Scotland's Innovation Strategy: Call for Evidence: Economic Evidence Paper

Office of the Chief Economic Adviser
Scottish Government
May 2022

Executive Summary

This paper provides a summary of the theory and selected evidence in relation to innovation in Scotland to provide context for stakeholders responding to the Call for Evidence for the Scottish Government's upcoming Innovation Strategy.

It provides a brief overview of the role of innovation in economic growth, the drivers of innovation and the role of government. It considers Scotland's recent innovation performance, drawing on a range of data sources. Finally, it sets out the current innovation funding landscape in Scotland and provides a brief review of some of the international evidence of policy effectiveness and best practice.

The key findings from the evidence reviewed suggest that:

- Scotland still suffers from very low levels of business research and development (R&D) spend, although there have been recent improvements. This is in contrast with Scotland's strong performance on higher education R&D spend, which suggests there remain opportunities to tap into this for wider economic benefit.

- The share of innovation active businesses in Scotland is lower than the UK as a whole, and the level of innovation active businesses in Scotland has decreased in recent years. Additionally, there is considerable variation in innovation activity across business sizes and sectors in Scotland.

- Scotland's broader innovation system is strong and has improved over time. Relative to the EU average, Scotland has notable strengths in tertiary education, lifelong learning, digital skills, scientific publications and innovative SMEs collaborating. However, in addition to business R&D spend, weaknesses remain in employment of ICT specialists, employment in innovative enterprises and trademark and design applications.

- International evidence suggests that in the short run, R&D tax credits and direct public funding are likely to be the most effective policy levers to stimulate innovation while, over the longer term, increasing the supply of human capital is likely to be more effective. Encouraging skilled immigration is also seen to be effective even in the short run. Competition and open trade policies are likely to have more modest benefits but incur no direct cost to government. Inward investment has also been found to boost innovation through increased R&D spend and, respectively, competition and demonstration effects.

- There is scope in Scotland to improve business management practices and to build capacity for innovation and productivity enhancing business models.

This includes policies to encourage a culture of entrepreneurship within the existing business base by building experimental and innovative capacity, and facilitating peer to peer learning between businesses.

- There is a need to tackle a wide range of barriers to businesses adopting and making the most effective use of existing technologies. This will go a long way in improving both the productivity performance and innovative potential of many businesses.

1. Introduction

The Scottish Government's forthcoming Innovation Strategy will set out how Scotland's research institutions and businesses can enhance the economy's competitiveness, whilst ensuring that government support for innovation is easy to access and focused on areas of greatest opportunity.

The purpose of this paper is to provide a summary of the theory and selected evidence on innovation in Scotland to provide context for stakeholders responding to the Call for Evidence for the development of the strategy. It sets out a brief summary of:

- The role of innovation in driving economic growth, the drivers of innovation and the role of government;
- Scotland's recent innovation performance; and
- The current innovation funding landscape in Scotland and international evidence on policy effectiveness and best practice.

Innovation will be central to achieving the aims set out in the Scottish Government's recently published National Strategy for Economic Transformation (NSET)[1]. NSET aims to make Scotland's businesses, industries, regions, communities and public services more productive and innovative, as well as to strengthen Scotland's position in new markets and industries.

In Scottish legislation, the definition of innovation is *"…the introduction and implementation of a new or significantly improved product, service, process, or method with the purpose of helping to solve societal challenges or delivering economic growth".* It is important to be aware that innovation goes far beyond the boundaries of traditional research and development[2] (R&D) it is typically associated with. The Oslo Manual[3] for measuring innovation defines four separate types of innovation:

- Product innovation: A good or service that is new or significantly improved. This includes significant improvements in technical specifications, components and materials, software in the product, user friendliness or other functional characteristics.
- Process innovation: A new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software.

[1] Scottish Government, 2022, Scotland's National Strategy for Economic Transformation
[2] "Research and development comprise creative work undertaken on a systematic basis to increase the stock of knowledge and the use of this knowledge to diverse new applications" – OECD Factbook 2013
[3] OECD, 2018, Oslo Manual 2018 – Guidelines for Collecting, Reporting, and Using Data on Innovation, 4th Edition

- Marketing innovation: A new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing.

- Organisational innovation: A new organisational method in business practices, workplace organisation or external relations.

All four of these aspects of innovation have a role to play in helping Scotland deliver economic prosperity.

2. The Role of Innovation in Driving Economic Growth

Innovation has been a consistent policy priority for many years in Scotland, the UK and internationally. Widely considered essential for economic growth and productivity[4], innovation drives the development of new or improved products and services or makes their production more efficient, increasing economic output, and ultimately creating wealth and employment.

R&D is often considered central to innovation and productivity growth. While many innovations are technological – faster computers, more powerful phones and more fuel efficient cars – innovation is also about doing things better through better business models.

While the link between innovation and productivity is complex, evidence suggests that innovation plays a key role in productivity growth, which ultimately feeds into economic growth. Indeed, work by the OECD and Nesta suggest that innovation could account for between 25% and 50% of labour productivity gains[5]. Productivity growth can be a result of increasing output at a rate faster than resource growth, but also through increasing the efficiency of firms' operations.

The gains from innovation activities also do not solely accrue to the organisations undertaking the work, as the benefits tend to spill over through adoption and further development of those innovations, further increasing productivity and output. Furthermore, benefits arising from R&D and innovation go beyond the economic. Innovation can produce, for example, better medicines, more effective public services and greener energy with resulting social and environmental benefits.

2.1. Drivers of Innovation

There are many factors that can influence the rate of innovation in an economy. This section considers some of the key drivers, drawing on the available evidence on their role in encouraging innovation and Scotland's performance in each area.

Private and Public Investment in R&D

As previously mentioned, investment in R&D, whether it is public or private, is generally considered a central pillar of innovation. By seeking new knowledge through research, companies innovate by developing, designing and enhancing products, services, technologies and processes.

Analysis by the UK Government[6] finds that private R&D investment successfully fosters innovation in firms, especially in terms of process innovation and the introduction of new-to-business and new-to-market innovative products. The research does not find evidence to suggest that public R&D crowds out private R&D.

[4] A seminal example is the work of Robert Solow which posits that, in the long-run, *only* technological change drives economic growth; Solow, Robert M. (February 1956). "A contribution to the theory of economic growth". Quarterly Journal of Economics. (Also subsequent papers).
[5] Innovation, knowledge spending and productivity growth in the UK
[6] Department for Business, Energy and Industrial Strategy, 2021, From Ideas to growth: Understanding the drivers of innovation and productivity across firms, regions and industries in the UK

Instead, it finds that public R&D seems beneficial as it supports new-to-market innovative products, with different impacts by UK region and firm size.

A review of Scotland's R&D investment performance is provided in section 3.1.

Organisational and Management Structures and Practice

Innovative success is dependent on far more than just investment. Within firms, the organisational and management structures themselves can have a significant effect on the propensity to innovate.

Recent ONS research[7] exploring the relationship between management practices and innovative activity found that firms with a higher management practice score were significantly more likely to undertake R&D. Additionally, the relationship between productivity and R&D was significantly stronger for firms with a higher management practice score. The ONS research suggests Scotland's businesses perform favourably on management practices, with Scotland ranked joint-highest among all UK regions (along with the South East of England) and with its performance improving significantly since 2016.

Innovation policy tends to focus on how best to encourage businesses to undertake research and innovate themselves, but it is also important to consider how best to empower businesses to adapt their organisational structures to adopt existing innovative technologies and practices. This is important, because widespread productivity gains from effective utilisation of general-purpose technologies such as electricity in the 19th - 20th centuries and digital technologies in the 21st century have tended to emerge slowly despite obvious benefits. If technological diffusion is slow, it can dampen productivity growth because of the impact of 'laggard firms' on the performance of the overall economy.

Human Capital

The level of human capital[8] within an economy and the skills of the labour force also play a significant role in innovation, both directly and indirectly. In a direct sense, this will spur innovation as educated and well trained workers are more likely to introduce new products or implement new processes. In an indirect sense, highly skilled workers can drive innovation as they are more able to absorb new knowledge and ideas, thereby maximising knowledge and technology spill overs of innovations from other firms. This knowledge absorption element of human capital is especially relevant for digital skills, which are becoming increasingly more important as a driver of innovation.

