement. The integrated nature of the funding is highlighted by the presence of a team of Innovation Specialists and other advisors, that provide technical expertise across a broad range of sector and technology areas, and help manage relationships with other programmes. This support can also help businesses to lever in funding and support from external bodies

and support businesses. The Smart Suite has generally performed well in supporting businesses to innovate, and building innovation and engagement in Wales' higher education institutions (HEIs). A particular strength of the Smart Suite is its regional focus, providing a greater sub-national coverage than comparable UK programmes provided by Innovate UK. It also supports a higher proportion of smaller research and innovation projects than is typical elsewhere in the UK (See Figure 12.). This funding profile is particularly well adapted to the large base of small and micro businesses in Wales. The recent mid-term evaluation found that the team have adapted the programme in response to recent technological developments such as the emergence of Industry 4.0 technologies and aligned the programme to important priorities such as the Well-Being of Future Generations Act (The Innovation Partnership & Penbryn Consulting, 2020). Indeed, the work of the Innovation team in adapting the Smart Suite to the WoFG saw it win an award in the Civil Service Innovation category at the 2020 Welsh Government Awards. Despite administrative and technical challenges, the mid-term evaluation of the Smart Suite noted that the Smart Suite is likely to exceed targets such as new to the firm products developed and patents registered by the end of operations, with reported high levels of beneficiary satisfaction.

SBRI

SBRI (The Small Business Research Initiative) Accelerator Programme is a more recent programme, providing support to address public sector challenges in Wales. SBRI is a UK programme based on pre commercial procurement with oversight and support by Innovate UK, managed and delivered by Innovation team within Welsh Government. It represents a procurement-led model of innovation, based on bringing the public sector and businesses together to address challenges. SBRI has particular significance to Wales due to the scale of the public sector, where it is estimated that public procurement accounts for some £6.5 billion per annum. The programme illustrates the potential to use procurement to address public sector innovation opportunities, moving beyond purely technological conceptions of innovation.

GovTech is a UK Government related programme that encourages small, emerging technology businesses with a focus on digital innovative solutions to public services. The GovTech Catalyst Fund provides funding for pre-commercial aspects of projects, helping to reduce risks to public sector partners. Since 2013/14, Welsh Government SBRI programmes have resulted in awarding over £7m of SBRI contracts over 20 SBRI Challenges, securing £5m UK competition funding for 4 Welsh Govtech challenges, thereby leveraging nearly £8.3 million

from additional sources. Indeed, Wales is considered to be a leader among the UK nations in the deployment of SBRI.

KTP

KTP (Knowledge Transfer Partnerships) is one of the oldest knowledge transfer support programmes in the UK. The programme is managed by Innovate UK, with Welsh Government providing funding as a stakeholder. Its aim is 'to help Welsh businesses to improve their competitiveness and productivity through the better use of knowledge, technology and skills that reside within UK Research Organisations, and funds business-led projects, delivered by a partnership between business, research organisation and associate. As a core funding partner in KTP, Welsh Government has been able to increase KTP contributions, and adapt its offer through enhanced SP/KTP activity. The programme supported 41 projects, with 21 knowledge base partners in the 2015-2018 period. These projects produced at total of £7.7m industry contributions, as well as 125 high skilled jobs. In contrast to other forms of innovation support, such as the Smart Suite, the KTP is characterised by its tripartite arrangement, with Associates employed, with the support of academic and businesses to conduct knowledge transfer projects.

Other ERDF-funded innovation support in Wales

The presence of ERDF funding in Wales since the early 2000s has enabled organisations such as universities to develop their own innovation support instruments. This has seen a broad range of instruments developed, often at the sub-national level, and targeting SMEs and specific sectors such as manufacturing, with examples of innovative projects emerging in the university sector. While it hasn't been possible to review all such activities established across Wales, it is noted that individual projects are subject to evaluation and are largely able to point to impacts on the economy. The overall picture, however, has the potential for fragmentation and duplication. A full list of ERDF-funded initiatives supporting research and innovation can be found in the annex. This illustrates the diversity of actors engaged in this support ecosystem and their spread across both the East Wales and West Wales and the Valleys areas of Wales.

The funding allocated to ERDF funded research and Innovation projects in Wales in the 2014 to 2020 period is broken down in Table 2.**Error! Reference source not found.** below.

Structural Funds Region	ERDF funds awarded	Total project cost
East Wales	£87,892,999	£194,274,594
West Wales and the Valleys	£288,225,235	£473,443,102
Total	£376,118,234	£667,717,696

Table 2. ERDF-funded investment in Wales, Research and Innovation priority 2014-2020

Source: Welsh Government (2021b)

This table highlights the scale of the funding challenge facing research and innovation support in Wales in the post-Brexit era, should other sources of funding not become available.

HEFCW I&E funding

Funding for Innovation and Engagement (I&E) activities within Welsh HEIs comes from HEFCW's Research Wales Innovation Fund (RWIF). This funding supports knowledge exchange, economic, social, and cultural growth across Wales and beyond, and is allocated according to institutional strategies. Funding for I&E (circa £8m per annum in the preceding period) was abolished in 2013/14 as a consequence of the introduction of the full-time undergraduate fee (HEFCW, 2020). In 2019/20 the RWIF was established, along with a one -off, separate funding injection for Innovation Capacity. The importance of I&E funding was highlighted in the Reid Review (Reid, 2018), which recommended that it be increased to £25m per annum. Table 3 below highlights the scale of the comparative underfunding of I&E in Welsh HEIs relative to other areas of the UK.

	Academic Year			
	2017/18	2018/19	2019/20	2020/21
	£m	£m	£m	£m
Wales	0	0	7.5	10.5
England	185	210	213	230
Scotland	12.2	18.7	13.5	13.7
Northern Ireland	4	4	4	4
Total	201.2	232.6	237.9	258.2

Table 3. I&E funding by UK nation

Source: HEFCW

In interviews undertaken for this research, major concerns were raised that I&E funding, in the most recent year, may have been allocated to other areas to address the challenges of

COVID. These emergency measures, though perfectly understandable, have compounded the under-funding of the I&E infrastructure in Welsh universities relative to their UK counterparts.

Innovate UK funding in Wales

Innovate UK provides funding for research and innovation activity in Wales based on its UK-wide remit. This supports researchers, businesses, universities, NHS bodies, charities and non-governmental organisations (NGOs), providing funding for innovative ideas and business growth through grant funding, loans and procurement. Such funding is primarily driven through competitive mechanisms, with funding for projects with commercial potential allocated through regular competitions. Concerns have long been raised, however, that Wales does not benefit sufficiently (relative to its population size) from Innovate UK funding (Jones-Evans, 2015). Indeed, Figure 11 shows that Wales falls below the UK average for Innovate UK spending, and is amongst a small group of areas that have both comparatively low business spending on R&D and low Innovate UK funding (Forth and Jones, 2020). This points to businesses in Wales having comparably lower levels of absorptive capacity for such funds, and there will be a considerable challenge ahead if funding models move towards top-down UK competitive funding allocations for research and innovation.

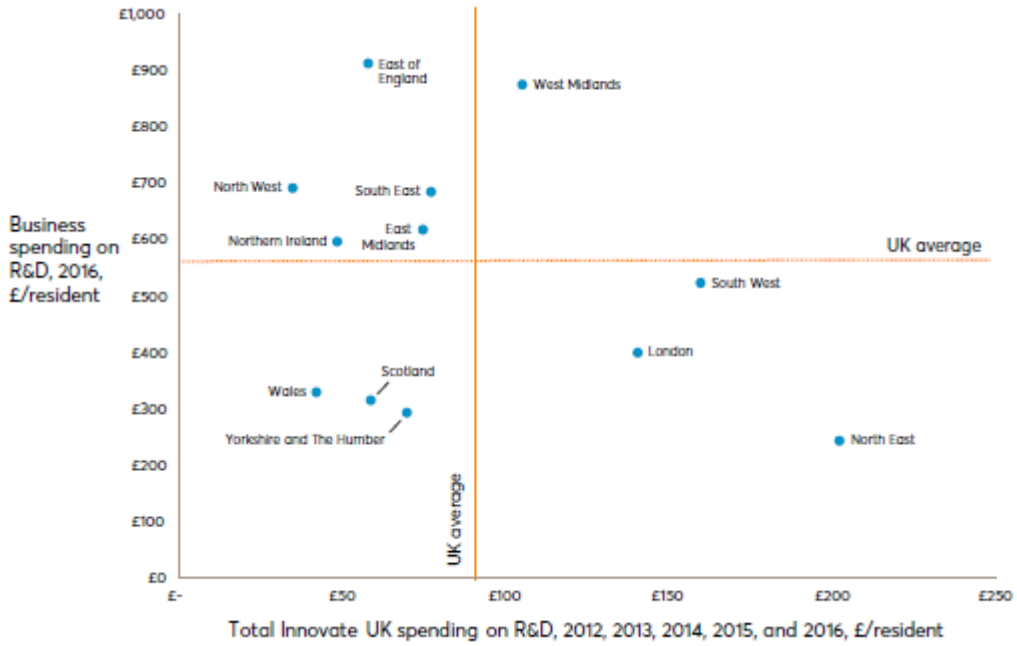


Figure 11. UK spending on R&D by Innovate UK and by business by NUTS 1 region

Source: Forth and Jones (2020)

The geographical spread of UKRI funding within Wales tends to be focused on the core areas of South East Wales and South West Wales (Figure 12). This contrasts markedly with Smart Cymru funding, which reveals a much wider spatial coverage within Wales, highlighting its potential to address important policy agendas such as 'levelling up' by boosting R&D and productivity across all the regions of Wales.

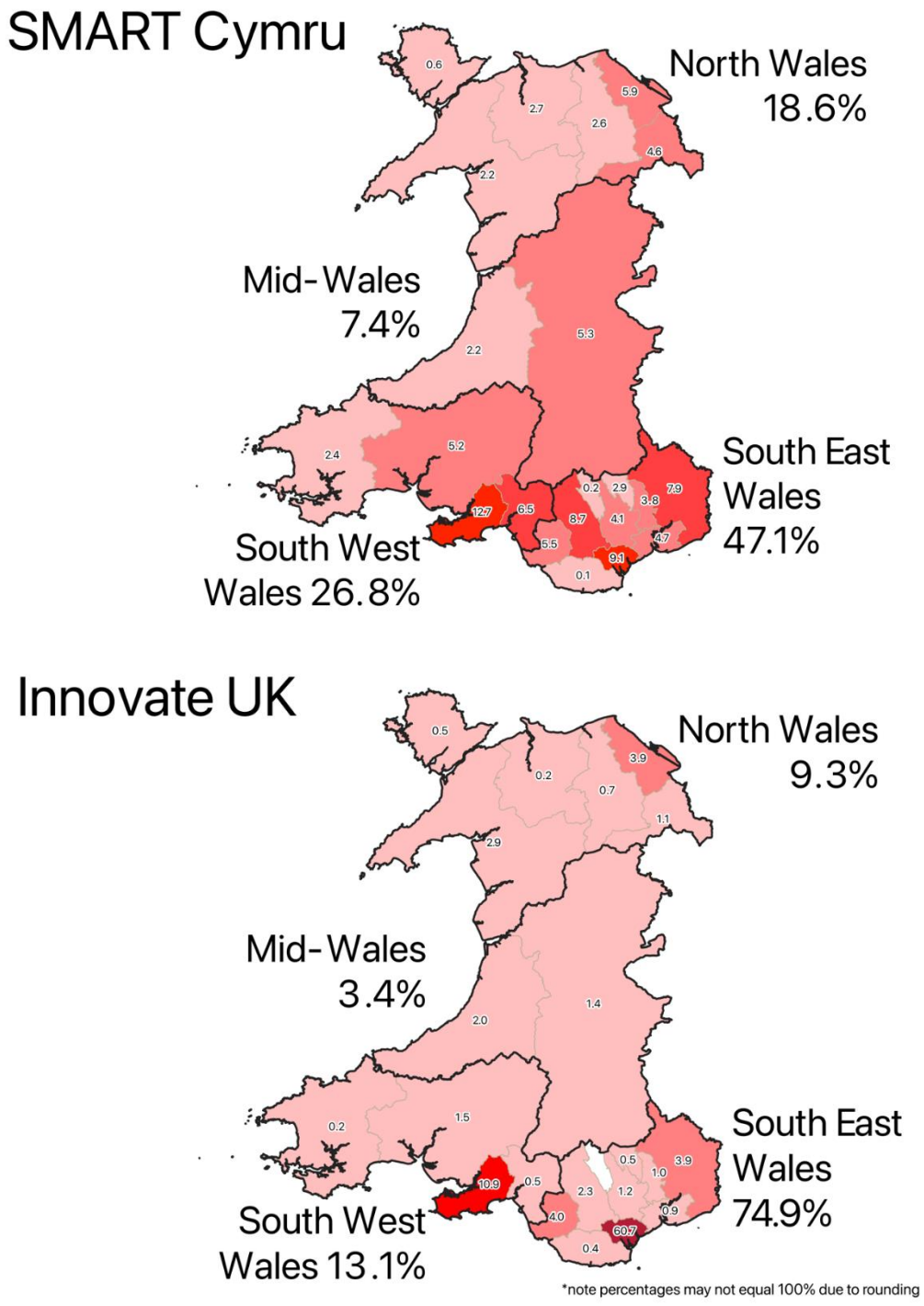


Figure 12. Innovate UK funding in Wales and Smart Cymru funding by economic region, 2014 to 2020

Source: Maps by Brian Webb

Innovate UK funding forms part of an increasingly UK-focused funding landscape for innovation, as highlighted by the UK's R&D Roadmap (HM Government, 2020) with its accompanying commitment to invest 2.4 per cent of UK GDP by 2027. This is expected to see an increase in public funding for R&D by £22bn per year by 2024-2025. The analysis set out above, however, raises questions as to whether Wales is currently well placed to access and absorb such funding.

City and Growth Deals and innovation support in Wales

City-regions provide an additional layer of support for innovation in sub-national areas of Wales. To date four such Deals have been signed in Wales, including: Cardiff Capital Region City Deal, Swansea Bay City Deal and North Wales Growth Deal, as well as the recently agreed Mid Wales Growth Deal. These Deals have been signed by the UK Government, Welsh Government, local authorities and other partners. The three established City and Growth Deals have all identified priorities for innovation and technological development as follows:

Cardiff Capital Region City Deal has established an Innovation Investment Fund to support projects 'demonstrating unique intellectual property, market leadership and competitive strength'[1] This is targeted at growth sectors with the potential to contribute to job creation and GVA growth and provide repayable finance for supported projects.

Swansea Bay City Deal is providing capital funding for a range of innovation projects, including the Swansea City and Waterfront Digital District, Innovation and Low Carbon Growth and Pentre Awel (business, education and health facilities that will include testing and piloting of life science technologies aimed at enhancing independence and assisted living[2].).

The North Wales Growth Deal includes support for Smart Technology & Innovation Resource Hubs. This seeks to contribute towards its goal of establishing the area as a centre for innovation and dynamic private sector (North Wales Economic Ambition Board, 2018).

[1] https://www.cardiffcapitalregion.wales/investment-overview/
[2] https://www.swanseabaycitydeal.wales/projects/

Mid Wales Growth Deal seeks to establish itself as a 'test bed for innovation', with applied innovation and research acting as one of its Strategic Growth Priorities (Growing Mid Wales, 2020).

These deals are all contributing to the support landscape for innovation in different parts of Wales. Their focus on sub-national areas along with major funding from UK Government (and Welsh Government and other partners) is rapidly re-shaping the governance and support systems for innovation across Wales, creating a more polycentric landscape.