For example, the 2021 Digital Economy Business Survey (DEBS) 2021 found that digital technology helped around a third of businesses to create new or significantly improved products or services. It also made business processes more efficient (59% of businesses), increased skills (48%) and enhanced competitiveness (41%). DEBS shows promising results for digitalization in Scotland[9]. 97% of businesses reported

[7] Office for National Statistics, August 2021, Management practices and innovation, Great Britain
[8] The term human capital refers to the economic value of a worker's experience and skills.
[9] Digital Economy Business Survey 2021: Findings

being connected to the internet, and almost all digital technologies saw an increase in use from 2017 to 2021. However, the uptake of some technologies is still fairly low, such as management software (20%) and data analytics (40%).

Digital skills are essential if businesses are to benefit from digital adoption and to develop better business models. However, only 1 in 5 Scottish businesses felt fully equipped with digital skills in 2021 - 15% reported that they were not very well equipped and had considerable skills gaps. While many businesses reported skills gaps, 46% of those surveyed were not taking, or planning to take, any action to address digital skills gaps. Amongst businesses with relevant skills gaps who were not taking action to address them, the most commonly cited barriers include 'resource or time constraints', and costs. Of the businesses that reported skills gaps, 23% were not able to identify specific skills for improvement, highlighting some knowledge barriers.

More generally, Aston Business School research, which looked at the drivers and barriers to technology adoption for SME firms, identified the following as key drivers for technology adoption: agile and lean decision making; work optimisation planning; business competitiveness; employee training activities; and pro-active decision-making. The following were identified as barriers to technology adoption: a lack of talent and knowledge management; poor skills development; limited finances; technology friction; a lack of systematic strategy; a lack of dissemination of successful business practices; and a lack of adequate technical infrastructure.

Similarly, the latest data from the UK Innovation Survey (UKIS)[10] identified that, except for the UK exit of the EU and coronavirus, the highest barrier to innovation in the UK listed was that 'present market conditions did not require innovation', at 27% of businesses. Excessive perceived economic risks were listed as the next biggest barrier, of 'high' importance to 19% of broad innovator businesses in 2018-2020. This marks a departure from the results of previous surveys, where cost factors, including finance availability, had been the largest barrier over 2014-2018.

Employee involvement is key to unlocking productivity as detailed in the 'European Company Survey 2019: Workplace Practices Unlocking Employee Potential'.[11] Only 19% of UK employees reported their job includes problem-solving, compared to 25% in Finland, which consistently performs in the top quartile in terms of innovation. Further comparisons show that 'high complexity & autonomy workplace practices' are evidenced in 16% of Finnish businesses, compared to 10% in the UK. When this is analysed by organisation size, only 4% of SMEs in the UK have 'high complexity and autonomy workplaces', compared with 10% in Finland. Finally, in the UK, 31% businesses operate a 'command & control structure', with only 24% of Finish organisations favouring this approach.

Culture and Ecosystem

A key enabler of innovation is that of an innovative culture or eco-system, both at the firm and industry level. Innovation centres, innovation networks and clusters play an

[10] Department for Business, Energy and Industrial Strategy, 2022, UK innovation survey 2021: report - GOV.UK (www.gov.uk)
[11] European Company Survey 2019: Workplace Practices unlocking employee potential, 2020

important role in supporting innovation (and, indeed, entrepreneurial) ecosystems. At the firm level, a workplace culture that connects workers to the strategic direction of the firm and facilitates opportunities for employees to participate in organisational decisions can be instrumental in encouraging a continuous flow of ideas that support innovation efforts. At a sector wide level, peer-to-peer business networks, industry clusters, and academia-industry collaboration can have significant effects in the sharing and development of new ideas, as well as facilitating the adoption of new knowledge and technologies. A good example of a sector level innovative culture is Silicon Valley, where academia, private sector and US government have all converged to create an environment that has enabled numerous tech start-ups to flourish.

Enterprise and Entrepreneurship

A central driver for a growing, innovating and dynamic business base is clearly entrepreneurship. Entrepreneurship can be defined as the ability to identify business opportunities and to translate them into viable business propositions that deliver economic impact and desirable social and environmental change. By innovating through the creation of new technology and processes, entrepreneurs cause productivity increases as those innovations diffuse across the economy. Furthermore, entrepreneurs are the primary source of 'creative destruction'[12] whereby incumbent firms are displaced and resources are reallocated in a more efficient way, leading to long term productivity growth.

While there is no target for the start-up survival rate in Scotland, there is a significant gap to close if Scotland is to match the best performing advanced economies. For instance, to match the best performing OECD countries, Scotland would need to raise its 3-year and 5-year business survival rate by around 20 percentage points[13]. Additionally, Scotland has a deficit of high-growth firms when compared with other countries, and there is evidence of constraints to business growth in the wider enterprise ecosystem.

The Scottish Government's National Performance Framework (NPF)[14] tracks Scotland's business creation using the Total Early-stage Entrepreneurial Activity (TEA) rate[15]. On this measure, Scotland's entrepreneurial activity has gradually improved over time but remains significantly below that of other advanced economies, sitting in the second quartile of OECD countries[16]. Scotland's TEA rate would have to increase by around 70% if it is to match the performance of other small advanced economies like Ireland[17].

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[12] In his Theory of Economic Development (1961), Joseph Schumpeter maintains that the creative destruction process is mainly due to entrepreneurs' innovations that create an endogenous motion which revolutionizes economic structures.
[13] Scottish Government, March 2022, Scotland National Strategy for Economic Transformation: evidence paper. Based on OECD and ONS Business Demography data.
[14] Scottish Government, National Performance Framework - National Indicator Performance
[15] The TEA rate measures the proportion of the working age population that is actively trying to start a business or that own or manage a business, which is less than 3.5 years old.
[16] Enterprise and Skills Strategic Board Annual Analysis 2020
[17] The latest published 2019 TEA rate for Ireland was 12.4%, compared to 7.2% in Scotland in the same year.

Following from the previous paragraph, successful, advanced entrepreneurial economies tend to feature thriving eco-systems, often operating through a "triple helix" of private sector, public sector and universities and linked to sectoral clusters. In terms of local economies in Scotland, Edinburgh is a good example of this.[18]

Nurturing entrepreneurial ecosystems requires building cultural, social and material attributes,[19] including education, role models, access to peers, celebration of success, learning from 'failure', social ties, entrepreneurial networks, skilled workers and access to talent and appropriate and diverse investment capital. Entrepreneurship can flourish when these attributes are supported by key institutions including universities (which are often anchor institutions), favourable government policies and appropriate infrastructure including transport, super-fast broadband and access to cultural activities including, for example, attractive places for entrepreneurs to come together in a "market-square" type environment.[20]

The funnel model outlined in Scottish Technology Ecosystem Review[21] provides a useful illustration of the importance of the local ecosystem in determining the rate of narrowing of the number of firms as they move through the stages from start-up to scale-up. It notes the opportunity that exists to improve ecosystems to close the gap between Scotland's current rate of funnel decay and the natural rate[22]. Further detail on the funnel model is provided in Annex 1.

Inward Investment and Exporting

Analysis underpinning Scotland's Inward investment plan[23] also finds that there are strong links between Scotland's university knowledge base, inward investment and innovation, and that foreign owned businesses typically invest more in business R&D spending. Additionally, these inward investors can further boost innovation in the Scottish economy through their engagement with domestic businesses. This can either be due to increased competitive pressures spurring innovation in domestic firms (competition effects), or through domestic businesses adopting the innovative processes of foreign owned firms (demonstration effects). Demonstration effects can also drive innovations through supply chains, as inward investment companies may share knowledge with domestic suppliers in order to improve inputs to production. Furthermore, employees of innovative inward investment companies may use the knowledge they have gained to start their own innovative companies.

Similarly, Scotland's export strategy, A Trading Nation[24], notes that, as well as driving business performance and scale, access to international markets and competition drives innovation and productivity growth. Evidence indicates that there

[18] Beauhurst and Barclays Eagle Labs, 2021, Unlocking Growth report and summary
[19] Spigel, 2017, The Relational Organization of Entrepreneurial Ecosystems, Entrepreneurship Theory and Practice, vol. 41, no. 1, pp. 49-72
[20] Logan, August 2020, Scottish Technology Ecosystem Review
[21] Ibid
[22] The natural rate refers to the natural narrowing of the number of firms from start-up to scale-up given that not all start-ups do or should become scale-ups and not all scale-ups do or should become unicorns. The natural rate is impossible to improve upon.
[23] Shaping Scotland's Economy: Inward Investment Plan
[24] A Trading Nation – a plan for growing Scotland's Exports

is a strong correlation between exporting and innovation. Innovative businesses are more likely to export and the experience of exporting can be a strong driver of investment in innovation and R&D as businesses compete in new markets. Additionally, evidence from the Enterprise Research Centre[25] finds that internationally active SMEs are three times more likely to introduce innovative products or services than those focusing entirely on the domestic market. Currently only one in five UK SMEs are exporters. However, estimates suggest that between nine and 12 per cent of non-exporting firms within the UK could become exporters.