Horizon 2020

The Horizon 2020 scheme is an EU programme providing for research and innovation. Since its inception in 2014, Horizon 2020 projects in Wales have secured some €138.8m, with total project costs amounting to €2.4bn.

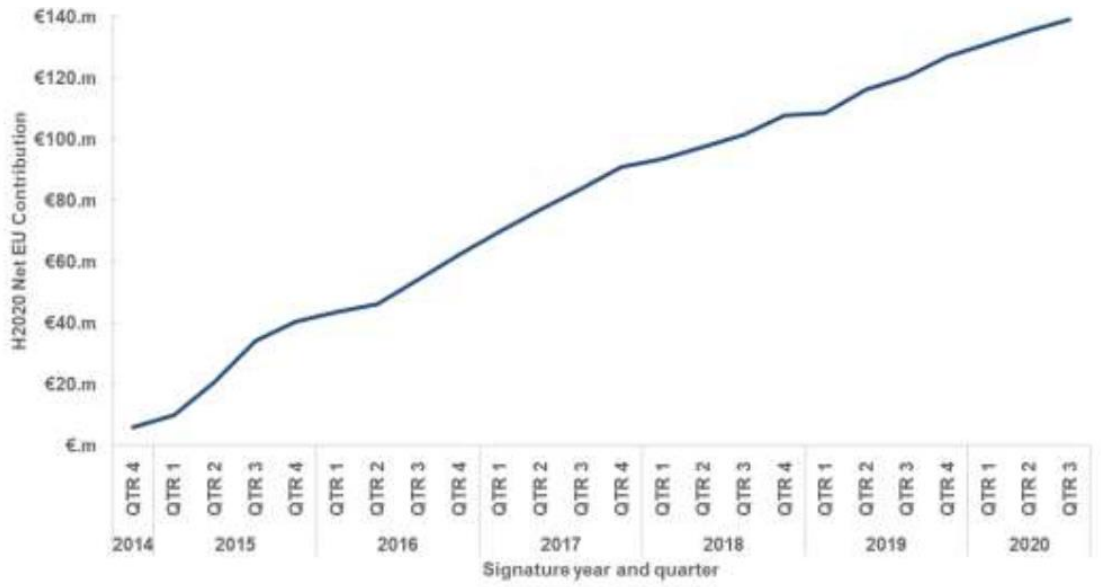


Figure 13. Cumulative progression of Horizon 2020 awards to Wales, 2014-2020

Source: Welsh Government (2020b)

A quarter of contributions to H2020 activity in Wales came from the private sector, 2014-2020. This contrasts with a figure of 18 per cent private sector contributions at the UK level (Welsh Government, 2020b). Within this, the main thematic areas of research relate to advanced manufacturing, food and environmental, with comparatively strong levels of funding secured in the biotechnology area.

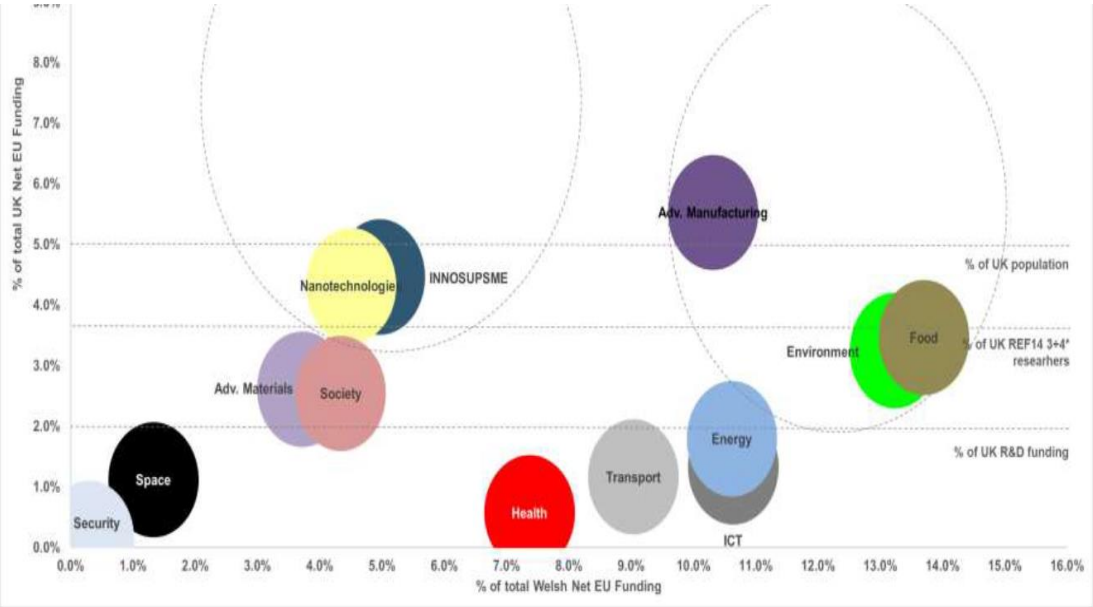


Figure 14. Percentage Welsh H2020 and its percentage of total UK net EU funding secured by thematic priority

Analysis of the innovation policy mix in Wales

The concept of the 'policy mix' refers to the presence and interaction between policy strategies, instruments, actors and outcomes, with the potential for synergies, tensions and trade-offs to emerge over time, impacting on the achievement of goals (Flanagan et al., 2011). In Wales, the research and innovation policy landscape reveals an increasingly complex mix of EU, UK Government, Welsh Government, local and sub-national City and area Deals, each with its own strategies and support mechanisms for innovation. In recent years, this mix has been dominated by ERDF funding for core R&I funding (the Smart Suite and predecessors), but also the proliferation of innovation support projects delivered by organisations across Wales. Concerns have been raised by our contributors about these arrangements, with the potential for overlapping activities, bureaucracy and grant dependency. The ability of university actors to develop ERDF supported innovation has also led to concerns that funding for innovation in Wales has been skewed towards the science agenda (Reid, 2018). This, it is argued, has been influenced by the structure of the Welsh economy and the comparative weakness of the private sector in research and innovation (Jones-Evans & Bristow, 2010). In other words, the absence of strong private sector innovators and high growth firms has resulted in university-led innovation becoming the primary avenue available to absorb such funding in Wales.

The current innovation policy mix in Wales is also characterised by uneven success in access to major UK funding sources for innovation. This has been a longstanding challenge for Wales (Jones-Evans, 2015) and is related, in part, to the presence of its own instruments for innovation support such as the Smart Suite. This support means that few businesses choose to apply to the competitive sources available from organisations such as Innovate UK. Indeed, some authors have argued that the presence of Wales' own support mechanisms has 'blunted rather than honed the competitive capability that will now be needed in this new funding environment' (Webb & Jones-Evans, 2021). The challenge here, as we noted earlier, is that Wales has traditionally funded smaller projects (linked, in part, to Wales' high proportion of small businesses and comparatively low levels of R&D) and has spread its funding out across its regions compared to the more concentrated pattern of UK government funding.

The innovation support landscape is also becoming more complex, with the emergence of the City and Growth Deals. This is witnessing the emergence of city-region and area actors, with their own research and innovation priorities and bilateral links to UK government. Such links suggest that these actors will be an important mechanism, alongside universities and business, by which the increasing UK R&D funding and levelling up agenda is achieved. This additional layer of actors further illustrates the growing challenge of coordination and governance of the policy mix for research and innovation in Wales (Economy Skills and Infrastructure Committee, 2017), as well as the need for focused and concerted investment.

4. Preparing for the future: the new innovation policy landscape

The world of innovation policy has been utterly transformed since the last Welsh innovation strategy, *Innovation Wales*, was published in 2015 (Welsh Government, 2015a). Although business remains the key driver of innovation in the technological sense of the term, it is increasingly recognised that innovation is being framed and defined in more capacious terms today, with social innovation and public sector innovation emerging alongside the traditional conception based on science and technology. The new innovation landscape is populated by a range of new agents other than firms. The new agents include social enterprises and civil society organisations in the case of social innovation; regional governments and their ecosystem partners in the case of place-based innovation clusters; urban municipalities in the case of 'smart cities'; consumers in the case of user-driven innovation; urban living labs in the case of green transitions; and a wide array of social agents such as Non-Governmental Organisations (NGOs) in the case of mission-led innovation programmes that are designed to address societal challenges such as climate change, renewable energy, healthy ageing and food security (Mazzucato et al., 2021; Morgan, 2019).

Although the new landscape has rendered *Innovation Wales* redundant in many ways – indeed many of the contributors listed in the Annex were not even aware of it - the old strategy remains relevant in four ways. Firstly, it anticipated the new landscape by saying that Wales needed to "move away from a traditional, technology-based definition of innovation by recognising that innovation can be achieved everywhere and anywhere and by anyone".

Secondly, it recognised that Welsh Government itself needed to change its culture and its policies, saying: "we will be less prescriptive and more outcome focussed. This means more competitions and prizes that are open to all, more imaginative public procurement across government departments, and more collaboration between businesses, academia and others who access UK and EU funding streams".

Thirdly, it stressed that a national innovation strategy needed to be embraced by the whole society because: "to succeed, this strategy must be owned by more than just the Welsh Government".

Finally, the four priorities at the heart of *Innovation Wales* – life sciences and health; low carbon energy and environment; advanced engineering and materials; and ICT and the digital economy – have assumed more rather than less significance in the past six years. The main problem with these four priorities is not that they lack relevance, but that they are too generic: in other words, they need to be refined and developed in a more granular fashion if

they are to become investable propositions. The need to tailor policy interventions to the specifics was a point stressed by many of our contributors.

To explore the nature and implications of the new innovation policy landscape, this section focuses on four policy challenges: (a) the impacts of COVID and Brexit (b) the systemic transitions of sustainability and digitalisation (c) future resourcing of research and innovation and (d) the challenge of governing R&I in post-Brexit Britain.

The Impacts of COVID and Brexit

COVID and Brexit will both have long-term impacts on the innovation policy landscape in and beyond Wales. With so many imponderables involved, it is impossible to estimate these impacts with any precision. However, some likely impacts can be anticipated and they need to be addressed as a matter of urgency.

COVID

Apart from the tragic scale of human casualties, including more than 126,000 deaths up to March 2021, the most tangible effect of the pandemic has been its uneven impact with respect to industrial sector, age band, social class and ethnic group. From an economic standpoint the sectoral impact has been especially uneven: while the overall economy shrank by nearly 20 per cent in the second quarter of 2020, services such as hospitality – including pubs, restaurants and hotels – recorded almost no output in April and May, but sectors such as information and communication, where staff could largely work from home, saw little change (ONS, 2020a).

The uneven sectoral effect helps to explain the uneven impact on age band. Since February 2020, the under-25s have accounted for 60 per cent of the decline of payroll employees (ONS, 2021).

The sectoral and social impacts will have long-term scarring effects on all the nations and regions of the UK for years to come and this will affect innovation policy as well as social policy. Firms cannot innovate if they do not survive, so business support systems will need to be integrated with innovation policy to a much greater extent than hitherto. Social innovation will be as important as technological innovation if the under-25s are to be properly compensated with special access to education and training opportunities, highlighting the importance of the new Digital Nation strategy that the Brown Review has recommended for Wales.

The pandemic has also demonstrated that Welsh Government (WG) and its partners can be more agile when necessary. The Critical Equipment Requirements Engineering Team (CERET) - a cross-government and industry group – was established early in the pandemic to address

NHS shortages for a range of products, including PPE (Personal Protective Equipment). WG's Innovation and Commercial Procurement teams were active members of the CERET team which promoted joint working alongside the Welsh Government Life Sciences Hub (LSH) in reviewing sourcing offers for the NHS. Further work between LSH and the NHS Wales Shared Services Partnership (NWSSP) to develop a collective PPE procurement approach also strengthened working relationships. These partnerships between WG and industry need to be developed and deepened if the priorities outlined in the COVID recovery strategy are to be effective (Welsh Government, 2020a).

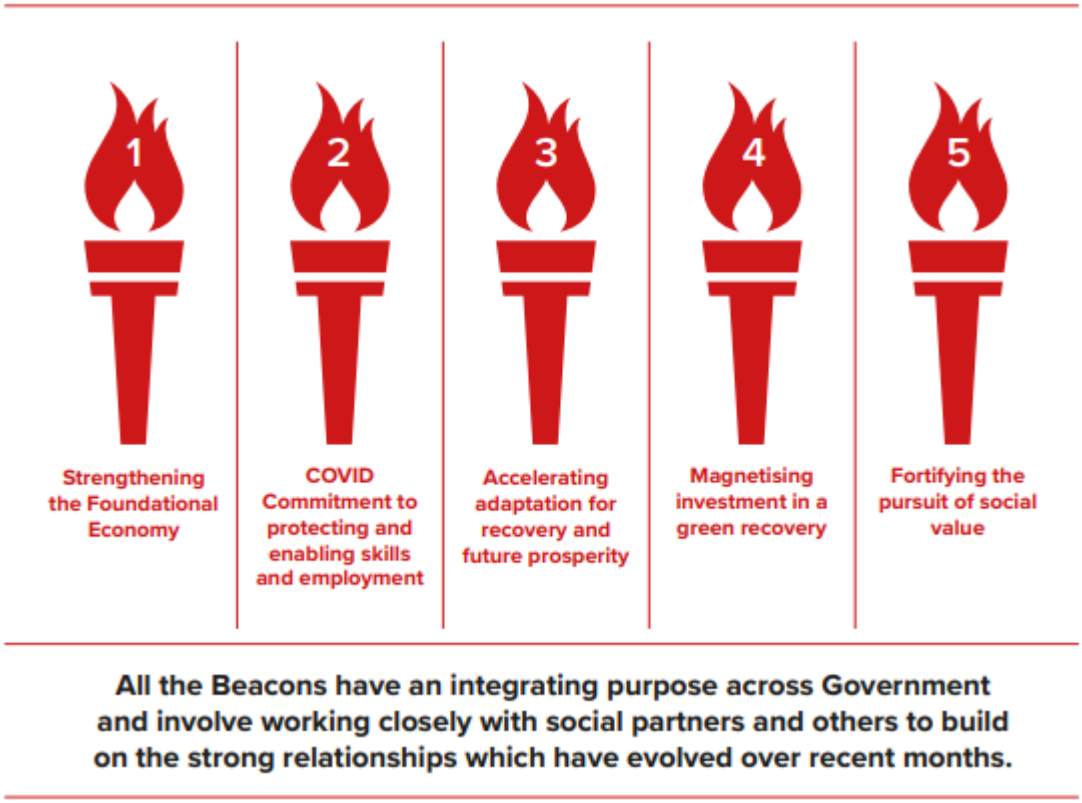


Figure 15. Welsh Government COVID recovery strategy

The COVID recovery strategy has been framed in terms of the Five Beacons shown in Figure 15. The success of this strategy will depend on a high level of cross-government working and an unprecedented degree of public sector innovation to calibrate WG actions with those of its public and private sector partners. COVID accelerated this collaborative process and encouraged WG to think of 'on-shoring' opportunities. As it said in its recovery plan: "The crisis also showed the fragility of the global supply chain and the economic opportunity of 'on-shoring' everyday products we currently import. In securing sources of PPE that give the Welsh NHS greater resilience, we can also support more local companies to grow" (Welsh Government, 2021a: 12).

Although the Five Beacons strategy for post-pandemic recovery are informed by the ethos and goals of the WFG Act, the real challenge for the next Welsh Government will be in the delivery not the design of the strategy. What compounds the post-pandemic recovery strategy is the fact that it coincides with the aftermath of Brexit.

Brexit

If the impact of Brexit has been temporarily dwarfed by the impact of COVID, the longer term economic effects of the UK's exit from the EU are widely expected to be more significant than the pandemic, not least because they are enduring and deep-seated structural effects. The fact that UK exports of goods to the EU declined by 40.7 per cent in January 2021, the worst since monthly records began, was a sobering reminder of the challenges ahead. Although many factors were involved in the January data, like stockpiling and lockdown effects, there is no doubt that non-tariff barriers also played a major role. The fundamental fact of the Brexit deal is that it did not remove non-tariff barriers to trade and some sectors – especially food exporters – were the first to feel the debilitating economic impact (BBC, 2021).

Like the COVID effect, the Brexit effect will be uneven in sectoral and social terms and therefore a judicious innovation policy will need to keep abreast of these nuances. Although it is too early to assess the longer term sectoral effects, a comprehensive risk assessment has been made of the potential economic effects by sector and this is illustrated in Figure 16 below.

	Effects of tariffs on sector export trade directly and indirectly	Effects of tariffs on inputs	Effects of non-tariff barriers on trade and activity	Labour market risks	Effects in regional economy of changes in activity of firms	Effects linked to loss of access to EU knowledge and innovation networks and frameworks	Current age and structure of assets in Wales, susceptibility to corporate investment cycles	Positioning in corporate networks, embeddedness and likely options to displace Welsh activity
Aerospace systems and services	Medium/High	Medium	High	Medium	High	High	Medium/High	Medium
Automotive, transportation and related	High	High	Medium	Low	High	Medium	High	Medium-High
Business services	Low	Low	Low	Low	Low-Medium	Low	Low	Low-Medium
Construction and civil engineering	Low	Low	Low	Low-Medium	Medium/High	Low	Low	Low
Elec. Eng.components, semiconductors	High	High	Medium	Low	Medium/High	Medium	Medium-High	Medium-High
Energy & utilities	Low	Low	Low	Low	High	Low	Low	Low
Financial services	Low	Low	Low	Low	High	Low	Low	Low-Medium
Food and drink	Medium	Medium	Low	Medium	High	Low	Low	Low
Information and communications technology	Medium	Low	Low-Medium	Medium	Low-Medium	High	Low-Medium	Low-Medium
Insurance	Low	Low	Low	Low	Medium/High	Low	Low	Low-Medium
Medical/health products and services	Low-Medium	Medium/High	Medium	Low	Medium	High	Low-Medium	Medium
Other adv. manufacturing and engineering	Medium-High	Medium	Medium	Low	Low-Medium	Low-Medium	High	Medium-High
Paper, wood, wood products	Low	Low	Low	Low	Medium	Low	Medium	Low-Medium
Process and chemicals	High	Low	Medium	Low	Medium/High	Low	Medium-High	Low-Medium
Steel	High	Low	Medium	Low	High	Low	Medium-High	Medium
TV production and creative	Low	Low	Low	Low-Medium	Medium	Low	Low	Low

Figure 16. Summary of Potential Welsh Sectoral Risks

Source: WERU

The WERU risk assessment was also extended to calibrate risks and the importance of the sectors to the Welsh economy by charting sector risk against that sector's employment location quotient - the LQ shows the relative importance of that sector in Wales compared to Great Britain (WERU, 2017).

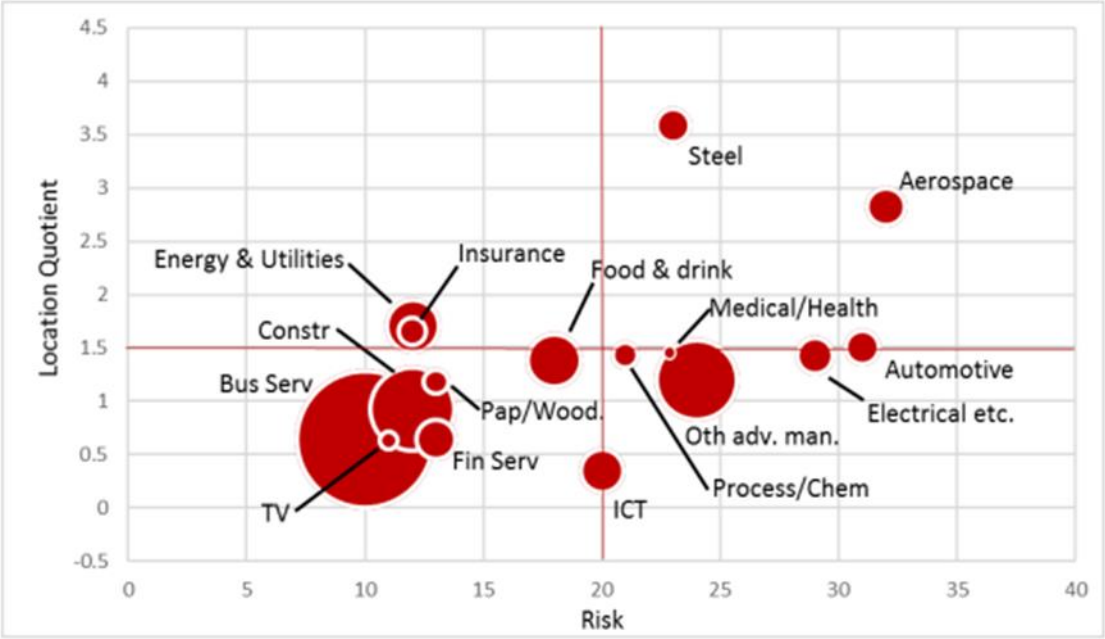


Figure 17. Risk, Location Quotient and Sector Employment in Wales

Source: WERU (2017)

Despite all the imponderables associated with Brexit, it is worth noting three of the most tangible and immediate risks to the Welsh economy, namely: (a) export markets (b) the loss of EU regional funding and (c) the rules of the new UK internal market. As we cover (b) and (c) in later sections, we confine ourselves here to the export market challenge, where Wales and the UK have very different trading profiles. For Wales, 59.8 per cent of total exports in 2019 went to the EU, the other 40.1 per cent went to countries in the Rest of the World. However, for UK exports, there was a more balanced proportion between the EU and Rest of the World, accounting for 48.6 per cent and 51.3 per cent respectively. In short, Wales is much more dependent on the EU market (ONS, 2020b).

WG and its partners need to monitor a range of threats and opportunities associated with Brexit to take early and effective remedial action. A good example of such remedial action is the New International Learning Exchange (NILE) scheme that WG designed to compensate for the UK Government's decision to withdraw from the EU's Erasmus+ scheme of student mobility. The NILE scheme will enable learners and staff, both from Wales and those who come to study or work in Wales, to continue to benefit from international exchanges in a similar way to the opportunities that flowed from Erasmus+, not just in Europe but also further afield. The new scheme – which will run from 2022 to 2026 - will be supported by an investment of £65m from the Welsh Government (Welsh Government, 2021c). The NILE scheme will provide funding to enable students, staff and learners across universities, Further Education and Vocational Education and Training, Adult Education, youth work settings and schools to undertake a period of structured learning or work experience overseas, as well as enabling strategic partnerships (ONS, 2020b).

Only time will tell what the longer term effects of Brexit will be, but they are likely to be felt most keenly in product markets (where Wales is relatively more dependent on the EU market); labour markets (where migration patterns are already changing with respect to EU students and researchers); and funding regimes for research, innovation and development (all of which are addressed later).

Systemic Transition Challenges: Sustainability and Digitalisation

Two of the greatest systemic challenges facing all countries are sustainability and digitalisation. While the former is an existential challenge, the latter is a technological revolution, and both call for new forms of collective action in which state, market and civil society actors work in concert to a degree not witnessed outside war economies.

Sustainability

More integrated actions are urgently required to promote sustainability to counter the noxious effects of climate change. Climate-friendly policies need to be adopted across the entire policy spectrum, particularly with respect to: internationally agreed climate targets; clean, affordable and secure energy; circular economy targets in all sectors; energy efficient buildings; smart and sustainable mobility; sustainable food chains from farm to fork; and nature-focused actions to preserve and promote biodiversity and ecosystems along the lines of the Dasgupta Review (Dasgupta, 2021).

Welsh Government won international acclaim for its commitment to sustainable development when it introduced the Well-being of Future Generations (Wales) Act in 2015 (Welsh Government, 2015b). But a recent review of the Act said it is now necessary "to lead the way in matching their ambition with reality, challenging and changing the Welsh public

sector culture to match the aspiration of the Act by showing strong leadership and commitment" (Future Generations Commissioner for Wales, 2020: 15).

Closing the gap between policy aspiration and policy delivery – the policy implementation gap – is arguably the greatest innovation policy challenge on the sustainability front. In framing its new innovation strategy for the post-Brexit era, Welsh Government will need to demonstrate strong leadership and commitment at both international and domestic policy levels.

At the international level, where its powers are limited, the most significant commitments that WG has made to date are through its responses to the recommendations of the UK's Climate Change Committee (CCC). The CCC recently recommended the Welsh 2050 emissions reduction target was changed from 80 per cent to 95 per cent. Welsh Government has accepted this more demanding target as its contribution to the Paris Agreement goal of net zero by the middle of the century. Meeting this emissions reduction target in Wales requires more concerted action from governments in Cardiff and Westminster, business and civil society. The CCC praised Welsh progress in a number of fields, including recycling, the deployment of renewable energy at scale and its ambitious new transport strategy. Although major challenges remain, especially the need to reduce emissions in agriculture for example, WG says it has stretched its devolved powers to the full to respond to the climate emergency.

In detailing its response to the climate emergency, WG has identified a number of steps that are pertinent to future innovation policy, particularly in the energy sector. These include public sector-led exemplar programmes, the development of zero carbon housing, the decarbonisation of existing homes, and funding businesses of all kinds in Wales to reduce their emissions through programmes such as the EU-funded Smart Cymru programme (Griffiths, 2020).

At the domestic level WG powers are confined to devolved competences and here the most significant ways it can demonstrate leadership and commitment are through the stewardship of its own estate and through influencing public procurement in Wales, which amounts to £6.5bn per annum. Public procurement has the greatest potential to encourage more sustainable practices in the public and private sectors and it should be deployed to greater effect as an innovation policy instrument as well as a means of promoting the WFG goals. However, the Future Generations Commissioner's progress report on procurement found that: "Welsh Government has failed to show clear joined up leadership on the role of procurement in delivering Wales' national well-being goals (and public bodies well-being objectives)" (Future Generations Commissioner for Wales, 2021). To its credit, however, the Welsh Government has recently responded by updating the 2015 Wales Procurement Policy

Statement by (a) committing itself more forcefully to the WFG goals (b) providing more national leadership and (c) working in a more collaborative fashion with other procurement bodies in the public sector (Future Generations Commissioner for Wales, 2021).

Given the constraints on public funds in the future, Wales can ill-afford to ignore the potential of the power of purchase in its public sector, where so much is spent every year procuring goods, services and works. The Welsh response to the pandemic showed that procurement can help to re-localise the supply of certain goods – such as PPE equipment – when the need arose and this experience should be utilised in the post-pandemic era to promote innovation and sustainability.

Digitalisation

Digitalisation amounts to a technological revolution on a par with the earlier systemic transitions associated with steam, electricity and ICT, and it is the primary driver of the emerging Fourth Industrial Revolution (FIR). The FIR refers to the digital transformation of business, public services and the wider society, driven by rapid advances in Artificial Intelligence, Robotics, Data Analytics, Internet of Things, and it challenges existing models of work organisation with major implications for the economy and the future of education, jobs, skills and the labour market.

Wales is well placed to respond to the multiple policy challenges of digitalisation as these have been comprehensively examined by the recent Brown Review of Digital Innovation (Brown, 2019), which WG had the foresight to commission in 2018. It concluded with 33 recommendations in total, but the Brown Review can be distilled into a smaller number of key actions, each of which will be crucial to the development of the future Welsh innovation ecosystem:

- A seismic shift in research, development and innovation. A commitment to support strategic and collaborative projects including the fields of AI and data, which build on the capabilities of academia and the entrepreneurial capabilities of industry. A key recommendation in the Review was to create an AI Institute aimed at transforming Wales into a Data Nation. Significant funding is now required to make the Welsh Data Nation Accelerator (DNA) a reality, with the potential to attract multi-million pound investment. It offers an opportunity to scale digital innovation to build national capabilities in Artificial Intelligence, grow and attract talent across Wales, including AI apprenticeships, facilitate

significant business-led experimentation, and build a platform ecosystem for data innovation and exploitation.

- At the local level, mainstreaming Digital as part of an inclusive and distributed approach to economic development. The pandemic has revealed inequalities in access to digital that are simply not acceptable. Mainstreaming digital infrastructure in our homes and communities is an urgent requirement but new technologies also offer the prospect of a 'distributed' bottom-up approach to economic development. We've tried taking jobs to the Valleys (inward investment), and we've tried taking the Valleys to the jobs (City regions), but now it is time to experiment with a much more ambitious approach to the 'foundational' economy. The separation between work and place, cloud-enabled distributed offices, micro-factories, local energy generation, bespoke makerspaces, online learning platforms, repurposing retail units, etc., all provide an unprecedented opportunity to create digitally enhanced, environmentally friendly, smarter places for people to live throughout Wales.

- Co-creating the digital innovation clusters of the future. A clear plan for supporting the development of key industrial innovation clusters – be that clean energy, cybersecurity, med tech, or smart production – which is backed and driven by industry, and where government co-invests in supporting technological innovations that address the missing-middle of Welsh industry, attracting new private equity investment, and advance a human-centred model of industrial transformation.

- Creating a skilled and agile future workforce. Digital means something more than just better digital skills, it means new ways of thinking about education and training for a different future of work. Ensuring there is a meaningful commitment to lifelong learning needs to go hand-in-hand with a new skills framework for Wales linked to regionally tailored industrial transformation roadmaps (ITR). Devising a challenge fund which allows our institutions to gear-up for the changes ahead is the next step in reforming post-compulsory education in Wales.

- Delivering economic transformation for a better future of work in Wales will require bold political leadership and re-allocating resources within Welsh Government. The current capacity constraints within the civil service to facilitate digital transformation on the scale required at both a national and regional level is a major impediment to change. Little progress will be made unless existing resources are reassigned and new resources secured to accelerate industrial transformation, including supporting business for better jobs and skills.

- Rebrand Wales as a Digital Nation with a shared narrative presenting a coherent vision of Wales in the World, committed to building a carbon-neutral world. This rebrand also

includes the launch of a national conversation with our citizens, businesses and public services, aimed at giving them a proper voice in our collective digital journey (Brown, 2019).

The Brown Review is an insightful and compelling review of the implications of the digital revolution for Wales and the above summary highlights the key actions that need to flow from it. WG has begun to address this agenda, for example by creating the Centre for Digital Public Services, a new arm's length body that aims to work with users to develop or improve services that help them to do something better in everyday life. While this is a start, WG needs to work at scale and pace with its partners in the public, private and civic sectors if the Brown Review is to have the impact it deserves.

Resourcing Research and Innovation in Wales

The landscape for funding research and innovation (R&I) in Wales is changing at such a pace that it is widely considered to be one of the most challenging innovation policy issues of all. As we have seen, Brexit will have major implications for the funding that is available to Wales. But this resourcing issue cannot be reduced solely to the quantum of money that is available. Equally important questions need to be asked about the balance of spending (between research on the one hand and innovation on the other) and the impact of spending.