[25] Boosting UK Productivity with SME Growth

2.2. The Role of Government in Promoting Innovation

If left solely to the market, economic theory suggests a market failure will arise whereby investment in innovation activities will be at sub-optimal levels, providing a rationale for government intervention to encourage and support innovation.

This is primarily because the benefits of innovation activity do not accrue solely to the business undertaking the innovation, in other words there is a positive externality. The benefits of innovation activity tend to 'spill over' to other organisations through adoption and further development of those innovations, further increasing productivity and output across the whole economy.

Additionally, businesses are often unwilling to invest in R&D activities because they are risky by nature, especially for technologies in the earliest stages of development. Because of this, smaller businesses which are less able to suffer the loss of a failed R&D project may simply not undertake any R&D activity, again resulting in sub-optimal levels of investment.

A review of existing evidence by the Research and Development Corporation Europe (RAND Europe[26]) found that there may be even greater benefits from innovation across society including impacts on culture, public engagement, social cohesion and environment, although these are difficult to measure. Thus, firms taking decisions to invest in innovation on the basis of benefits accruing to their business only will tend to underinvest.

Finally, there is a clear role for government in providing the basic infrastructure for innovation to thrive, from digital infrastructure to skills programmes to funding for basic research.

[26] RAND Europe, 2017, Evidence synthesis on measuring the distribution of benefits of research and innovation

3. Scotland's Recent Innovation Performance

There are various measures for tracking innovation in the economy – from looking at expenditure on research and development, to the prevalence of innovation activity in the business base. This section shows that Scotland has a mixed performance in terms of innovation, with areas of strength, but also some notable challenges.

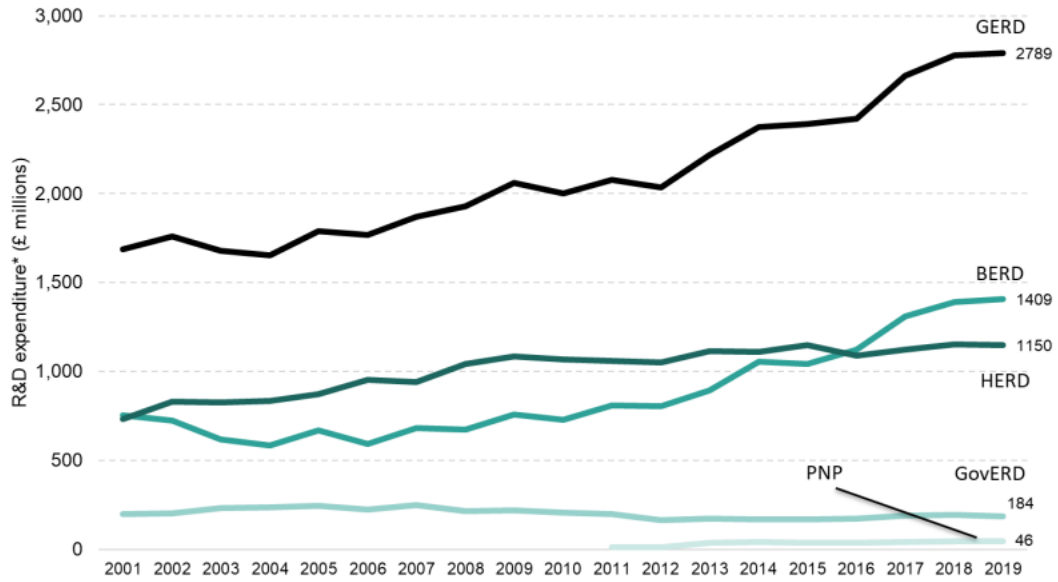
3.1. Expenditure on Research and Development

Gross Expenditure on Research and Development

Gross Expenditure[27] on Research and Development (GERD) comprises R&D undertaken by the Business Enterprise (BERD), Higher Education (HERD), Government (GovERD) and Private Non-Profit (PNP) sectors.

Scotland's GERD was £2,789 million in 2019, an increase of 0.4% in real terms from 2018. Over the longer term, Scotland's GERD increased by 49.3% between 2007 and 2019.

Figure 1: GERD, BERD, HERD, GovERD and PNP, Scotland (2001-2019)



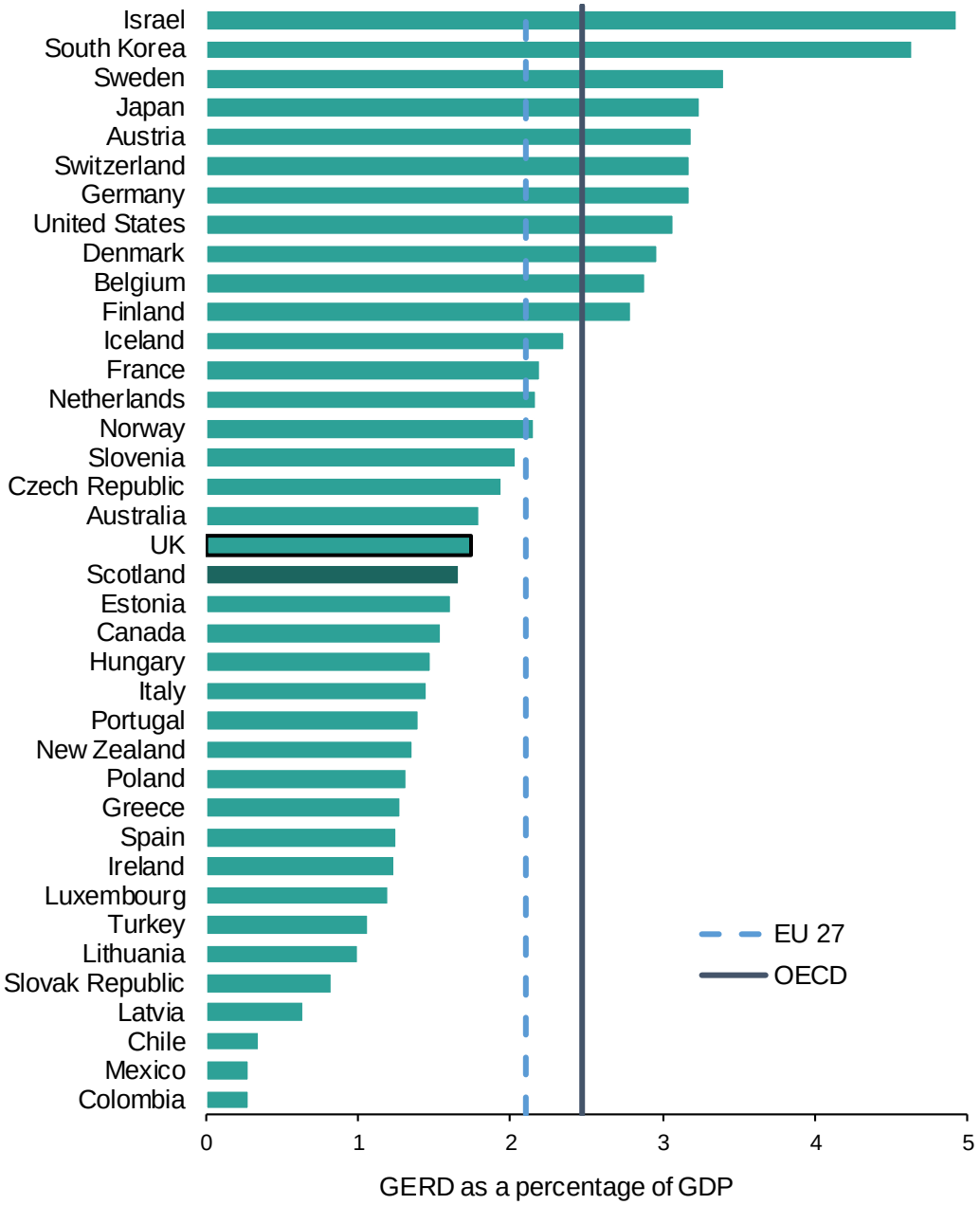
Source: Gross Expenditure on Research and Development Scotland 2019

In 2019, Scotland's GERD represented 7.2% of the UK total and 1.66% of Scotland's Gross Domestic Product (GDP).