The debate about the quantum of money available has been triggered by Brexit and the fact that Wales will no longer be in receipt of EU Structural Funds such as ERDF. Figure 18 below is instructive for two reasons: (a) Wales had the highest level of ERDF money in the UK on a per capita basis and (b) Wales received the lowest level of Horizon funds (Welsh Government, 2020b).

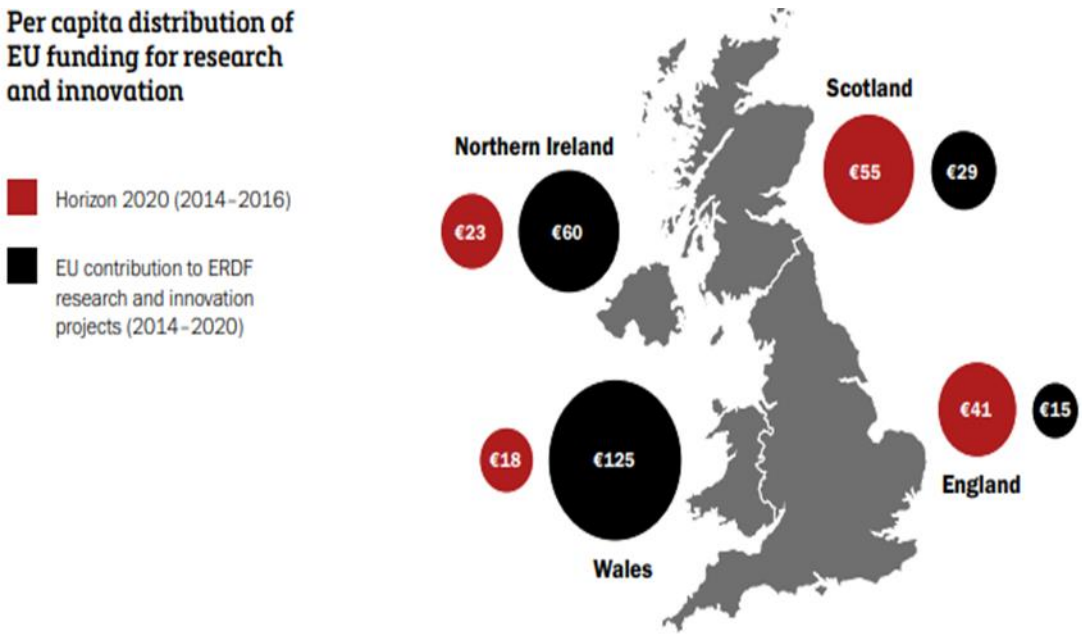


Figure 18. Distribution of EU funding for research

The distinction is important because ERDF funds are allocated on the basis of need, while Horizon funds are allocated on the basis of excellence in open competition. Future research funding decisions are set to be taken exclusively on the basis of the latter so the key question is to what extent is Wales equipped to secure its R&I resources from open competitions for UKRI funds in the UK and Horizon Europe funds in the EU? This was one of the questions that was raised but not fully addressed in the Reid Review of Government-funded R&I in Wales (Reid, 2018). The Reid Review argued that long-standing weaknesses in the R&I ecosystem in Wales had been masked by EU Structural Funds. To offset this post-Brexit threat, Reid signalled that "the growing budget in UKRI now presents major opportunities for businesses and universities in Wales to win sizeable amounts of additional research and innovation funding. There is no limit to the proportion of UKRI funding that can be won in these competitions and the benefits to Wales that would come from that success". But he added a cautionary note, saying: "Only the strongest competitors will win" (Reid, 2018: ii).

To create a stronger R&I ecosystem in Wales, Reid made three very important funding recommendations:

(a) to strengthen the research base in Wales by implementing the Diamond proposal to protect QR funding at £71m annually in real terms and to create a new fund, the Future of Wales Fund, with a budget of £30m that should be allocated to universities in direct proportion to the amount of additional funding they secure in competitions outside Wales;

(b) to re-instate the Innovation and Engagement Fund with a higher budget of £35m, and;

(c) to enhance support for innovation in business and the public sector in Wales, Reid recommended the creation of a single overarching brand: the St David's Investment Fund. This should be worth some £35m yearly in the first instance, he said, but with the potential to grow to £100m yearly or more, post-Brexit (Reid, 2018).

Although the Welsh Government accepted all these recommendations in principle on 6 June 2018, the resourcing of the Future of Wales Fund and the St David's Fund has thus far failed to materialise, bequeathing a major challenge for the Sixth Senedd.

Implementing the FWF on its own would probably have exposed WG to the charge of 'picking winners'. But Reid's recommendations were designed to work as a trio, which could have prevented that happening. The rationale was that the three recommendations would simultaneously protect the underlying research base (QR) and the capacity for innovation (I&E), while also incentivising best practice and excellence (FWF).

Reid was concerned to devise a system with stronger performance metrics in order to incentivise universities to attract the highest levels of external income through collaborations with businesses and other partners. This innovation agenda urgently needs to be more strongly incentivised within universities because university managers have conceded that "science had captured the term 'Innovation'" (Reid, 2018: 58).

More recently, however, Welsh universities have made a genuine effort to address the innovation agenda by investing in a whole series of initiatives to valorise their knowledge-generating activities, as we can see from the following examples:

University	Example
Aberystwyth	Aberystwyth Innovation and Enterprise Campus (Aberinnovation) provides world-leading facilities and expertise within the biotechnology, agri-tech, and food and drink sectors. The campus seeks to provide an ideal environment for business and academic collaboration to flourish. Aberinnovation
Bangor	M-sparc, a Bangor University Company, provides space for businesses of all sizes, from start-ups to large corporate companies. Outstanding facilities, bespoke business support services, flexible office space and laboratories are all available on site. m-sparc
Cardiff	sparc | spark co-locates researchers with collaborators in a vibrant new hub that will nurture partnerships between entrepreneurs,

	business leaders, professional advisers, academics and students. Embracing social innovation and featuring commercial units and lab space for spin-outs and start-ups, spark will house facilities that help collaborators bring ideas to life. sparc | spark
Swansea	AgorIP is a new approach to innovation which can help bring ideas and innovation to life. It can help realise the potential of new ideas, products or research. A team of experts will help take "IP" to the marketplace and make it a commercial success. AgorIP

Table 4. *Examples of how Wales' research-intensive universities are developing their innovation capacity*

Reid's recommendations also underline the importance of the balance of R&I funding and not merely the quantum. The perennial debate about whether to invest in research/science on the one hand or development/innovation on the other is a spurious choice because they are inextricably related. The main point to note is that Wales has been disadvantaged on the research side of the R&I spectrum (because the value of QR funding still lags behind England) and on the innovation side because of the Education Minister's decision in 2013-14 to abolish the Innovation and Engagement Fund through which Welsh universities funded their knowledge transfer and business engagement activities. This put Welsh universities at a considerable disadvantage relative to their counterparts in other UK nations as we saw in Table 3 (p. 19).

Although HEFCW managed to re-instate a portion of I&E funding for 2020/21 (under its new Research Wales Innovation Fund), the value falls far short of what was recommended by Reid, with the result that the capacity of Welsh universities to craft knowledge exchange partnerships with partners in business and civil society remains severely limited. Indeed, if this I&E shortfall is not remedied as a matter of urgency, it is difficult to see how Welsh universities can be expected to compete with their UK counterparts in new place-based programmes like the £4.8bn *Levelling Up Fund* and the £220m *Community Renewal Fund* (a pilot version of the forthcoming *Shared Prosperity Fund* that is intended to be a replacement for EU Structural Funds) because these funds require strong place-based alliances. The recently formed Innovation Greater Manchester – an alliance of local government, business and academia – offers a blueprint of what English city-regions are doing to secure funds from the new generation of place-based funding programmes (Greater Manchester Combined Authority, 2021).

To enhance the impact of R&I funds in the future, the new innovation strategy in Wales needs to avoid the sterile debate between research versus innovation and recognise the need to strengthen both sides of the equation. Basically, this means investing in *translational* research on the supply-side of the ecosystem and boosting the *absorptive capacity* of firms on the demand-side so that they are more able and willing to act as informed consumers and commissioners of R&D. And this needs to encompass the marginal gains that are accumulated through incremental innovation and productivity improvements as well as radical innovation and the outcomes from breakthrough science and technology R&D. This is a learning-by-doing process for both sides of the ecosystem – universities and firms, both large and small – and it underlines the need for a future innovation policy to contain a strong capacity building component along the lines of a reformed Smart Cymru scheme. As we noted in chapter 3, one of the great merits of Smart Cymru grants relative to Innovate UK grants, is that they contain a progression pathway, so that SMEs can acquire the absorptive capacity to enable them to mount credible bids to Innovate UK, highlighting the point that Smart Cymru 2.0 needs to be understood as a complement to, rather than a surrogate for, Innovate UK awards.

The impact of future innovation policy can also be enhanced through a more agile and less bureaucratic monitoring and evaluation (M&E) system. The evidence suggests that policymakers tend to see M&E in terms of an externally imposed audit function – a command and control tool to police compliance – and this misses the real significance of M&E activity: that it is primarily a learning tool and not a compliance tool. This was the key point that Charles Sabel made at the *Smart Regions Conference* in 2016, when he argued that regional innovation policy needed more diagnostic monitoring, which involves "monitoring to underscore the continuing need at all levels to check on progress, given the limits of planning, and diagnostic because the aim is to facilitate and organize problem solving by the actors, not to use the threat of punishment for bad performance as an incentive for good behaviour" (Sabel, 2016).

Some of our contributors highlighted the challenge of navigating innovation support schemes in Wales because of the red tape and onerous monitoring procedures attached to them. The need for a reformed M&E system has never been more urgently felt because, with the demise of the bureaucratic ESIF regulations, WEFO has an opportunity to design a more enabling system. It would be counter-productive to give WEFO a new mandate if its M&E culture remained the same because many respondents, from the public and private sectors, said that it added complexity and inflexibility by interpreting ESIF regulations in a more conservative fashion than its counterparts in other countries.

Governing Research and Innovation: the new multilevel policy landscape

Being aware of the changing governance of research and innovation activity in the UK is just as important as staying abreast of new funding programmes, indeed the two issues are inextricably linked. In this section we focus on three distinct dimensions of governance: (a) the UK level, where many new R&I programmes have been launched since the Johnson government assumed office (b) the Wales level, where a new and more polycentric landscape is emerging following the creation of four development regions and (c) the Welsh Government level itself, where the organisational status of R&I needs to be addressed anew.

The UK Level

The UK Government (UKG) plans to assume many of the roles that that the European Commission once played with respect to the allocation of regional development resources, albeit with one major difference. The main difference is that UKG intends to play a more direct role in regional development affairs than the EC was either able or willing to do, despite the fact that economic development is a devolved competence and a core part of the devolution settlement that has been in place for over 20 years. It would be naïve for innovation policymakers to ignore this new institutional context because the current system of inter-governmental relations in the UK is suffering from the lowest level of political trust since devolution was established. The Dunlop Review confirmed this assessment, saying: "There is a broad consensus, with which the Review agrees, that the UK's intergovernmental relations machinery is not fit for purpose. The problem should be addressed by the creation of a UK Intergovernmental Council (UKIC). It would replace the Joint Ministerial Committee and reset relationships for the future. It would be a forum for co-operation and joint working on both opportunities and challenges" (Lord Dunlop, 2019: 10).

However, this unfortunate situation has got worse rather than better since the Dunlop Review was conducted because UKG has awarded itself powers under the UK Internal Market Act (UKIMA) that empowers it to intervene in a wide array of policy domains that were hitherto deemed to be devolved matters.

Drawing on these new powers, UKG has launched a series of new place-based investment programmes – like the *Levelling Up Fund* - and plans to build up regional offices in the nations and regions of the UK to manage these programmes directly. The reason why this is so important to a future innovation strategy in Wales is because the direct management of these programmes renders it more difficult for Welsh Government and its partners to deliver the plans that they have collectively devised over the past two years under the auspices of the Regional Investment in Wales Steering Group, a highly effective stakeholder forum for discussing place-based investment.

Despite this political conundrum, the new Welsh Government would do well to adopt a pragmatic stance of enlightened self-interest and focus on the multiple funds that have been made available for place-based investment and assume a role that only WG can play – which is to act as the convenor of regional ecosystem plans to ensure that they are coherent and consistent with national goals like the WFG goals for example. Playing a more strategic role is also consistent with the recommendations of a recent OECD review of regional development in Wales (OECD, 2020). Furthermore, since UK government clearly wants to deal bilaterally with local authority interlocutors rather than the Devolved Administrations, it would be prudent for WG to work in concert with the new local authority vehicles, the Corporate Joint Committees, to access these new UK investment programmes.

The goal of innovation policy remains the same, namely to strengthen regional innovation ecosystems, and the more WG and its partners can focus on these pragmatic ends rather than the political means, the better it will be for all concerned. This means mobilising partnerships to access competitive UK programmes such as the Strength in Places Fund and other UKRI programmes as well as EU programmes such as Horizon Europe. The fact of the matter is that R&I is not a wholly devolved competence and therefore Wales needs a multilevel mindset if it is to meet the challenge of these new place-based investment programmes.

The Regional Level

A significant change in the governance of Wales is underway and it carries major implications for the design and delivery of R&I activity in the post-Brexit era. The creation of four development regions following the recent OECD review of Welsh multilevel governance has fashioned a new and more polycentric innovation policy landscape in Wales. What this means in short is that WG is no longer the only locus of decision-making when it comes to place-based investment decisions and the full implications of this institutional upheaval have yet to be fully digested by WG at the national level or local government at the regional level.

Figure 19 shows the new development regions where regional working arrangements will be governed by a Corporate Joint Committee to give the regions new statutory powers in three policy domains – economic development, strategic planning and regional transport. The place-based innovation priorities of each of these regions have been designed in partnership with regional partners within the region and with WG and UKG beyond the region as part of the City Deals in Cardiff and Swansea and the Growth Deals in North Wales and Mid-Wales. As we noted in section 3, these priorities reflect what the regions themselves consider to be their main innovation strengths.