As a percentage of GDP, Scotland ranked in the third quartile of OECD countries in 2019, below the UK (1.74%), EU (2.10%) and the OECD averages (2.47%).

[27] Scottish Government, Gross expenditure on research and development Scotland 2019

Figure 2: Gross Expenditure on Research and Development across the OECD (2019)



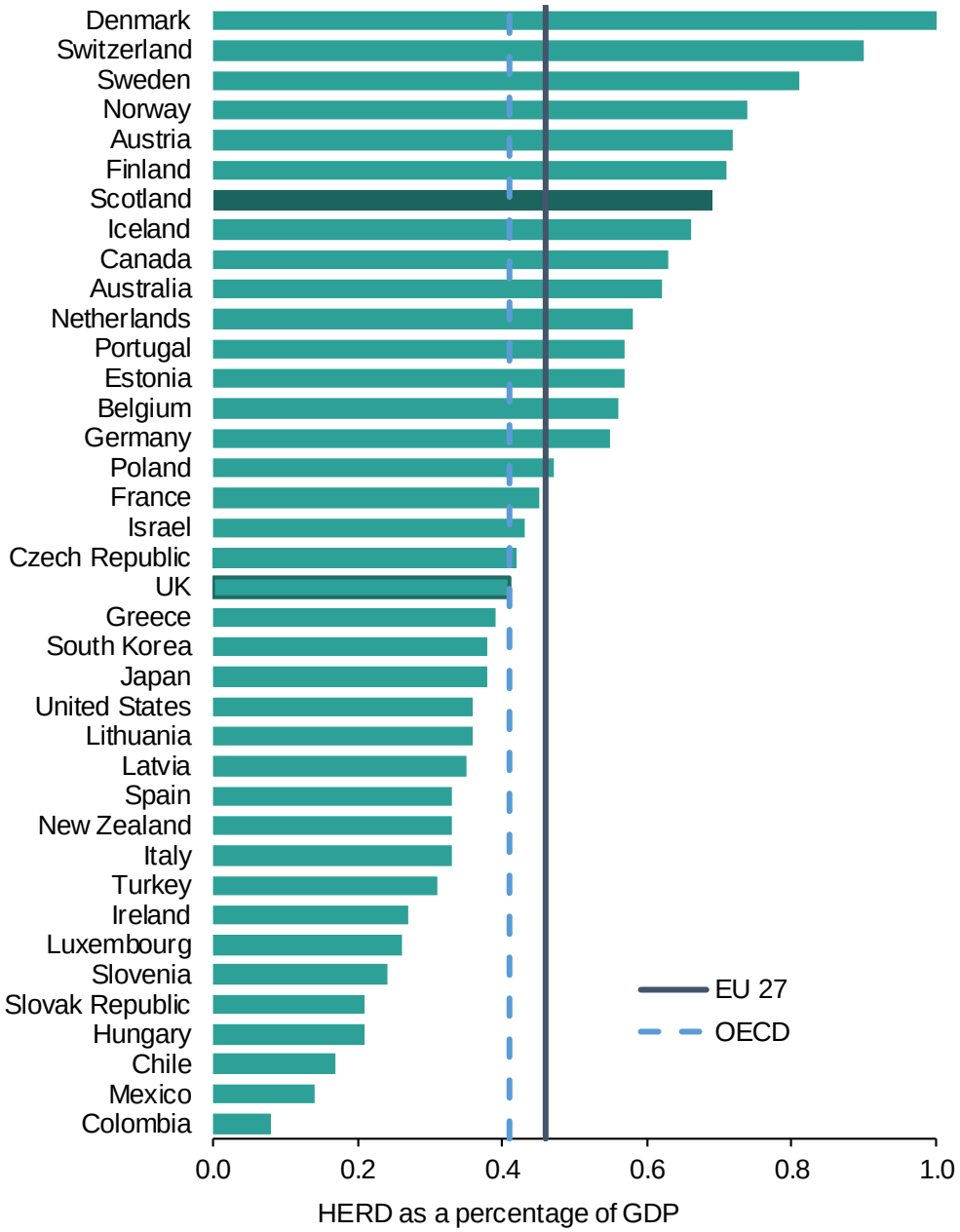
Source: Gross Expenditure on Research and Development Scotland 2019

Higher Education Research and Development

Scotland's HERD spend was £1,150 million in 2019 – down 0.3% in real terms from 2018. In contrast the UK's HERD increased by 1.3% over this period.

Compared to most other OECD countries, Scotland's HERD spend makes up a relatively large proportion of total GERD. As a percentage of GDP it was 0.69%, compared to an OECD average of 0.41%. Scotland ranked seventh among the OECD countries for HERD spend as a percentage of GDP, putting it in the first quartile, in contrast to the UK's position in the third quartile.

Figure 3: Higher Education Expenditure on Research and Development across the OECD (2019)



Source: Gross Expenditure on Research and Development Scotland 2019

Business Enterprise Research and Development[28]

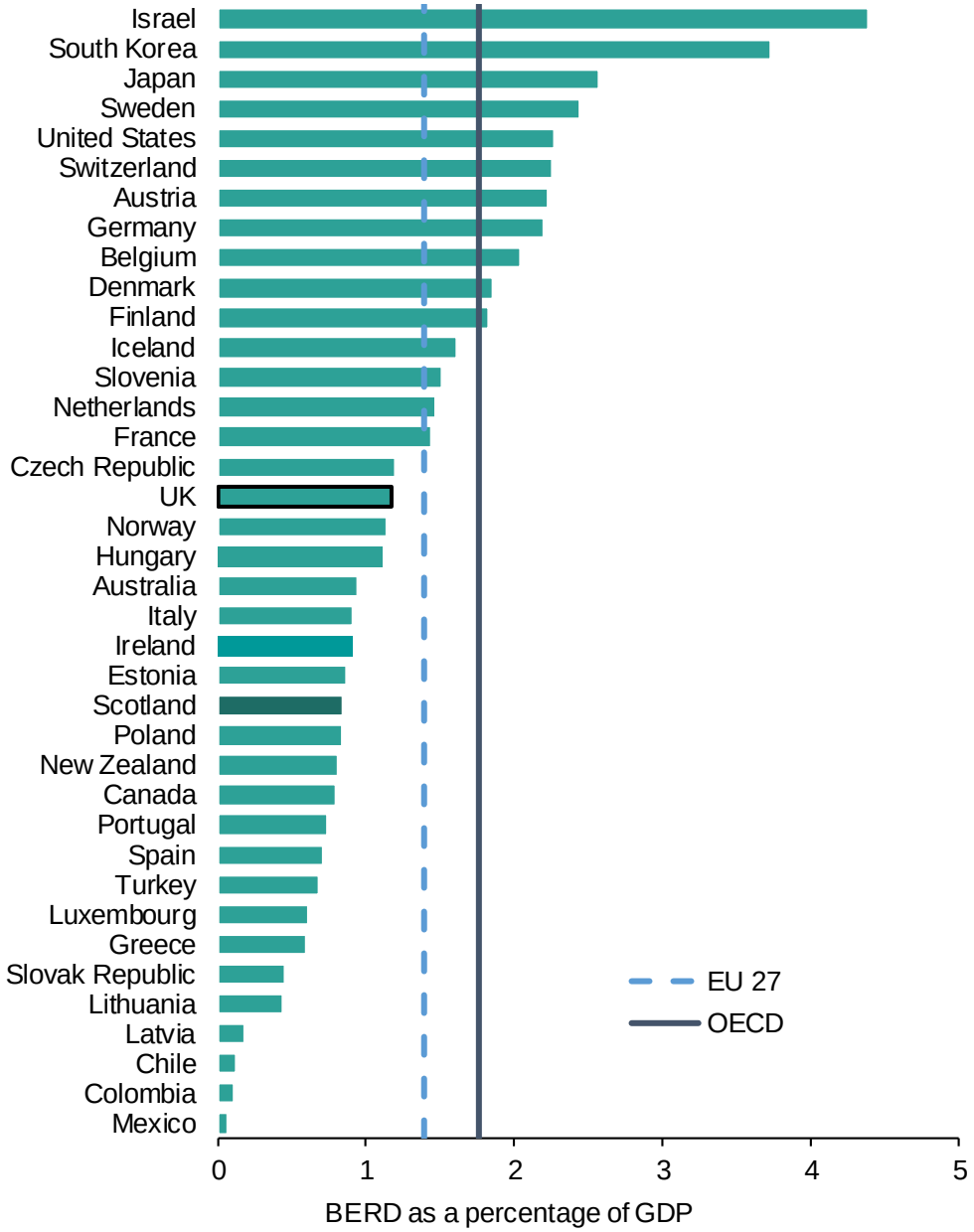
The latest data shows that BERD spend in Scotland decreased by 6.1% in real terms between 2019 and 2020. However, the timing of major research projects undertaken by a few large firms can cause fluctuations in the overall levels of business R&D. This is particularly important for 2020 given that some companies may have paused research projects because of the pandemic.

[28] Please note that while 2020 headline BERD data is available for Scotland, only 2019 data is available for international comparisons.

BERD employment is a more stable measure of BERD performance, and latest data shows that BERD jobs in Scotland increased by 9.0% between 2019 and 2020 – taking BERD jobs in Scotland to the highest level in the series back to 2001.

Looking over the longer term, Scotland has experienced relatively strong growth in BERD spend and is still on course to meet its target of doubling BERD spend between 2015 and 2025. However, Scotland's BERD spend is still relatively low compared with other countries. At 0.84% of GDP, Scotland's BERD spend as a percentage of GDP ranked in the third quartile of the OECD countries in 2019, well below the EU and OECD averages, which are 1.39% and 1.76% respectively.

Figure 4: Business Enterprise Expenditure on Research and Development across the OECD (2019)



Source: Gross Expenditure on Research and Development Scotland 2019

In regional terms, the picture on BERD spending in Scotland is mixed. Business spending on R&D in Scotland is not evenly distributed across the country, with

Edinburgh alone accounting for almost of a third (30.8%) of BERD expenditure in 2020 and three local authority areas (Edinburgh, Glasgow and West Lothian) accounting for nearly three fifths (57.6%). In terms of BERD employment, Edinburgh accounted for 27.4% of the Scottish total and Glasgow ranked second with 11.5%.

In 2020, BERD expenditure as a percentage of GDP was highest in West Lothian, where BERD spend accounted for 3.49% of GDP. Edinburgh ranked second. Dundee City, Aberdeen City, West Dunbartonshire and Midlothian were the only other local authority areas (LAAs) where BERD spend as a percentage of GDP was higher than the Scottish average (0.92%). The Scottish average spend on BERD as a proportion of GDP is low compared to highly scoring LAAs, suggesting that nationally, BERD investment is quite supressed, with high-performing outliers.

Figure 5: BERD expenditure as a percentage of GDP by Local Authority Area (2020)

Source: Business expenditure on research and development Scotland 2020

Government Expenditure on Research and Development

In 2019, GovERD in Scotland was £184 million, 4.7% (£9 million) lower in real terms than in 2018. It represented 6.9% of the total GovERD in the UK, which decreased by 0.2% in real terms between 2018 and 2019. GovERD as a percentage of GDP was 0.11% for Scotland and 0.12% for the UK in 2019. This was the only component of GERD that decreased over the longer term, falling by 25.8% in Scotland and 9.6% in the UK, between 2007 and 2019.

Scotland ranked in the third quartile for GovERD as percentage of GDP (0.11%), at less than half the level of the EU (0.24%) and OECD (0.24%).

Private Non-Profit Research and Development

In Scotland, PNP R&D spend was £46 million in 2019, 5.5% of the UK total and 0.03% of GDP. Between 2018 and 2019, Scotland's PNP R&D spend increased by 4.5%, compared to 3.7% in the UK.

The above evidence suggest Scotland potentially faces some challenges with aligning its higher education and business and enterprise research and development activities. There may be scope for HERD to help leverage additional BERD if Scotland is to improve on its overall ranking within the OECD on GERD.

3.2. Prevalence of Innovation Activity in the Business Base

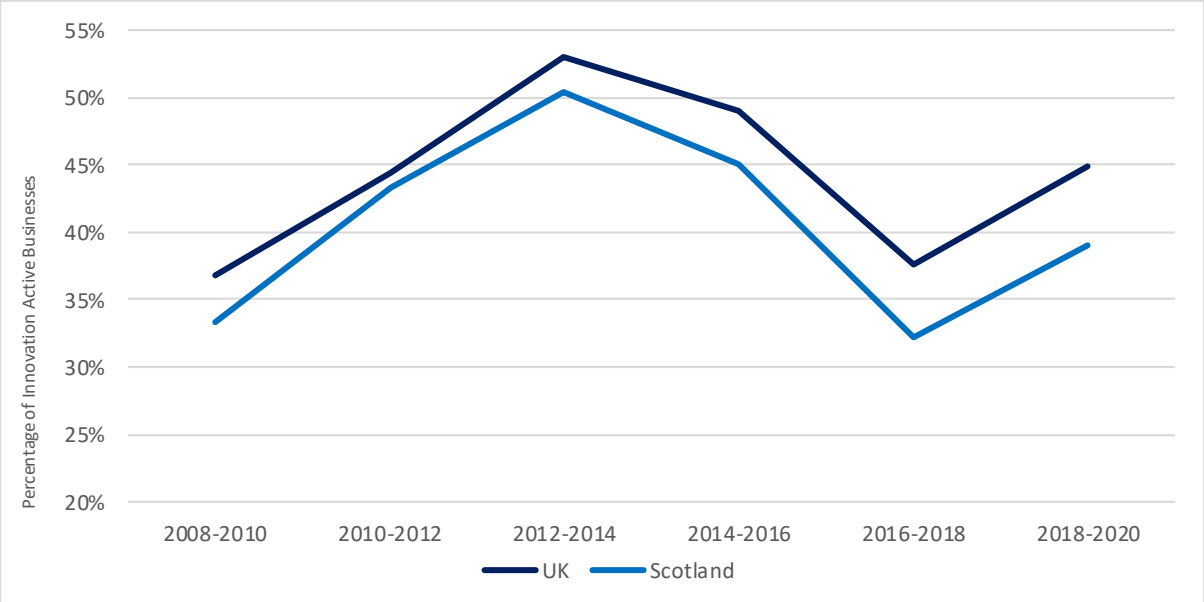
The Scottish Government's National Performance Framework[29] tracks the level of innovation activity within Scotland's business base using data on the proportion of businesses that are 'innovation active'[30] from the UK Innovation Survey[31]. In 2018-20, the share of 'innovation active' businesses in Scotland was 39.0%, lower than in the UK as a whole (45.7%). Between 2016-18 and 2018-20, innovation activity rose in both Scotland (+6.8 percentage points) and the UK (+7.3 percentage points).

[29] Scottish Government, National Performance Framework

[30] The UKIS defines as business as being 'innovation active' if it has engaged in any of the following activities: the introduction of a new or significantly improved product (good or service) or process; engagement in innovation projects not yet complete, scaled back, or abandoned; new and significantly improved forms of organisation, business structures or practices, and marketing concepts or strategies.

[31] Scottish Government, October 2020, UK innovation survey 2019: results for Scotland

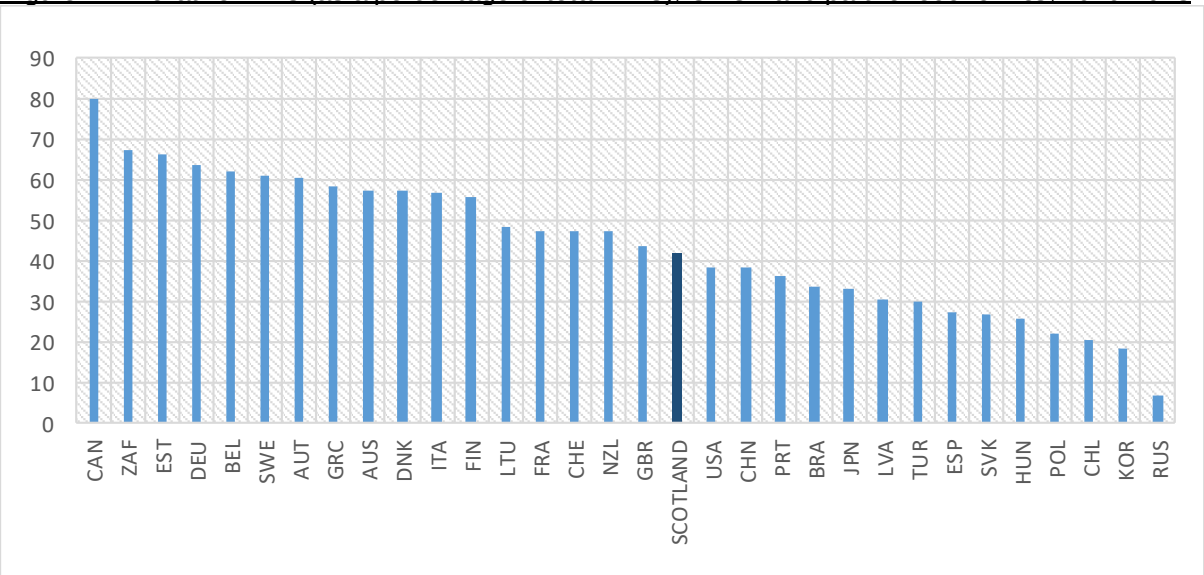
Figure 6: Change in the share of innovation active enterprises in Scotland and the UK, 2008-2020



Source: UK Innovation Survey 2019 – Results for Scotland

When ranked against OECD and partner economies, Scotland ranked 18th in 2016-18, placing it at the top of the third quartile[32].