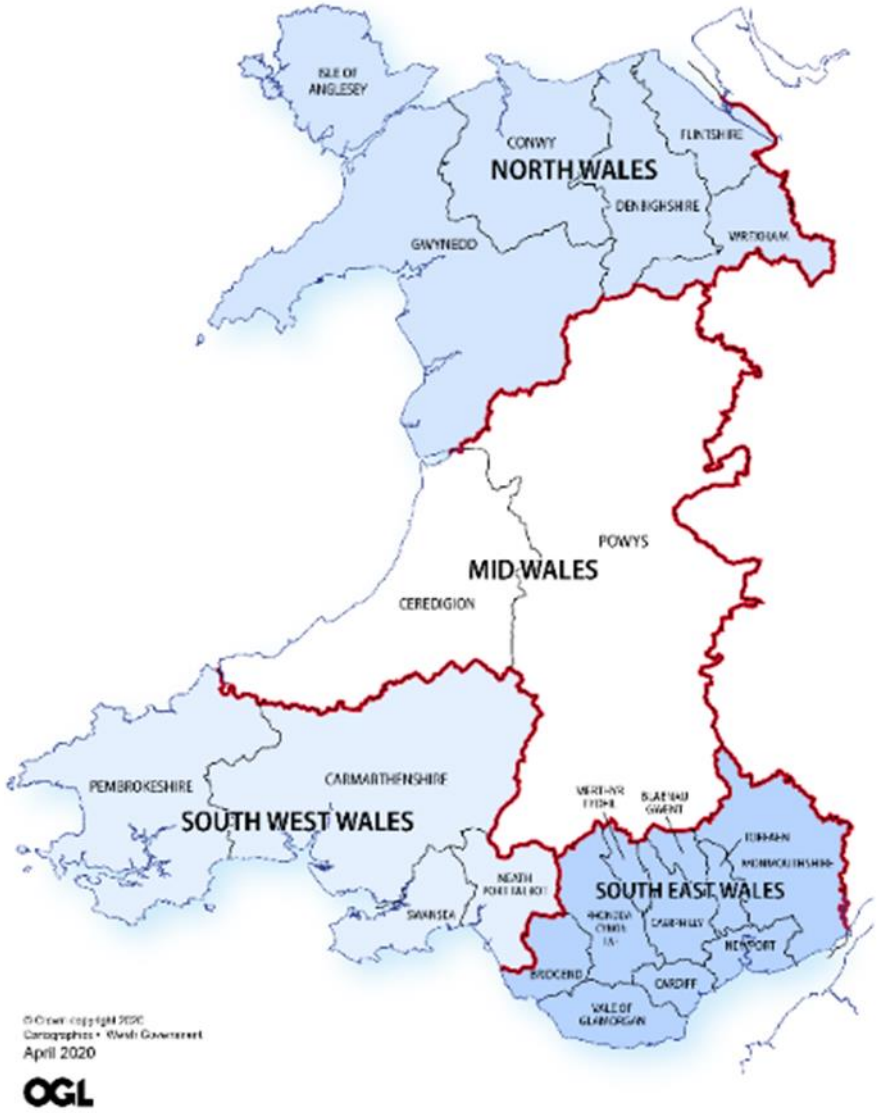


Figure 19. The New Development Regions of Wales

One of the many imponderables that surrounds the new regionalism in Wales will be the interplay between regional level policymaking and pan-Wales policymaking, particularly with respect to innovation policy and delivery, which remain national level functions. This question will assume more significance when the CJCs are fully operational in 2022 because some of the better resourced CJCs, like the Cardiff Capital Region for example, clearly have an appetite for developing stronger institutional capacity at the regional level to match their counterparts in the English city-regions, where the Greater Manchester Combined Authority is the pioneer. Building more institutional capacity in each of the development regions will be essential if the CJCs are to become credible interlocutors for UKG in the new wave of place-based investment programmes.

Welsh Government Level

The organisational status of R&I within Welsh Government clearly needs to be addressed anew because it surfaced time and again in our stakeholder engagements. The main issue concerns the political visibility of innovation within WG, especially after the innovation team was transferred from the Economy to the Education department. Both private and public sector stakeholders felt that there was no political champion of innovation in Welsh Government and this needed to be remedied in the near future given the systemic significance of the digital innovation agenda in particular.

But it would be pointless to create a Minister for Innovation if the organisational structure within WG remained the same because it is too fragmented at present, especially as regards the separation of health and care from the mainstream R&I system. A Minister of Innovation would need to be complemented by the creation of a new post of Director-General for Innovation and Technology to signal that the culture and structure of the civil service in Wales was attuned to, and aligned with, the strongest forces that are re-shaping economy and society throughout the world.

As we are on the cusp of the Sixth Senedd, it is worth recalling the unfinished business of the Fifth Senedd. In its Legacy Report, the Economy, Infrastructure and Skills Committee of the Welsh Parliament concluded by saying: “The Welsh Government did not fully implement the recommendations of the Reid Review in the Fifth Senedd. Research and innovation is known to be a key driver of productivity and will have a fundamental role in the COVID recovery, yet faces fundamental challenges in Wales due to the ending of EU funding…The Committee is concerned the Welsh Government may not fully understand its own total levels and areas of spending on these activities as this information was not provided in the budget statements (Welsh Parliament, 2021:27).

The Sixth Senedd would do well to prioritise a new innovation strategy because, far from being marginal to the twin challenges of COVID and Brexit, it will catalyse the processes of recovery and reconstruction, helping Wales to build back in a greener, fairer and more innovative fashion.

5. Shaping the future Welsh innovation landscape: reflections and recommendations

A number of key points have emerged in our discussions on innovation in Wales with our wide range of contributors. As one would expect, there was not always consensus on what should be done about particular aspects of innovation, but there was considerable agreement on what the most pressing issues were. In this final section, we reflect on the most important issues in considering the future development of Wales as a successful innovation ecosystem. We draw on the input of our contributors and, where appropriate, offer our own considered thoughts and recommendations.

The most successful innovation ecosystems have some key characteristics in common: they are coherent, connected, agile, and adaptive systems with access to the resources, skills and capabilities needed to generate new ideas, technologies and services which meet or create market demands and produce new value. It is widely acknowledged that such complex systems cannot be created by government, but it is also increasingly accepted that innovation policies can play a part in nurturing their development and sustaining their vitality. While there is no single or simple recipe for success, the evidence indicates that successful innovation systems draw on their collective strengths across corporate business, entrepreneurs, finance and risk capital, government, and universities. The precise form and combination of roles played by these stakeholders will vary – and evolve – over time but there is clear evidence from our discussions with contributors that Wales needs to revisit and revise its strategy to ensure that it is better placed to meet the demands and take the opportunities that will present themselves in the emerging new context for innovation. As we noted earlier, such developments are taking place elsewhere with, as an example, Greater Manchester's business, science, academic and local government leaders recently announcing their 'Innovation Greater Manchester' plan to secure major new investment in an already strong research and development base in the region.

We need a frank and robust discussion of what is working and what needs to change in Wales with respect to innovation if we are to be able to nurture a unique and capable innovation ecosystem that will deliver for the nation in the future.

The first aspect of this new innovation ecosystem for Wales will be a national innovation narrative that unites and excites our stakeholders. The Brown Review has highlighted the possibilities of rebranding Wales as a Digital Nation and recent work undertaken collaboratively by the four research intensive universities has developed proposals for how Wales can take advantage of its data-richness through a Data Nation Accelerator.

These initiatives have the benefit of being relatively inclusive, embracing actors from across multiple sectors. There was considerable scepticism expressed about a future narrative that seeks to 'pick winners' and 'puts all our eggs in one basket' or that heralds Wales as 'world-class' in areas where we cannot (yet) deliver on such claims. A number of contributors commented that Wales needs to concentrate on being a 'fast-follower' rather than expecting to lead on technological and science breakthroughs. Here the right balance between science and innovation, and between ambition and realism, needs to be struck. One contributor captured this balance in the following way: 'Wales will always be a tiny player on the world stage for research whereas we could create value for Wales in Wales through investing more in innovation'. Some contributors took the idea of a national innovation narrative further and advocated the creation of an independent National Innovation Body operating at arm's-length to Welsh Government which: 'incorporates elements of a strategy that is still relevant, including a high level vision for Wales for transformative change, and selected priority areas: responsibility for catalysing the innovation ecosystem, championing innovation, strengthening international innovation links and building capacity'.

Recommendation 1: A new innovation strategy for Wales needs to be founded on a compelling and inclusive narrative that can act as a catalyst for activity, promoting the innovation agenda and the nation.

There were some strong voices arguing that the new innovation landscape of Wales needs to be shaped in ways that take the opportunities presented by innovation in the public sector, and embraces the foundational economy, in order that the vision is one that is embedded in Wales' specific resource base and speaks to the majority of the key actors rather than the minority that are targeted in more selective policy discourses and investment decisions. Those investment decisions are crucial since Wales has a limited capacity to support research and innovation. As one might expect, our contributors were very keen to see greater investment in innovation, with some feeling this should be prioritised over research, or at least that the translational research space should be emphasised. For this to be successful, we will need to see further developments of the type of university-industry collaboration that has witnessed the compound semiconductor cluster secure significant research and innovation funding from UK government sources. More generally, many contributors were critical of universities' capability in commercialising their research. A number commented that universities had been slow to recognise that: 'Research and innovation are very different. They are complementary but they need different conditions'. The chronic underfunding of innovation and engagement in Wales' universities may go some way to explaining the perceptions of poor performance, but it is also true that research tends to be seen as the priority by the majority of academics and more needs to be done to improve the collaborative working across academia and industry which is how innovation thrives. As noted above, there are some encouraging signs here and Welsh Government has an important role to play – possibly in conjunction with a new National Innovation Body – in convening and supporting this activity. Universities Wales and the Learned Society of Wales can also play significant roles in mobilising at institutional and individual researcher levels respectively. UK government funding opportunities for innovation, and often also research, are increasingly requiring strong evidence of this 'triple helix' of collaboration and Wales has some way to go before its institutions are delivering at the level that they and the nation will need to achieve in order to be successful.

Recommendation 2: Future innovation policy should do more to encourage universities to develop their translational research activities to bridge the gap between research and innovation in Wales.

The corollary of any criticism of the university sector in Wales is the perception of weaknesses in the business, entrepreneurship and finance elements of the innovation ecosystem. A number of contributors commented variously that Wales lacked 'critical mass' or 'connectivity' and there were numerous complaints that there was a lack of ambition which held the nation back. Others felt that the levels of venture capital were inadequate in support of both starting up and scaling up businesses. There were positive comments made about the role being played by the Development Bank of Wales but also concerns that the scale of funding was insufficient and that the bank tended to be too 'hands-off' in how it managed its investments. Initiatives such as the Alacrity Foundation, the Computer Software Academy and the Data Science Academy were welcomed as important investments in building the capabilities needed to create new firms, particularly as they are focused on the skills needed to succeed in some of the most economically vibrant and innovative sectors. The Welsh Government's Smart Suite was seen to be important in providing a capacity building pathway for SMEs. But again there was concern that more was needed in nurturing both the supply-side and the demand-side of the innovation equation. In addressing these twin challenges we see the importance of government and business working together to invest in the 'industrial commons' of skills, capabilities, resources and enabling technologies that are central to a healthy innovation ecosystem (Pisano & Shih, 2009). For example, a recent paper by Sir Geoff Mulgan has directly addressed the opportunities of governments 'linking data and organising

it as more of a commons (with appropriate anonymisation and acknowledging the huge practical challenges around every aspect of management of data)' (Mulgan, 2021: 23). Such developments would be an important component of advancing Wales as a Digital Nation and unlock the rich resource base that would feed a Data Nation Accelerator.

Recommendation 3: A new innovation strategy must be accompanied by investment in the skills, capabilities and resources needed to support innovation. This should include a suite of innovation support programmes for SMEs, increased availability of venture capital, and investments in unlocking data resources and enabling digital technologies.

These investments in an 'innovation commons' will help to create a context where innovation can flourish in various ways that are inclusive, agile and responsive but not overly reliant on specific sectors, or even individual firms, being successful. Innovation ecosystems are place-based and do best when there is an alignment with the wider features of their specific landscape. In Wales, that means innovation that is open to the private, public and civic sectors.

We concur with Mazzucato and colleagues (Mazzucato et al., 2021) who have argued that, rather than supporting selected sectors, innovation policy should focus on key themes and take an inclusive approach to innovation. This would see actors from across the Welsh innovation landscape mobilise collaboratively to create economic and social value. This approach would be well placed to leverage public procurement through challenge-driven innovation that addresses societal issues, in for example health or sustainability, through the creation of commercial opportunities, particularly for local firms.

Recommendation 4: The new innovation strategy should support the development of greater capacity for mission-orientated innovation that tackles societal challenges, thereby engaging the public, private and civic sectors, leveraging public procurement and proactively shaping markets.

Innovation ecosystems are multi-actor systems and research and innovation funding is a multi-level game. As noted above, success will need our key actors to work together in a more collaborative and effective manner. One aspect of that greater effectiveness is a recognition of the need to tailor activity to these multiple levels, engaging with Cardiff, London and Brussels in a concerted and coherent manner. That engagement must be joined-up and synchronised. Many contributors bemoaned the lack of a capacity or willingness for actors to develop and deliver a Team Wales approach. Stark contrasts were drawn with how well Scottish institutions across government, business and higher education have mobilised to secure funding from UK Government. Here again it may be that a NIB can play an important

convening and coordinating role. The new Wales Innovation Network that is being created in Universities Wales to support collaboration across HEIs is also promising, at least in principle.

While we are clear that a collaborative approach must be the cornerstone of Wales' innovation ecosystem, that should not be mistaken for an approach that lacks ambition and does not reward the most capable. It must be that the strongest actors in Wales are the benchmark against which others are measured. We heard too often from ambitious and innovative contributors that they felt held back by expectations that they 'should work at the speed of the slowest' or that 'this must work for or be done in the whole of Wales'. Wales is not blessed with a large number of leaders and innovators – at either individual or institutional level – and it is important that we nurture a culture of learning from the best (both within and beyond Wales) while supporting those who wish to forge ahead and pave the way for others. How that learning takes place is crucial and again there are roles for Welsh Government, universities and convening bodies such as the Federation of Small Businesses Wales in supporting learning and the sharing of successful practice. Wales must confront that perennial complaint that it is a place where 'good practice is a bad traveller'. The recent development of Intensive Learning Academies across the health sector is a promising development in this regard.

The multi-actor, multi-level innovation ecosystem has become significantly more complex in the years since *Innovation Wales* was published (Welsh Government, 2015a). There is a new multilevel polity in the UK, a radically changed context in the light of Brexit, and a newly polycentric system emerging within Wales through the establishment of the four economic regions. Upon this are layered the City Deals and Growth Deals that provide new sources of funding and capacity for innovation within Wales. These subnational developments raise new challenges as to how Wales' institutions can work effectively and collaboratively to deliver at a national scale while operating within these regional systems, each of which has discrete links to London and UK Government Departments. As one respondent put it: 'We need to get the institutional conditions right so we can have serious dialogue with the key UK actors'. Recent developments with regard to Whitehall departments setting up offices in the devolved nations are further complicating this landscape.

Recommendation 5: The innovation policy landscape is becoming more complex, within the UK and within Wales, and Welsh Government will need to build on the Regional Investment for Wales Steering Group to coordinate place-based investment plans.

In this context, the visibility, capacity and ambition of Welsh Government in the innovation space is absolutely crucial. It is possible to review the figures reported earlier in the report,

reflect on the implications of the pandemic and the still-to-be-felt consequences of Brexit, and to ponder the very many challenging and sometimes stridently critical voices that we have heard, and feel a degree of pessimism about the future. But since necessity is the mother of invention, one should never let a good crisis go to waste. It is absolutely crucial for Wales' future economic prosperity and the well-being of its citizens that a more prominent, connected, ambitious and appropriately resourced capacity for innovation lies at the heart of the next Welsh Government. This was a very strong message that many of our contributors voiced, albeit in differing ways and to some extent with differing specific suggestions. One aspect of discussion on a future innovation ecosystem was the location of innovation within the WG bureaucracy. There were numerous views expressed that innovation would sit more appropriately within the Economy department. A number of people felt that a disentangling of research from innovation might assist both in being more appropriately supported and funded. Others were less persuaded of the significance of the organisational charts and advanced a strong argument that innovation needed its own champion, both politically and within the civil service, irrespective of its location. This is a crucial issue in our view, not least because without careful reflection on both the capacity and capability of those charged with responsibility for innovation in Welsh Government, it will be difficult to avoid an innovation policy implementation gap, a central concern of a number of our respondents, including one who commented: 'The challenge of an innovation strategy will be that the writing of it will be seen to be the outcome not the beginning… How would innovation strategy be enacted? Who is going to own this? Someone needs to own it'. That contributor also advocated an independent innovation structure working alongside the likes of Transport for Wales and the Development Bank and seeing Welsh Government 'outsource delivery'. Whether the lead on delivery is to be taken by Welsh Government itself or a new institutional structure is to be created, innovation needs championing in Welsh Government and by Welsh Government. A further consideration raised by our contributors concerned the capability of civil servants working to support innovation, particularly in fast-moving technologies and sectors. A number were attracted to the idea that was mooted some time ago of Wales creating its own version of the Kennedy School of Government to ensure that the civil servants of Wales have access to high standards of support and training in furthering their professional development. Certainly, in our view, the challenges facing Wales in nurturing an innovation ecosystem that is fit for the future are such that radical, rather than incremental, developments that embrace both institutional and cultural change will be needed.