Figure 7: Innovative firms (as a percentage of total firms), OECD and partner economies, 2016-2018



Source: OECD, based on the 2021 OECD survey of Business Innovation Statistics and the Eurostat's Community Innovation Survey (CIS-2018)

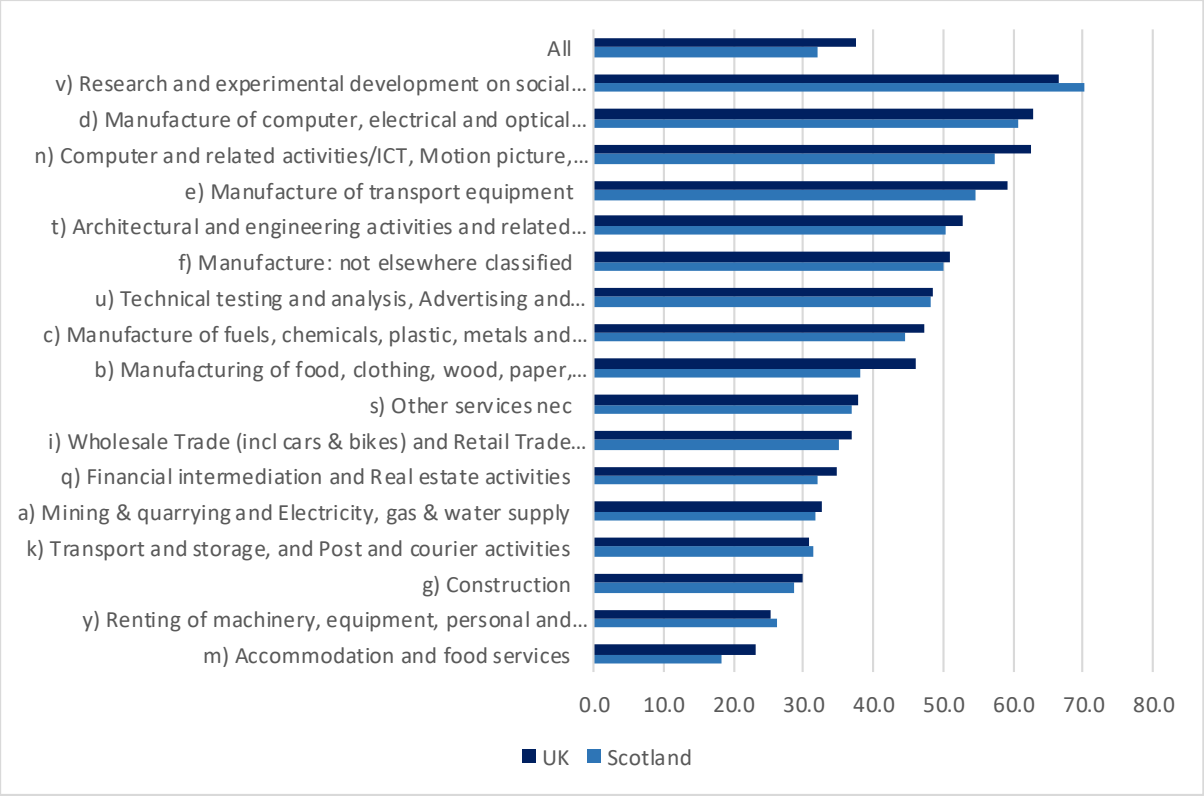
In terms of business size band, in 2016-2018 small (10-49 employees) businesses were least likely to be innovation active (30.2% for Scotland) and large (250+ employees) businesses were most likely to be innovation active (43.8%).

[32] It is important to note that for international comparisons, data on the percentage of innovation active firms is based on a subset of sectors of the sectors covered by the UKIS survey (focussing on the most innovative sectors). On this basis, the proportion of businesses innovation active in Scotland in 2016-18 was 42%.

For types of innovation, in 2016-2018, more businesses in Scotland were product innovators at 12.3%, than process innovators, at 10.3%. The UK outperformed Scotland at 18.0% and 12.7% over the same period for product and process innovation respectively.

Innovation activity in Scotland varies by sector. Businesses in the 'research and experimental development on social sciences and humanities' sector were the most likely to be innovation active in Scotland (70.2%) and the UK (66.5%). Businesses in the 'accommodation and food services' sector were the least likely to be innovation active. In terms of comparisons with the UK, less innovation active sectors in Scotland are in types of manufacturing such as manufacturing of transport equipment and manufacturing of computer, electrical and optical equipment. Scotland outperforms the UK in innovation in a variety of sectors, such as architectural and engineering activities, research and development in social sciences, and in certain types of manufacturing.

Figure 8: Share of Innovation Active Businesses by Broad Economic Sector, Scotland vs. UK, 2016-18



Source: Scottish Government, UK Innovation Survey 2019 – Results for Scotland

3.3. Broader innovation Performance

The European Commission's Regional Innovation Scoreboard[33], which assesses the performance of 240 European regional innovation systems against 21 indicators, provides an insight into Scotland's key strengths and weaknesses in relation to

[33] European Commission, Regional Innovation Scoreboard 2021

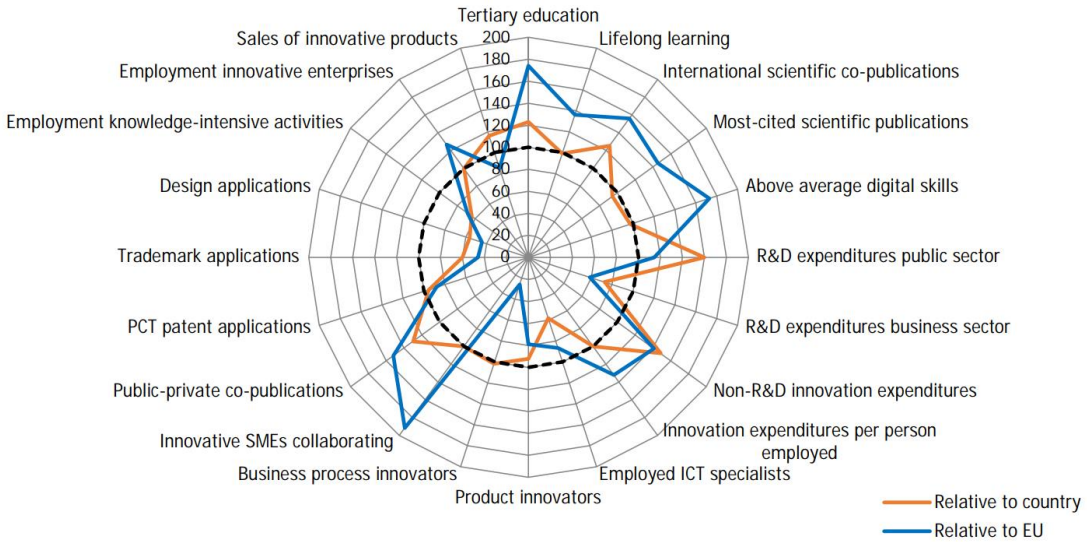
innovation compared to the UK and EU. In 2021, Scotland was classified as a strong+ innovator, with its performance improving over time.