Recommendation 6: Innovation has a significant role to play in the Sixth Senedd's immediate tasks of recovery and reconstruction, and in meeting the longer-term goals of fashioning a greener, fairer and more innovative Wales, and therefore the innovation policy agenda should be brought into the centre of Welsh Government, championed at Cabinet level and better integrated across the civil service.

The energy and commitment that was apparent in our wide range of contributors gives us confidence that a more ambitious, inclusive and place-based approach which strengthens key institutions and invests in the innovation commons that fuels the ecosystem would be welcomed by those across Wales who share our aspirations for a bold and compelling innovation agenda.

Annex

The authors

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Dr Dylan Henderson is a Lecturer in Management, Employment and Organisation at Cardiff University. His research and teaching interests include business innovation, digital transformation and regional development. He is a member of the Centre for Innovation Policy Research, and the Welsh Economy Research Unit at Cardiff University. As a former policy consultant he has extensive experience of developing and evaluating regional innovation policies across Europe, and contributed to Wales first generation regional innovation strategy – the Regional Technology Plan.

Professor Kevin Morgan is Professor of Governance and Development at Cardiff University, where he is also the University Dean of Engagement and co-convenor of the Centre for Innovation Policy Research. He is an advisor to the European Commission on regional innovation policy; he was a member of the OECD Multilevel Governance Team that produced the recent OECD report on Wales; and he is a visiting research fellow at Orkestra (the applied research institute of Duesto University) in the Basque Country.

Interviewees

Name	**Organisation**
Rhian Hayward	Aberinnovation, Aberystwyth University
Caroline Thompson Wil Williams	Alacrity Foundation
Chris Nott	Capital Law
Jonathon Gray Keith Harding Clive Morgan Stephen Riley Len Richards	Cardiff and the Vale UHB
Kellie Beirne Rhys Thomas	Cardiff Capital Region City Deal
Dave Bembo Phil Brown Richard Duffy Kim Graham Andrew Henley Colin Riordan Ian Weeks	Cardiff University
Karen Cherrett	Cherrett Change Consultants Ltd
Claire Durkin	ex Head, Department for Business, Energy and Industrial Strategy
Rhian Elston Carl Griffiths	Development Bank for Wales
Ben Cottam	FSB Wales
Emma Morris Alyson Thomas	HEFCW
James Davies	Industry Wales
David Notley	Impact Innovation
Dr Ian Brotherston	Innovate UK
Pryderu ap Rhisiart	Menai Science Park, Bangor University
Christopher Christie	Metrobio
Carwyn Jones-Evans Claire Miles	Mid Wales Growth Deal
Siwen Rees	NatWest Accelerator
Alwen Williams	North Wales Economic Ambition Board
Caroline Gray	Optic Glyndwr, Glyndwr University
Meirion Thomas	Penbryn Consultants
Mark Wood	Splunk

Jonathan Burnes	Swansea Bay City Deal
Paul Boyle Helen Griffiths Ceri Jones	Swansea University
Mark John	Tramshed Tech
Phillip Wallace	TWI
Andy Middleton	The Tyf Group
Amanda Wilkinson	Universities Wales
Robert Brown	University of Wales Trinity St David
Phil Allen Julie Cunnington Ifan Evans Greg Green Tony Guile Peter Halligan Duncan Hamer Matt Hicks Huw Morris	Welsh Government

Note: Two consultees chose to be interviewed on an anonymous basis.

Geographical profile of respondents

Region	**Interviews complete**
All Wales	17
Mid	3
North	3
South East	23
South West	7
UK	2
Total	55

Sectoral profile of respondents

Type	**Interviews complete**
Private	18
Public	25
University	12
Total	55

Research and innovation projects part-funded through ERDF in Wales 2014-2020

Project	Region
SMART Innovation	East Wales ERDF /West Wales and the Valleys ERDF
Ser Cymru II	East Wales ERDF / West Wales and the Valleys ERDF
SMARTCymru	East Wales ERDF / West Wales and the Valleys ERDF
FLEXIS	East Wales ERDF / West Wales and the Valleys ERDF
Cardiff University Brain Research Imaging Centre II (CUBRIC II)	East Wales ERDF
SMART Expertise	East Wales ERDF / West Wales and the Valleys ERDF
Supercomputing Wales	East Wales ERDF / West Wales and the Valleys ERDF
Institute for Compound Semiconductor	East Wales ERDF
ASTUTE 2020	East Wales ERDF / West Wales and the Valleys ERDF
Data Innovation Accelerator	East Wales ERDF
Accelerate: the Welsh Health Innovation and Technology Accelerator	East Wales ERDF / West Wales and the Valleys ERDF
Avenues of Commercialisation for Nano and Micro Technologies	East Wales ERDF
Advanced Design Engineering	East Wales ERDF
Centre of Excellence in Mobile and Emerging Technology (CEMET)	East Wales ERDF / West Wales and the Valleys ERDF
Cardiff Catalysis Institute - Electron Microscopy Facility	East Wales ERDF
Magnetic Materials & Applications (MAGMA)	East Wales ERDF
Cardiff Centre for AI Robotics and Human Machine Sustems (IROHMS)	East Wales ERDF
Beacon East Wales / Beacon Plus	East Wales ERDF / West Wales and the Valleys ERDF
AgorIP	East Wales ERDF / West Wales and the Valleys ERDF
Aberystwyth Innovation and Enterprise Campus (AIEC)	West Wales and the Valleys ERDF
Computational Foundry	West Wales and the Valleys ERDF
M-Sparc	West Wales and the Valleys ERDF
IMPACT	West Wales and the Valleys ERDF
Advanced Engineering and Materials Research Institute	West Wales and the Valleys ERDF
SEACAMS 2	West Wales and the Valleys ERDF
SPECIFIC	West Wales and the Valleys ERDF
Solar Photovoltaic Academic Research Consortium (SPARC II)	West Wales and the Valleys ERDF

SMARTAQUA	West Wales and the Valleys ERDF
Centre for Environmental Biotechnology	West Wales and the Valleys ERDF
Reduced Industrial Carbon Emissions (RICE)	West Wales and the Valleys ERDF
Geographical Data & Earth Observation for Monitoring (GEOM)	West Wales and the Valleys ERDF
Future Foods	West Wales and the Valleys ERDF
SESS	West Wales and the Valleys ERDF
Shellfish Research Centre	West Wales and the Valleys ERDF
Advanced Design Engineering	West Wales and the Valleys ERDF
Centre for Photonics Expertise (CPE)	West Wales and the Valleys ERDF
Smart Efficient Energy Centre (SEEC)	West Wales and the Valleys ERDF
Digital Signal Processing Centre (DSP)	West Wales and the Valleys ERDF
Legal Innovation Lab Wales	West Wales and the Valleys ERDF
Awen Institute	West Wales and the Valleys ERDF
Marine Energy Engineering Centre of Excellence (MEECE)	West Wales and the Valleys ERDF

Source: Welsh Government (2021b)

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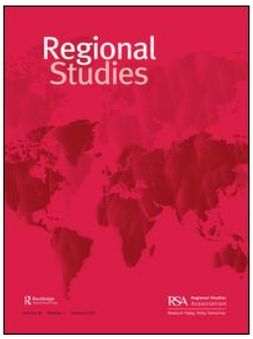

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POLICY DEBATES

Putting missions in their place: micro-missions and the role of universities in delivering challenge-led innovation

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ABSTRACT

We draw on first-hand experience and empirical evidence to address current concerns that the mission approach carries too much emphasis on technological innovation and top-down state-led action. We identify the concept of smaller scale 'micro-missions' that address place-based challenges. In so doing, we show a role for universities that extends beyond the entrepreneurial triple helix and demonstrate how a mission approach can be effective beyond an emphasis exclusively on science and technology and economic outcomes. We highlight universities as safe, convening spaces and their role in bringing together local actors in designing and delivering a micro-missions approach.

KEYWORDS
universities; place; micro-missions; public services; innovation

JEL O31, O38, R11, R58
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1. INTRODUCTION

Mission-oriented innovation (a 'missions' approach) has been widely discussed in the literature as a potential solution to the grand challenges associated with social, economic and environmental problems (Janssen et al., 2021; Mazzucato, 2021; Schot & Steinmueller, 2018). In providing a novel agenda for socio-economic development through innovation policy, the missions literature has explored empirically and prescriptively how large, system-level changes and goals can be achieved by establishing visions, and steering innovation in a particular direction (Kattel & Mazzucato, 2018; Schot & Steinmueller, 2018). To date the emphasis has been on missions that are underpinned by, and produce, technological innovation and sector development (Foray, 2018). But addressing societal challenges is likely to be far more complex than that of purely technology-based missions for all the reasons suggested by Nelson (2011).

Yet if missions-oriented innovation is to deliver the promises of its advocates, a more holistic and multiscalar approach is likely to be needed. Among other things, the potential for subnational and smaller scale missions may need to be developed. While the possibilities of such missions have begun to be explored (Bours et al., 2022; Tödtling et al., 2021; Wanzenböck & Frenken, 2020) there is little consensus about the actors and processes involved in implementing them. In this paper we contribute by exploring how smaller scale, micro-missions may be designed and implemented in a way that addresses these place-based challenges. This represents an important empirical and policy issue given the growing interest in the missions approach at the subnational level. We focus our attention on the role of universities in such micro-missions, a role that has remained underdeveloped in the wider missions literature. There are reasons, however, why universities might be able to play a more important role in place-based micro-missions. They have long been identified as important actors in regional innovation systems and economic development (Trippl et al., 2015; Uyarra, 2010), but have been seen as largely focused on entrepreneurial models of support for spin-outs and knowledge transfer (Marques et al., 2019; Pugh et al., 2016). While there are increasing calls for universities to play a fuller role in social and ecological innovation at the heart of many grand challenges, their precise role is unclear (Benneworth & Cunha, 2015; Cinar & Benneworth, 2021). Yet if mission-oriented innovation is to be extended beyond the state-led and top-down approach, universities have a potentially significant role, particularly at subnational levels.

In this paper we explore the role of universities in localized, bottom-up approaches to missions. In doing so, we introduce the concept of the 'micro-mission', which we define as missions created to address specific place-based issues at subnational scales. We argue that such missions

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require broader forms of innovation than typically harnessed in science and technology missions, and have the potential to address social, economic and ecological challenges faced by local citizens and those at the forefront of such challenges. They may also be able to contribute towards multiscalar challenges and contribute to larger regional and national goals. While micro-missions may allow for a more spatially targeted and decentralized approach, concerns have been raised more generally about the potential for regions to develop such missions (Brown, 2021; Tödtling et al., 2021). Here, successive iterations of regional innovation policy has provided limited evidence of impacts over time and space (Edler et al., 2013), with implementation identified as particular challenges for many regions (Uyarra & Flanagan, 2016). The new generation of place-based innovation policy in the European Union (EU) – Partnerships for Regional Innovation – has already embraced the concept of small-scale missions in local areas as multi-stakeholder partnerships designed to address 'territorial challenges with the aim of achieving impacts within established time frames' (Pontikakis et al., 2022, p. 5). The motivation of this paper is, therefore, to explore how smaller scale micro-missions may be designed and implemented in a way that addresses these place-based challenges.

We provide early first-hand experience and action research evidence of the role that universities might be able to play in mission design and delivery in line with both recent theoretical advancements on the importance of the subnational level and the emerging critique of missions. In doing so we argue that while missions need to be conceived in multiscalar terms, universities can play a role at the subnational level, working with regional partners to trial and test place-based experiments, and in doing so benefit from localized knowledge, lower set-up costs and collaborative working arrangements among partners who know each other well (Wanzenböck & Frenken, 2020). Such a role for universities in more localized endeavours means they are particularly well placed to contribute towards 'micro-missions'. In light of the potential role for universities to engage in these processes, the paper addresses three main research questions:

- How can micro-missions be designed and delivered?
- How can missions be framed spatially?
- What are the roles for universities and regional partners?

We consider these in the light of an ongoing example of a university acting in partnership with local actors to design and develop skills in a mission approach to innovation.

We illustrate our ideas with reference to a novel regional policy taking place in Wales, comprising two related initiatives designed to embed and support challenge-led missions and activity across the region: The Cardiff Capital Region Challenge Fund (CCR CF) and the Innovative Future Services project (Infuse) seek to embrace both the practical development and delivery of a challenge fund alongside the necessary investment in development of capabilities, backed by policy action to help the approach to gain traction in the region. Our findings suggest how localized knowledge can be brought to bear on practical challenges faced by actors, with the university acting in partnership with the CCR as a catalyst for change and providing a safe incubation space outside of traditional organizational boundaries, for public and private sector actors to work together to explore potential solutions. This engagement of universities and other local actors within cities and regions points to the need for research to reflect the regional and place-based settings within which missions are created, providing a much greater spatial sensibility to research in this area. We conclude by identifying limitations of the study, areas for future research on both micro-missions and the role of universities, and policy implications.

2. LITERATURE REVIEW

2.1. Missions as place-based innovation

The burgeoning interest in mission-oriented innovation policy forms part of a wider reappraisal of regional innovation studies, away from economic and structural analysis of regional development towards a wider 'normative' lens encompassing the socio-ecological dimension of innovation (Coenen et al., 2015; Uyarra et al., 2019; Weber & Rohracher, 2012). This has focused attention not only on innovation as a generic process, but also on its directionality, legitimacy and responsibility (Edler & Fagerberg, 2017; Janssen et al., 2021; Mowery et al., 2010). Such missions reflect a largely top-down focus on science, technology and innovation projects such as the Manhattan Project, the Apollo programme and Concorde (Mowery et al., 2010) and have highlighted the importance of big science, centralized control and multiple sectors and sources of expertise, in achieving technological objectives (Foray et al., 2012).

Along with an emphasis on technology, governance of missions has typically been framed at the national level (Mazzucato, 2018). While this may be relevant to grand societal challenges, it has underplayed the role for smaller scale micro-missions to be conceived and implemented at the subnational level. In this respect, greater bottom-up engagement in localized contexts offers the potential both for responsiveness and for multiscalar approaches to missions to be developed that address societal grand challenges in a place-sensitive manner (Pontikakis et al., 2022). The importance of the spatial scale of missions has been the subject of recent calls for decisions to be taken as closely as possible to citizens (Wanzenböck & Frenken, 2020). More widely others have highlighted place-based innovation policy as offering the basis for taking better account of local characteristics and capabilities and adopting a long-term approach to tackling challenges (Barca et al., 2012; Hassink, 2020). In contrast to spatially neutral (or blind) policies, a place-based approach highlights the importance of local context and its 'social, cultural and institutional characteristics' and local knowledge in the policy development process (Barca et al., 2012). Challenges facing missions have,

however, been raised by scholars, arguing that they represent a 'fuzzy' policy that fails to provide 'comprehensive and detailed mechanisms for their operational deployment' and not always aligned to their demand context (Brown, 2021, p. 756).