Of the 12 UK regions, Scotland ranked fifth, behind South East England, London, East England and South West England. Three UK regions (London, South East England and East England) were classified as innovation leaders with the remaining nine classified as strong innovators. Of the 240 European regions, Scotland ranked within the first quintile (43rd).

As shown the diagram below, Scotland has mixed performance when compared to the EU, with some areas of strength but also some notable challenges. Scotland's innovation performance exceeds the EU average in the following areas: tertiary education; lifelong learning; international scientific co-publications; most-cited publications; above average digital skills; R&D expenditure public sector; non-R&D innovation expenditure; innovation expenditures per person employed; innovative SMEs collaborating; public-private co-publications; and employment in innovative enterprises.

Scotland's innovation performance falls short of the EU average in the following areas: R&D expenditure business sector; employed ICT specialists; product innovators; business process innovators; patent applications; trademark applications; design applications; employment in knowledge-intensive activities; and sales of innovative products.

Figure 9: Relative Scottish strengths compared to the UK and the EU[34]



Source: European Commission's Regional Innovation Scoreboard 2021

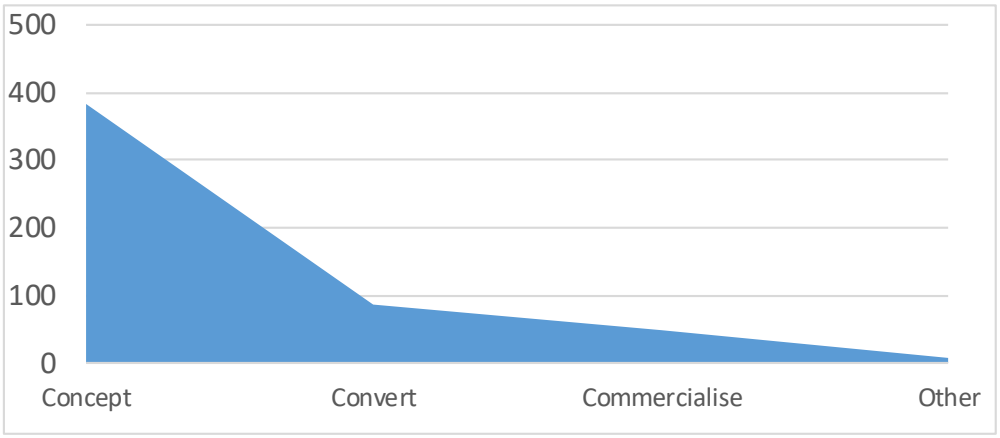
[34] Dashed black line indicates no difference, above indicates stronger performance and below indicates weaker performance.

4. Review of Innovation Funding in Scotland

4.1. Distribution of Spend

The innovation support landscape in Scotland is complex. It includes grants and wider non-financial support for innovation and around 90 innovation initiatives across the Scottish Government and enterprise and skills agencies, with estimated funding of around £480m in 2018-19. This rises to around 500 initiatives when including innovation funds run by other organisations, such as the UK Government, EU, and third sector.

Figure 10: Innovation Spend in Scotland by Scottish Government and Agencies, 2018-19 (£m)



Source: Enterprise and Skills Strategic Board Innovation Review

As illustrated in the diagram above, innovation spending is heavily skewed towards the earlier 'concept' stage of the innovation journey. A large portion of this (around £284m in 2018/19) is research funding for higher education institutions which, while potentially contributing towards innovation, has broader objectives. Even excluding this funding, there is around £200m per annum of innovation support from the Scottish Government and the enterprise and skills agencies[35]. Additionally, of the 49 initiatives across the enterprise and skills system, 85% of funds are administered by agencies, with 16 of the funds spending £100,000 or less in 2018/19.[36]

In light of this complex landscape, in September 2021 the Enterprise and Skills Strategic Board were asked by Mr. McKee, Minister for Trade, Innovation and Public Finance, to undertake a high level review of innovation support in Scotland. As part of the innovation funding review, the Scottish Government Enterprise and Skills Analytical Unit drew together existing evidence on the range of different innovation initiatives and mapped these against the established innovation framework set out by ministers. A table of this mapping is shown overleaf.

[35] Please note that for figure 10, some programmes were counted more than once if they related to multiple aspects of the innovation framework.
[36] Enterprise and Skills Strategic Board's (ESSB) Innovation Review

Figure 11: Mapping Innovation Initiatives on a 3x3 Framework

	Infrastructure	Activities	Organisations
Commercialise	University Innovation Fund Medicines Manufacturing Centre Oil & Gas Technology Centre	Small Innovation Grant Innovate Your Business (Advisor Support) Scaling Accounts HGV Advisor Support High Growth Spinout Programme Unlocking Ambition Enabling Grants Scottish co-Investment Fund Can do Innovation Challenge Fund Edge	Wave Energy Scotland Hydro Nation Water Innovation Service Scotland Can Do
Convert	The Innovation Centre Programme University Innovation Fund Fraunhofer Lightweight Manufacturing Centre Medicines Manufacturing Centre Oil & Gas Technology Centre	HIE Business Funding Innovate Your Business (Advisor Support) Northern Innovation Hub SMART ScotGrad Innovation Support Industry – Academia links Innovation Voucher Scheme Edge CivTech Unlocking Ambition	Interface Wave Energy Scotland
Concept	Research Postgraduate Grant Research Excellence Grant The Innovation Centre Programme University Innovation Fund Research Institutes Funding Fraunhofer Medicines Manufacturing Centre Oil & Gas Technology Centre	ScotGrad –Graduate Placement Industry – Academia Links Broadcast Content Fund Charging Points Knowledge Transfer Partnerships Innovation Voucher Scheme Research Pools Strategic Funds KE EXPO Fund – festivals Innovation COIG Route Development Production Growth Fund	Interface

Source: Enterprise and Skills Strategic Board Innovation Review

Key: Lead organisation:

Scottish Funding Council

Highlands & Islands Enterprise

Scottish Enterprise

Scottish Government

The following key themes emerged from the review:

- **Strategy and promotion**: there is a need for a clear overarching strategy for innovation in Scotland which drives where funding is targeted and this needs to be accompanied by clear branding which businesses can easily recognise.

- **Complexity**: over time a substantial number of small innovation funds have been established, many of which are trying to achieve common objectives. These are often designed around the administrative arrangements for service providers rather than the needs of the end user.

- **Flexibility**: greater flexibility is required as often support is targeted at particular sectors, potentially limiting viable proposals from businesses in other parts of the economy.

- **Coordination**: there is scope for much greater coordination to maximise the impact from Scotland's investment in innovation, as most initiatives currently exist in isolation.

- **Collaboration and knowledge transfer**: existing networks and groups, such as the Innovation Forum, could be utilised to foster greater collaboration between funding organisations and a step-change is required in knowledge transfer between research organisations and Scottish businesses.

- **Language and accessibility**: innovation often means different things to different people and this can act to limit the ability of firms to access the right support at the right time.

4.2. International Evidence on Policy Effectiveness

Key Innovation Policy Levers

Recent work by the Scottish Government Enterprise and Skills Analytical unit concluded that there is currently limited evidence on the impacts of innovation activities within Scottish Government and its agencies. This does not necessarily mean that these initiatives are not achieving benefits, but the lack of evidence makes it difficult to judge which initiatives are having the greatest impact on the Scottish economy.

We can however draw on international evidence to consider which types of policy interventions are most effective in stimulating innovation. Recent research from Bloom, Van Reenan and Williams[37] synthesized a wide body of evidence to produce a 'toolkit' for policymakers which ranks the effectiveness of innovation policy levers in terms of the quality and implications of the available evidence and the policies' overall impact from a social cost-benefit perspective. Policies were also scored in terms of their speed and likely distributional effects (Figure 12).

[37] Bloom, Van Reenen and Williams, 2019, A toolkit of policies to promote innovation, Journal of Economic Perspectives—Volume 33, Number 3—Summer 2019—Pages 163–184

The evidence reviewed suggests that, in the short run, R&D tax credits along with direct public funding are the most effective while, over the longer term, increasing the supply of human capital (for example, through expanding university admissions in the areas of science, technology, engineering, and mathematics) is more effective. Encouraging skilled immigration was seen to have significant effects even in the short run. Competition and open trade policies were deemed likely to have benefits that are more modest for innovation, but as they are relatively less costly in financial terms, also score highly.