The premise of missions has also faced more fundamental criticism from mainstream innovation scholars who argue that the mission-oriented innovation policy approach advocated by Mazzucato and others suffers from three overarching weaknesses:

> First, we do not know how to pick them or operationalize them. Second, we do not know how to evaluate their successes and failures, and it is likely that we will never be able to do so in a satisfactory way, since the opportunity costs are incredibly complex. Third, it is difficult to make an actual flesh-and-blood person accountable, which greatly increases the risk that an unproductive, or even destructive, project is initiated, as well as supported past its due date.
>
> (Larsson, 2022, p. 89)

Although these criticisms are not without merit, they seem to be driven primarily by an ideological aversion to the state having a more prominent role in the design and delivery of innovation projects. But as we noted in the introduction, the missions approach need not be framed in a top-down fashion in which the central state is the dominant actor in the process. The 'new industrial policy' approach developed by Rodrik and the 'experimentalist governance' approach advocated by Sabel both suggest that the state can be part of a pluralistic group of actors that are jointly engaged in a process of economic self-discovery to overcome the informational deficits that can otherwise stymie innovation and development (Morgan & Marques, 2019). A greater spatial sensibility can also help to frame the missions approach in more pluralistic terms because it aims to put missions in their subnational place, be it a city or a region, where there is arguably more scope for place-focused collaboration around a more granular agenda that facilitates the operationalization of mission-based activity.

Adopting a greater place-based approach to innovation missions raises the question of how to manage the increased complexity that may emerge from smaller missions. Bours et al. (2022), for example, examine how mission projects may be able to self-organize at the local level. They argue that a small-wins strategy in this context could benefit from synergies across multiple small wins to 'propel' solutions, and to do so in a way that limits potential contestation from incumbent solutions and actors (Bours et al., 2022). Indeed, the anchoring of micro-missions in local places may have further benefits in terms of local knowledge and support for small-scale mission processes. Therefore, we seek to extend research on subnational missions by exploring the potential for purposive action to design and implement micro-missions in local places.

Although attention to the place-based nature of missions highlights the potential for solutions to respond to the everyday needs and aspirations of citizens and businesses, the capabilities of local actors to engage and manage missions is unclear. In this respect all places are not the same, indeed the capacity of actors to engage in missions in some places may also be limited, presenting both challenges of coordination and implementation (Brown, 2021; Marques & Morgan, 2021; Tödtling et al., 2021). Others, however, point to alternative assets such as industrial, natural, human, infrastructural and material assets that may form the basis for regional missions (Tödtling et al., 2021, p. 7). That is, different forms of innovation and unheralded actors may be able to coalesce around place-based missions (Coenen et al., 2015; Tödtling et al., 2021; Trippl et al., 2020). These combinations are potentially more likely when a more capacious and less technology-focused approach is adopted.

The implications of this are that we need a much better understanding of the ways in which different actors may come together to address these place-based missions. The next section turns to this challenge and examines the potential role that universities may be able to play in such place-based missions. Universities are increasingly faced with the challenge of addressing social and ecological problems in their region (Cinar & Benneworth, 2021) and may be able to engage in a more direct way in mission-oriented innovation than hitherto recognized.

2.2. Universities, missions and place-based development

While knowledge creation and human capital development have been the primary objectives of universities for many years (particularly research-intensive universities), they have been increasingly viewed as agents of commercialization and economic development (Pugh, 2017; Uyarra, 2010). This has seen universities identified as important actors in regional innovation systems (Trippl et al., 2015), with research highlighting the drive for universities to adopt a more entrepreneurial approach to their role in the regional economy, as reflected in concepts such as the Triple Helix (Etzkowitz, 2012; Gunasekara, 2006; Pugh, 2017). Universities are widely recognized as key actors in these regions, but current approaches still tend to treat them as reactive 'black-box' institutions, failing to acknowledge both their heterogeneity and uneven strategic capacities (Goddard & Vallance, 2013; Kohoutek et al., 2017; Pinheiro et al., 2012). While the precise role of universities as place-based actors may be somewhat ambiguous, with researchers' careers governed by the national and international reach of their research (Uyarra, 2010) and the tendency for research-led institutions to collaborate externally (Power & Malmberg, 2008), they are being challenged to 'move from a space-blind approach to the idea that place-responsiveness is an important feature of the modern HEI [higher education institution]' (Kempton et al., 2021, p. 1).

Typical interlocutors of universities in the entrepreneurial model of university–industry interaction include science, technology and innovation firms, often from the manufacturing sector (Huggins & Johnston, 2009). This

entrepreneurial model emphasizes science and technology interactions as comprising support for entrepreneurship, spin-outs and knowledge transfer (Pugh et al., 2016). Yet focusing on traditional forms and metrics of innovation does not reflect the diversity of roles played in the region, as a supplier of expert knowledge to regional governance and strategic processes (Benneworth et al., 2017; Fonseca & Nieth, 2021; Raagmaa & Keerberg, 2017; Uyarra, 2010). It may also underplay the challenges faced in university place-based collaboration (Kempton et al., 2021; Vallance et al., 2020). Here, research has identified internally focused challenges associated with the teaching and research excellence objectives of many universities, the limited incentives for researchers to both engage with, and difficulties for firms to access expertise (Goddard & Vallance, 2011; Kempton et al., 2021; Lach & Schankerman, 2008). Research has also identified contextual challenges that may limit the potential for such engagement, including limited focus of research and teaching on local industrial challenges and needs, weaknesses in firm absorptive capacity and fragmented regional innovation system (Huggins & Kitagawa, 2012; Trippl et al., 2015). Such problems may be particularly acute in less developed regions and left behind places (Marques et al., 2019), and can limit the potential for such regions to engage in commercialization activities, but also wider developmental roles (Gunasekara, 2006).

Despite the recognized challenges for universities to engage in place-based collaboration they have been increasingly called on to respond to grand challenges and different forms of innovation, such as social and ecological innovation (Cinar & Benneworth, 2021; Goddard et al., 2012). While engaging with a broader range of social and ecological mission agendas is unlikely to be straightforward for many institutions (Cinar & Benneworth, 2021; Kempton et al., 2021), there are reasons to believe that university roles in missions could be developed. They represent anchors in particular places with a broad range of expertise (in social science and humanities as well as science and technology) and may be able to act as a 'broker' in providing collaborative experimental spaces that could be brought to bear on social innovation activities such as urban demonstrator projects (Benneworth & Cunha, 2015; Tewdwr-Jones & Wilson, 2022; Vallance et al., 2020). As key actors within local areas universities have knowledge and expertise, as well as the potential of bringing together academics, policymakers and practitioners in interdisciplinary research groupings to co-produce knowledge that addresses societal grand challenges and mission-like processes. Indeed, universities may be well placed to provide such experimental spaces given their perceived independence of formal policy processes (Vallance et al., 2019).

3. THE RESEARCH CASE AND METHOD

The research draws on a case study of the Cardiff Capital Region Challenge Fund (CCR CF). The CCR CF forms part of a £1.28 billion City Deal agreed with UK and Welsh governments. Created in 2013, the CCR comprises 10 local authority partners across South East Wales, with two cities – Cardiff and Newport – and some 1.5 million inhabitants. While its objectives are those of traditional forms of economic development – gross value added (GVA) uplift, additional investment and jobs – its approach seeks to marry economic and social objectives in its portfolio of projects. In this respect, the CCR's approach recognizes the potential for innovation in the tradeable sector, but also public sector and the wider foundational economy. As its director, Kellie Beirne, put it, 'In CCR we invest in [the] ability of public sector to create/shape markets, to be a co-investor and take risk for reward' (Beirne, 2022).

The case study research comprises two aspects of the CCR's micro-mission approach to innovation: *Infuse* – integrated support to build innovation capacity in public services; and *CCR CF* – a public sector challenge programme to co-create solutions to societal and economic challenges faced by the CCR. In both cases the research builds on participation of researchers from Cardiff University's Centre for Innovation Policy Research and Y Lab[1] in the initial discussions around the creation of a public services test-bed (Ashelford, 2017), and subsequent design and implementation of these projects alongside the CCR and public and private sector partners between 2018 and 2022. The empirical evidence reported draws on the authors' own participation in both the design and delivery of these mission activities, complemented by analysis of a range of secondary data sources such as CCR corporate documentation, participation in challenge events including the bid review process for challenge projects (tracheotomy, sustainable food and decarbonization challenges), plus interviews with key informants undertaken by the first author (14; see the supplemental data online). While the first author of this paper brings a detached perspective to the data, the second and third authors have played a central role in the conception, creation and now implementation of the two case projects working closely with the CCR and colleagues in Y Lab and Nesta. In this regard, the project may be seen as 'action research' since the researchers are both active in shaping the micro-mission approach and in researching the initiative, its processes and outcomes. Action research is a well-established methodology, particularly in the social sciences (Reason & Bradbury, 2012) and has been used to good effect in researching and delivering regional innovation policy (e.g., Larrea & Estensoro, 2021). Here we draw on the first-hand experience of the second and third authors based on their involvement throughout the period of development and delivery of the initiatives reported.

4. PLACE-BASED MICRO-MISSIONS IN THE CARDIFF CITY-REGION

The creation of the CCR in 2013 represented a new era of collaboration amongst its 10 municipalities. It drew on the incentives provided at the UK level for the creation of City Deals (Waite & Morgan, 2019) and sought to develop a

negotiated approach to place-based development in the city-region, with one member one vote (Morgan & Henderson, 2023). City Deals form part of the growing devolution agenda in the UK, with the introduction of 'a new form of urban governance and infrastructure investment based upon negotiated central–local government agreements on decentralized powers, responsibilities and resources' (O'Brien & Pike, 2019, p. 1448). They constitute a selective transfer of funding and responsibilities to deliver against UK Government priorities and to engender competition between places (O'Brien & Pike, 2015). Such policies have particular implications for Wales, where the Welsh Government has led on social and economic policy agendas since its creation in 1999, with the UK-sponsored City Deals presenting the potential for conflict between different 'devolution narratives' (Waite & Morgan, 2019).

The CCR has established three priorities for its Economic Growth Plan, with 'Challenges' representing one of these priorities (along with Infrastructure and Innovation). This activity is focused on challenges that shape places, market creation, intellectual property (IP) commercialization and responses to regional priorities. An innovative feature of its investment strategy is its commitment to long-term staged investment (so-called 'evergreen' investment[2]) and co-investment principles that 'recognise that risks must be taken to drive the CCR's objectives', while addressing disparities (CCR, 2019, p. 2).

The CCR's approach to challenges recognizes the value of a mission approach which places social and economic development goals on a more equitable footing than has hitherto been the case in traditional regional development policy. This starts from an entrepreneurial position of wishing 'to have a go rather than fail by omission' (Beirne, 2022), and the belief that a focus on social challenges and equity within the city region can ultimately produce the outcomes by which it will be judged. It would be wrong, however, to view these initiatives as being divorced from the Welsh Government. The government represented an important funding partner in several initiatives, and whose Wellbeing of Future Generations of Wales Act (Welsh Government, 2015) provides a prism through which the university and the city-region's municipalities are addressing the needs of citizens and places.

Municipalities represent unheralded actors within the regional innovation system and archetypal place-based actors (Morgan, 2019). Public services, however, are increasingly viewed as a possible source of place-based social and ecological innovation (Morgan, 2019). The mission-framing of the CCR's strategy highlights how such municipalities may be able to engage in supporting social innovation and place-based issues. The role of Cardiff University as proponents of mission-oriented innovation and place-based development should also not be underestimated in the initial formulation of the approach. While traditionally associated with national and international research (as a Russell Group[3] member), its vice chancellor has advocated a stronger role for the university in place-based innovation, viewing the university as a core partner in the 'Cardiff University innovation ecosystem' and actively promoting the development of translational research and facilities to support innovative engagement of research in the city-region (Riordan, 2018). This was developed in parallel with new strategic commitments to innovation and engagement that emerged around the period of the vice chancellor's appointment that saw the university take a more active role within its local community.

The CCR CF was launched in 2020 and is a three-and-a-half year, £10 million fund aimed at building local wealth and creating jobs through the development of innovative solutions to societal challenges that are proposed by public sector organizations ('Challenge owners') in the city-region. Designed and managed in a partnership between the university and the CCR, it draws on emerging thinking and practices in addressing societal challenges, including the Nesta Challenge Prize, The Small Business Research Initiative (SBRI) and the work of mission-oriented innovation theorists (I1–I6 and I12). The novelty of its approach within a City Deal context, however, required the CCR to justify its approach within the narrow constraints of the City Deal (GVA, jobs and investment leverage) to a sceptical UK Treasury (CCR Cabinet, 2020). This required a delicate balance to be made between these economic metrics with the potential for challenges to address social and economic problems:

> GVA, jobs and private leverage are the key objectives most frequently associated with City and Growth Deals. Challenge funds still deliver on these – but intentionally don't start out with the answer, the amount or a specific project. Instead, they start with data and a problem statement. Through exploration, the answer, solution or project is arrived at. The process drives innovation and unlocks added value for both the problem owner and problem solver(s). … The focus of the proposed programme is to rebuild local economies for a post-Covid world, through solving societal challenges that have economic impact and potential commercial-scale opportunities.
>
> (p. 5)

In practice this commitment has meant that the CCR is unable to fund challenges that deliver only on purely social or ecological issues. Such issues are in scope but must be addressed in ways that also provide market opportunities for the innovative 'solution providers'. While challenges may be developed by individual local authorities, the rationale for the CCR CF is to identify public services innovation that may be scalable within the region and beyond. As one CCR CF partner put it: 'we represent the body of 10 local authorities, whereby the vast majority of the problems or challenges that they face are exactly the same' (I4).

The CCR CF's approach is thus one that incorporates support for the development of innovative solutions to societal challenges with the intention of providing a route to market for the solution. Its approach, however, is distinct to large-scale challenge-led innovation approaches in its focus on place-based challenges at a more granular level. As one partner noted:

> I think there's a danger that we think so big … in big societal challenges and big complex problems, it kind of scares people off in a way. Really big investments in solutions … that's just part of the role, but I think the [CCR CF] projects are actually bringing it down to, a regional and subregional level, and looking at what problems there are, even down to the community level.
>
> (I1)

In practical terms the university team, which comprises both research and administrative staff, is the delivery partner for the CF working closely with the CCR challenges team. This has meant working very closely with the CCR in the development of bespoke processes and documentation, the communication of funding opportunities, the hosting of events and workshops, identifying potential challenges and the supporting the development of proposals, evaluating these proposals and overseeing the delivery of individual challenges In addition, the university team provides ongoing research expertise in support of challenges and project selection and has led on the development of a 'community of practice' in the region centred on challenge-oriented innovation. The senior academics are part of a strategic board which has overall responsibility for the CF. This role is part of the academics' wider leadership roles in establishing the university's approach to place-based innovation and development.

Despite the role of the university in providing a convening space, with administrative and research support the challenges themselves were identified and led by public sector organizations in the CCR – working with the CCR and university team – and involved collaboration with local partners. To support this process the university acted as a convenor, providing virtual and physical spaces to foster discussion between public sector challenge 'owners' and solution providers, with each project intended to deliver place-based public benefits. This role, in many cases, is one that will cease as 'owners' work with solution providers, although in some instances ongoing links will see academics provider additional research and expertise, at the request of projects. The value of the university in this process was described by one municipal participant:

> So for us, academia offers rigour, which we probably haven't come across in public service often. It offers legitimacy, you know, in specialisms. It has also pushed us, pushes our thinking … it's a different level of thinking that we in public service desperately need.
>
> (I4)

This role, however, did not extend to a lead role in the subsequent challenges – a role that was taken by the challenge holder, with varying or limited subsequent involvement by the university in areas such as contributing to innovation proposal evaluation and supporting events.