Figure 12: Review of International Evidence on the Effectiveness of Innovation Policies to Promote Innovation[38]

	Quality of evidence	Conclusiveness of evidence	Net benefit	Timeframe	Effect on inequality
Direct R&D grants	Medium	Medium	++	Medium run	
R&D tax credits	High	High	+++	Short run	
Patent box	Medium	Medium	Negative	N/A	
Skilled immigration	High	High	+++	Short - medium run	
Universities: incentives	Medium	Low	+	Medium run	
Universities: STEM supply	Medium	Medium	++	Long run	
Trade & competition	High	Medium	+++	Medium run	
IP reform	Medium	Low	Unknown	Medium run	Unknown
Mission-oriented policies	Low	Low	+	Medium run	Unknown

Source: Bloom, Van Reenen and Williams, A Toolkit of Policies to Promote Innovation

Promoting Higher Education – Industry Collaboration

The Muscatelli Report: Driving Innovation in Scotland[39] considered how the economic impact of Scotland's higher education institutions (HEIs) can be maximised through improving links between the higher education sector and industry. To inform this work, a review of international systems and approaches was undertaken. The below provides a curated summary of examples of policy best practice in this area from some of the nations identified in the report.

[38] Column 1 summarizes the authors' view of the quality (in terms of quantity and credibility) of the available empirical evidence; column 2 summarizes the conclusiveness of the evidence for policy; column 3 scores the net benefit (benefits minus costs) in terms of a '+' ranking where three is the highest. This ranking is meant to represent a composite of the strength of the evidence and the magnitude of average effects. Columns 4 considers whether the main effects would be short term (three to four years), medium term, or long term (ten years or more), and column 5, the likely effects on inequality.

[39] Muscatelli, 2019, The Muscatelli Report: Driving Innovation in Scotland - A National Mission

Denmark

With a similar size to Scotland and, as one of the top performers on innovation spend, Denmark is an interesting comparator for Scotland. Denmark spends the most on Higher Education Research and Development of all OECD countries, at 0.98% of GDP, and spends more than 3% of GDP on Research and Development. A large part of innovation in Denmark is dominated by the public sector. In the past 10 years, public investment in research and education has been extensively boosted.

Today, the public sector invests more than DKK 18 billion (€2.4 billion) annually, equivalent to 1 per cent of GDP, in research and innovation. The investments have contributed to Danish research being of the high quality it is today, the doubling of the number of PhD students, and the development of an innovation system that is considered well-functioning internationally. Danish universities invest heavily in supporting the ecosystem for entrepreneurship – the universities and partners located at the university campuses (or in proximity) supply a number of services to entrepreneurs and potential entrepreneurs, such as incubators, advisory services, facilities, training, funding opportunities, matchmaking services etc.

Finland

Since a deep recession in the early 1990s, Finland has transformed into one of the most innovative and productive countries in the world. It became a world leader in electronics, led by the global domination of Nokia in the late 1990s and early 2000s. It invests heavily in R&D (more than 3 per cent of GDP). Technology and gaming remain a key strength, even though Nokia is no longer a world-leader in handsets. Finland's transformation builds on a long–standing and widely-held belief in the importance of innovation as part of the future direction of the country.

The Finnish Government put innovation at the heart of its response to the crisis of the early 1990s, maintaining spending on technology in the face of wider cuts. Since then, the level of research and development investment has increased by a factor of five, buoyed by the ambitious R&D targets set by the government throughout the past 20 years. Notably, much of this increase has been driven by increasing amounts of R&D in the private sector.

In Finland, innovation has been increasingly placed at the heart of government policy with active coordination taking place at the highest level. The Research and Innovation Council, established in 1987, is chaired by the Prime Minister. It has the input of the Finance, Education and Employment Ministries which has encouraged a more systemic, whole of government approach.

Norway

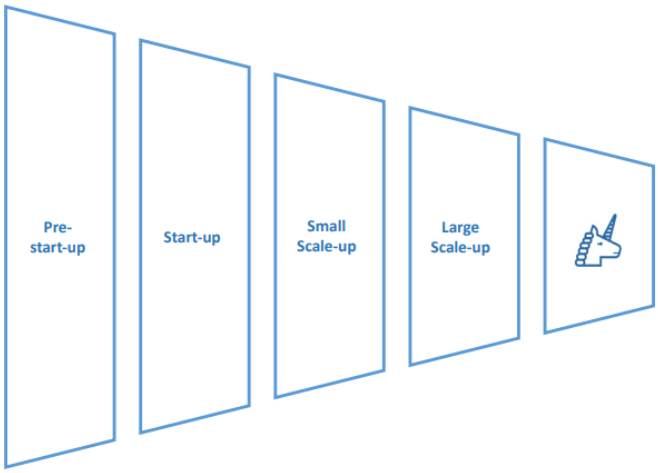
Norway has a high level of HERD (0.71% of GDP in 2017) and BERD above the level in Scotland (1.1% of GDP in 2017). For the past two decades there has been a focus on commercialisation of research from HEIs in Norway and several initiatives have been launched to support the development of patents, spin-offs and licences. In addition, there has been an increased emphasis on collaborative research between HEIs and the public/private sector, seen in the increase of the number of

collaborative research programmes and in funding of these activities. Collaborative research receives the largest public budget allocation. Both commercialisation of research and mobility between sectors are also prioritised

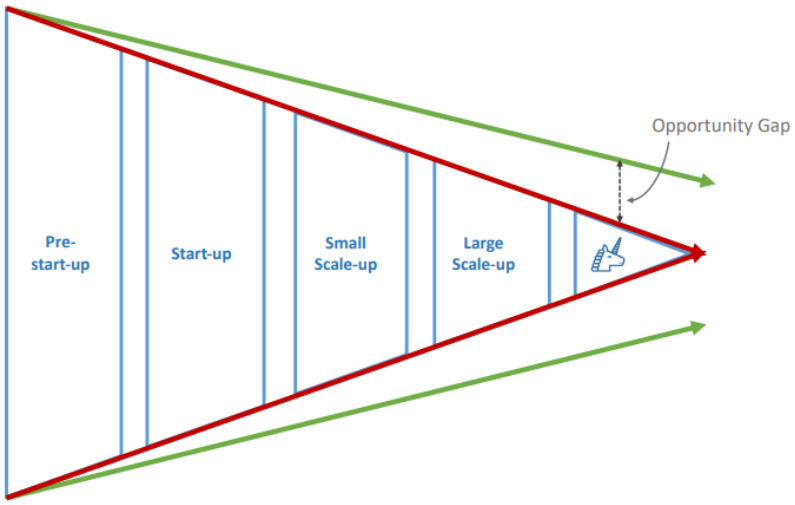
There are several schemes for collaborative research projects. According to qualitative evidence, large schemes that run for several years, such as cluster and centre programmes, seem to impact the largest HEIs in the way that they plan and co-ordinate the applications in advance of the calls as partnership in these are recognised as important for knowledge transfer.

Annex 1: Funnel Model of Innovation

Scotland's innovation funding ecosystem is outlined in a funnel model system by the Scottish Technology Ecosystem Review.[40] This model can be explained visually as a flow between stages of development from pre-start up, to 'unicorn', as shown below.



The model funnels from left to right, with the smaller scale stages later in the process showing that not all start-ups progress to scale-ups, etc. This provides a useful visual tool for understanding that the rate of narrowing between steps of the model influences the number of successful 'unicorns' which emerge.



The funnel model asserts that the difference in the rate of narrowing between each of these steps is a function of how supportive the local ecosystem is for start-ups and scale-ups. If one of these steps or more becomes too narrow, then the funnel model breaks down, and it becomes unlikely that start-ups reach the final stage. Potential reasons for the collapse of the model are:

[40] Scottish technology ecosystem: review - gov.scot (www.gov.scot)

- There just aren't enough companies to create a sustained learning and experiential environment. This, in turn, means that there aren't enough experienced employees emerging who know how to take a start-up to scale.

- The ecosystem is too small to attract outside talent. The risk is just too great that if a job doesn't work out at a particular company for which an executive relocated her family from London, then there aren't other companies to move to locally, and she has to return home. Few people will relocate their families in the first place, in these circumstances.

- The ecosystem doesn't attract larger investors. Venture Capitalists regard the ecosystem as too small to be worth exploration or they consider it unlikely that the ecosystem is capable of producing viable scale-ups. Consequently, they don't invest or limit their investments. This in turn reduces the number of viable start-ups flowing through the funnel. The gap is partly filled by private individual investors and government, but their limited aggregate capital is unable to fuel the growth of businesses beyond the earliest stages of the funnel.