The fund's first project addressed the challenge of providing clinical training for tracheostomy procedures during the COVID-19 pandemic. The challenge was led by Cardiff and Vale University Health Board in partnership with other health boards and an SBRI approach was adopted and delivered in partnership with the Welsh Government's SBRI Centre of Excellence (I5).[4] Two innovative proposals, drawing on both the novel use of virtual reality and immersive technologies, were funded through the development of marketable products that are currently being trialled in hospitals in both Wales and England with the likely outcomes benefitting both the challenge owners in the region (the university health boards in the CCR) and the solution providers (businesses, one of which is based in the region). Further challenges, relating to the sustainable production and supply of food are under development,[5] alongside early-stage plans for a social care challenge, were launched in the later period of the research.

The CCR CF was established both to deliver challenge-oriented innovation and also to build capacity and capability for such an approach within the CCR. This has involved an extensive programme of workshops and events to engage local actors across the public, private and third sectors, and the gradual nurturing of a 'community of practice' in the region. However, the most extensive aspect of this activity is undertaken by its 'sister' project Infuse, with its complementary focus on building capacity for innovation in the public sector. The *Infuse project* is a three-year, £5.6 million partnership involving a local authority (Monmouthshire County Council), Nesta and Cardiff University. It is focused on addressing two challenge areas of accelerating decarbonization and supportive communities – both of which have been identified as being important to the CCR. It operates through a series of six-week interactive learning 'Labs' delivered by university research staff to local authority officers from the city-region. This includes: an *Adaption Lab* to enable participants to work together to understand how to adopt or adapt innovations to their organization's needs. The *Data Lab* provides tools to enable participants to make use of data to inform decision-making. The *Procurement Lab* focuses on helping participants to maximize the value when commissioning or purchasing goods and services. In each lab the university and Nesta provide tools and techniques that participants are able to take back to their organizations to support public services innovation. Project support for the legitimacy of such public service activities is also developed through regular meetings between the Infuse participant and their chief executive, giving 'each participant … one hour a month to "reverse mentor" their senior leader [helping] to embed the learning and get high level buy-in to any innovation that they bring forward and to embed it' (I4).

It is anticipated that building innovation capacity in the municipal partners may provide the basis for local places to benefit from these skills alongside the potential for subsequent applications to the CCR CF, thus supporting the mission objectives of the partners. These labs also highlight the convening role of the university, providing both a space in which public partners could meet to engage in processes to incubate and develop and test ideas, often collectively.[6] This convening role represented more than

that of a simple hosting of activities and provision of research. Instead, it was supplemented by the recruitment of a team of researchers (overseen by senior academics) to support mission capacity development and the process of 'reverse mentoring'. Together role helped to provide, what one participant, described as a safe space for innovation skills development:

> I think two big things happen that allow it to become a safe space. Probably three, actually. So the first is that you get senior management buy-in for them to be part of the programme. So senior management commits to them being able to get … cover from middle management. The second is that they're committed to doing this for two days a week. So they have time. And then the third is the we're here to help and we have quite a big team of people who are there to help them negotiate the anxiety that can exist around uncertainty in innovation.
>
> (I3)

The project expects to support some 120 local government officials, with all 10 local authorities in CCR participating to date.

It is important to note that several practical challenges for both the CCR CF and Infuse were evident with regard to engaging public sector actors in the challenge approach during the study period (2020–22). Capacity deficits were evident in the difficulties that public sector bodies had in providing time and resources to develop challenge proposals; a problem compounded by the demands of the COVID-19 pandemic budgetary pressures (I2), and evident more generally across the public sector in Wales (Jones, 2022). While the support of specialist 'mission' support bodies such as the SBRI Centre for Excellence (to advise on, and contribute to, the management of missions) and Innovate UK KTN (to promote missions to private sector innovators) were able to alleviate such deficits (I5, I13), capability deficits were manifest with challenge-oriented innovation skills and knowledge being in short supply (I1, I3, I5). Such capacity deficits could also stretch beyond participants in Infuse and the CCR CF to their wider organizations with respect to absorbing and acting upon mission ideas. As one interviewee put it:

> They probably get good buy-in at senior level, but then when officers go back to their day job … at officer/middle management slash officer level, it's much more difficult to push innovation and to get other people to understand why behaviour change is a good thing, and how they could benefit.
>
> (I7)

In parallel to practical organizational challenges, political challenges were also evident, not least in the difficulties associated with implementation in the context of the multilevel polity in Wales. This was a feature of the experimental governance underpinning the mission-oriented activities, which recognized the difficulties of retaining the loyalty and solidarity of the CCR municipalities, whilst building new regional institutions to catalyse innovation, alongside the national level, where the Welsh Government was nervous about the rapid pace of change in the CCR and the latter's direct links with central government in Westminster (CCR Cabinet, 2020).

Although it is too soon to draw definitive conclusions about Infuse or the CCR CF, the results to date illustrate the potential benefits of viewing universities as actors to convene place-based mission activities. This provides important innovation opportunities for public services, which may otherwise be absent. As one local authority interviewee argued, when reflecting on the benefits of Infuse participation, 'we are trying to run services under budget, with spiraling need and complexity … we just don't spend enough time in that proactive space, which in my experience for 25 years in public sector is really important' (I4). Moreover, by seeking to nurture public services innovation and collaboration they not only build capacity, but also raise awareness about the potential for joint action through resource pooling. This potential for scaling solutions to challenges within the region points to the importance of ensuring good practices from particular places are diffused in the wider region and beyond. This represents an ongoing challenge (and opportunity) for the CCR but also for the Welsh Government.

5. POLICY IMPLICATIONS

The mission approach has largely been conceived as a national-level responsibility, with an emphasis on science and technological challenges and excellence (Mowery et al., 2010). In this section our aim is to draw out policy implications for smaller scale, place-based approaches and the potential for regional policymakers, but also municipalities, business and civil society to engage in such processes. In doing this we acknowledge the potential problems for regions noted in previous research, namely capacity and coordination (Brown, 2021; Tödtling et al., 2021). These challenges may be heightened at the local level where municipalities in Wales and the wider UK have been subject to a sustained period of austerity, impacting on their ability to engage in innovation activities (Morgan, 2019). The approach highlighted in the case evidence, however, suggests micro-missions offer the potential for policymakers to add to, and complement, grand challenges. We consider the policy implications for missions in three main areas: objectives, participants and capacities:

5.1. Micro-mission objectives

While missions have traditionally been conceived as addressing global grand challenges through excellence, science and technology the findings of this research are that policymakers may be able to harness micro-missions to address a much broader palette of social and ecological forms of innovation. Such challenges, while having global relevance, are experienced by local areas particularly, and most acutely by their citizens (Coenen & Morgan, 2020). This means that there is greater potential for policymakers to explore solutions that are meaningful to

local areas and to draw on local knowledge in addressing localized challenges has the potential for gaining a greater degree of local input and support for mission activities. These objectives may also be typically shorter than traditional missions and draw on extant sources of knowledge as well as leading edge innovations.

5.2. Micro-mission partners

The evidence presented in this paper highlights the importance of policymakers working in partnership with local place-based partners as a way of overcoming the limitations of individual action in micro-missions. Such an approach offers the possibility of sharing expertise and working across organizational boundaries to achieve place-based objectives. Drawing together multiple actors from different sectors can also help to bringing different types of expertise to bear on mission challenges, beyond that of the usual suspects (e.g., innovative firms). Universities may have a particular role to play here as sources of expertise at the regional level and an emerging interest in social challenges (Benneworth & Cunha, 2015; Cinar & Benneworth, 2021). Engaging through micro-missions may also offer benefits for universities, helping them to signal their openness for mission partners and providing spaces for businesses and civil society organizations to work together to develop solutions. This role is a far cry from conceptions of the entrepreneurial university and traditional objectives for research and commercial exploitation.

5.3. Micro-mission skills and capacities

Mission skills and capacities represent recognized challenges for mission participants (McLaren & Kattel, 2022), and may be a particular issue in less developed regions with limited innovation activities (Morgan, 2019). This lack of capacity may be faced in both the design but also the implementation of missions. Here the research highlights the potential role of the university to work with the public sector to develop mission thinking and skills for micro-missions. It also suggests a model of working for universities to provide a neutral space in which public actors can develop mission skills as well as potential projects. Universities may also be able to play a role in supporting the public sector to establish and implement missions. Such actions provide the possibility of building public sector mission skills for the future but will also require universities to be suitably resourced.

Finally, the findings suggest that micro-mission activities should not be viewed by policymakers as 'silver bullets' to place-based innovation challenges and are likely to need policymakers to consider other forms of support at the regional level. It will also require them to consider the question of scale-up, for those missions that produce successful outcomes. Here this scale-up challenge may require collaboration and input from multilevel governance and industry to ensure that micro- and grand challenges are integrated. A more modest, but no less important, challenge for policymakers is one of disseminating good practices from micro-missions within a region including others facing similar place-based challenges.

6. DISCUSSION AND CONCLUSIONS

In this paper we provide first-hand evidence as to how missions might be designed and delivered in line with both recent theoretical advancements on the importance of the subnational level and the emerging critique of missions. In particular, we examine the issues in designing and delivering a mission approach that may be mobilized effectively at the subnational level. The opportunities for universities to play a role in these processes are revealed through our case study of challenge-led instruments in Wales. We contribute to the emerging policy debates by making three main arguments.

First, we contribute to the growing discussion about the spatial scale and content of missions by arguing that they should be viewed as multiscalar activities in which national missions can be complemented by localized, place-based missions (e.g., UK Government and Welsh Government funding alongside City Deals with university, local authority and business collaboration and support for mission activities). While much attention has been given to grand societal challenges, the activities examined in our research highlight the role of micro-missions to address place-based challenges. Although this may create tensions between different mission activities and multiscalar objectives (e.g., the tensions between economic and social outcomes), it presents opportunities for linkages to be developed between innovation policies that support mission outcomes. A focus on *place* in such micro-missions provides for a more inclusive range of actors to engage in missions in solving the challenges faced by local communities. That is, they can draw together less celebrated actors (e.g., municipalities and healthcare providers) that have a stake in the effective solutions to localized challenges (Wanzenböck & Frenken, 2020). The findings further illustrate how mechanisms such as Infuse can be designed to help to develop linkages between public services innovators, and support participants with advice from public service innovators (e.g., the Infuse Alumni network), offering the potential for ongoing collaborative learning to develop around micro-missions at the local level. The spatial framing of missions as place-based activities in this research does not detract from the need for national and international science and technology focused 'grand' missions – which are vital in addressing societal challenges at scale. Instead, our findings highlight the potential for such micro-missions to be complementary to mission approaches being developed at other spatial scales.

Second, we highlight a new role for universities in providing a convening space for such micro-missions, in which it can provide spaces for actors to come together to both build capacity and support the generation of micro-missions. This role represents a more facilitative role than one traditionally associated with the

entrepreneurial university, and one that has been identified in research on the university's role in establishing demonstrator projects with quadruple helix partners in the North East of England (Tewdwr-Jones & Wilson, 2022; Vallance et al., 2019, 2020). While the convening role highlighted in this research shares similarities with that of other contributions to the literature (e.g., the role of the university in providing spaces for experimental innovation), our findings suggest that the convening role is one that emphasizes the university's openness to engagement individual projects. That is, it addresses the traditional challenge of signalling access routes into university expertise and resources (Goddard & Vallance, 2011). In this respect the convening role of the university may not require it to play a lead role in subsequent mission activities. Indeed, such an approach may respect the expertise of partners (e.g., public sector and businesses taking the lead on implementing missions), as well as their potential to legitimize challenges and solutions within their communities. Development of mission skills represents a further element of the convening role, highlighting the potential for such roles to sustain mission practices in the region over time. This convening role for universities, however, is not one that is based exclusively on goodwill, with external funding (from the CCR) necessary to resource such activities. Moreover we do not assume that the convening role of universities, alone, is the 'silver bullet' to regional innovation policy (Kempton, 2019, p. 2262), and recognize that a less muscular approach to supporting place-based innovation may be a way for universities to engage with partners in mission processes. This, of course, requires the incentives and institutional support for such a role to be present, as illustrated in the case results, and may not be the case in other regions.

Third, our findings illustrate the capacity challenges associated with place-based micro-missions at the subnational level. While such challenges have been identified in the literature (Brown, 2021; McLaren & Kattel, 2022; Tödtling et al., 2021), the case studies highlight capacity challenges in both *mission design* and *mission implementation*. Here the findings highlight how mechanisms can be developed to support the capacity of public sector organizations to identify and develop mission ideas. Infuse, for example, provides support for public sector participants to develop mission skills and ideas in a safe space alongside other municipal participants (facilitating joint actions). Alongside this support, the university CCR CF team has run a series of events and workshops, created a web-based portal and led the creation of a local community of practice to build capacity in the region. The Infuse case further illustrates how these mission design skills processes can be supplemented by activity to support the legitimacy and implementation of micro-mission activity within public service organizations (e.g., the reverse mentoring process). Both CCR CF and Infuse further highlight how regions may be able to develop a multi-actor approach to support micro-missions. Despite the potential for these capacity-building mechanisms, our findings point to more prosaic, but no less important, deficits in the availability of public servants to make sufficient time to engage in these processes.

Limitations are present with respect to the early-stage nature of these innovation activities. Here, further empirical research could usefully explore the nature of impacts from micro-missions over time, and respond to calls for richer 'policy histories' in regional innovation research (Uyarra & Flanagan, 2022). Indeed, such longitudinal studies have much to offer in addressing what may be long-term challenges, by offering greater opportunities to conceptualize micro-missions, as well as the preconditions and challenges of scaling-up solutions. The focus of this study has been on a research-intensive institution and its potential for micro-missions. The rationale, actors and nature of such micro-missions in other models of university engagement – such as vocational institutions – may provide a further area for researchers to interrogate the potential of such missions (Kohoutek et al., 2017). As an individual case study of a single region, further empirical research is needed on how micro-mission processes in different regional settings may operate, as well as comparative research. The interactions between place-based micro-missions and national/international missions for innovation, as well as other mainstream innovation policy instruments, is an area where research may be able to illuminate the mechanisms and the multiscalarity of micro-missions. Similarly, the growing focus on actors and strategic agency in both universities and wider place-based actors within regional innovation systems (Benneworth et al., 2017; Grillitsch & Sotarauta, 2020) represents an additional area where future research could cast light not merely on the constellations of actors involved but also on the permutations of power and control that can determine the outcomes of place-based micro-missions.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

NOTES

1. Y Lab is a public services innovation lab originally established by Cardiff University and Nesta in 2015, and now wholly operated by the university (https://ylab.wales/index.php/who-we-are/our-story).
2. Whereby investments are recycled back into the CCR's main funds on maturity; https://www.business-live.co.uk/economic-development/plans-100m-cardiff-capital-region-19960913.
3. The Russell Group is the representative body for the UK's 'research-intensive, world-class universities'; https://russellgroup.ac.uk/about/.
4. A provider of services to support the design and implementation of missions in the Welsh health and social care sector (https://sbriwales.co.uk/) (accessed on 6 January 2023).

5. See https://www.challengefund.wales/news/the-sustainable-production-supply-of-food-challenge-is-now-open-for-applications/ (accessed 6 January 2023).
6. See, for example, https://www.monmouthshire.gov.uk/infuse/mapping-the-ccr/ (accessed 6 January 2023).

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