

# Research Bulletin 23/1 | Small Advanced Economy Insights on Innovation Policy for Northern Ireland

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August 2023

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## Summary

The 10X Vision signals a central role for innovation in driving a transformation of the Northern Ireland economy. It aspires for Northern Ireland to become a top-performing small advanced economy in terms of innovation and specifies key metrics.

Innovation is central to the performance of small advanced economies, supporting the development of competitive advantage in externally-oriented sectors as well as strengthening low productivity in domestic sectors. However, generating strong innovation outcomes can be challenging in a small economy context; government support is required.

Small advanced economies support innovation policy in a variety of ways: providing funding support, investing in research universities, building clusters, enterprise policy, and so on. High-performing small advanced economies have been strengthening their commitment to innovation policy over the past several years in response to emerging challenges in the global economic context.

This international experience has implications for Northern Ireland. Transforming the Northern Ireland economy will require significant policy commitments to upgrade innovation capabilities, which extend beyond fiscal support. Potential areas for policy focus include enterprise policy initiatives, policy around research universities, as well as cluster policy, FDI attraction, and so on.

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## Introduction

The May 2021 10X Vision signals a central role for innovation in driving a transformation of the economy. It states that 'Northern Ireland's decade of innovation will encourage greater collaboration and innovation to deliver a ten times better economy with benefits for all our people'.<sup>1</sup> Several 10X Metrics are being used to capture Northern Ireland's performance in moving towards an innovation-led economy: total R&D spending

as a share of GDP; the number of innovation active enterprises; tertiary level educational attainment; and labour productivity levels.<sup>ii</sup> Performance is being compared internationally, against 16 other small advanced economies.<sup>iii</sup> In addition, more granular innovation metrics have been specified to track performance: such as R&D conducted in the business and higher education sectors, the number of STEM graduates, and so on.<sup>iv</sup> These measures reflect a broad understanding of innovation, which extends from investing in research and technology to the development of new business models.

Furthermore, a number of 10X objectives have been set within the innovation pillar, for achievement by 2030: to increase total R&D expenditure by 55%; increase the number of R&D performing businesses by 450; increase the number of innovation active firms to 55% of NI businesses; 10% of NI businesses receiving innovation accreditation; and increase the proportion of individuals leaving NI Higher Education (HE) institutions with first degrees and post-graduate qualifications in narrow STEM subjects, from 24% to 27%.<sup>v</sup>

This Research Bulletin aims to contribute to this ongoing policy work by providing a sense as to how high-performing small advanced economies approach innovation policy, as well as recent innovation policy developments in response to a changing global economic and political context. Innovation policy has always been a central part of economic strategy in small advanced economies, but a more challenging international environment further increases its importance.

This paper is structured in three Parts. Part I discusses innovation performance in small advanced economies and outlines why innovation matters in a small advanced economy context. Part II discusses the key ways in which small advanced economy policy supports innovation, with a particular focus on recent developments in innovation policy. Part III outlines some of the possible insights/implications of this analysis for innovation policy in Northern Ireland.

## **I. Innovation Performance in Small Advanced Economies**

The international experience shows that innovation is central to the performance of small advanced economies. On multiple measures there is a close relationship between strong overall economic performance and innovation in small advanced economies.<sup>vi</sup>

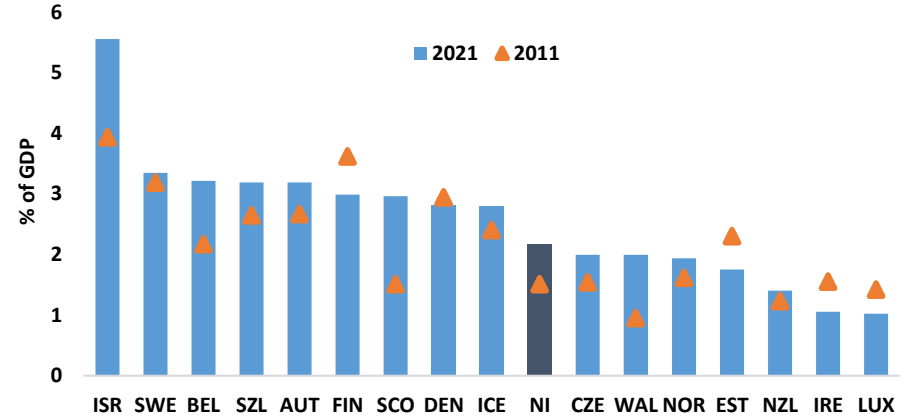
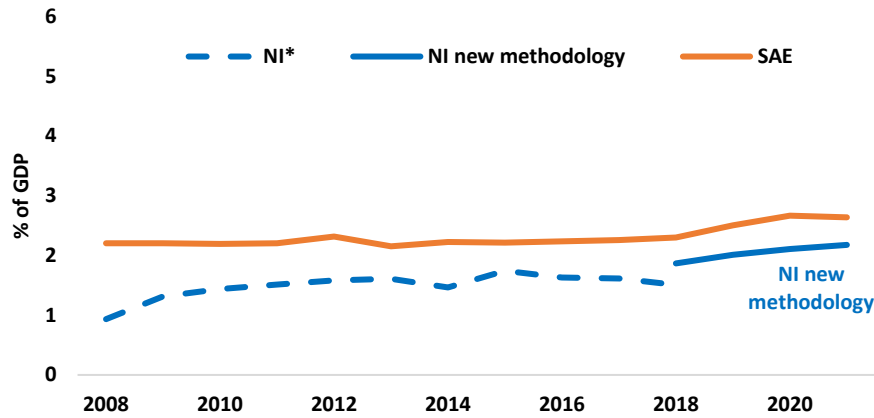
It is only those small advanced economies with strong innovation capabilities and performance that have been able to converge towards the per capita income frontier, and then sustain this position (unless they have natural resources). Variation in measures of innovation (R&D spending, Global Innovation Index rankings, and so on) have strong explanatory power over variation in per capita income across small advanced economies. Differences in innovation capabilities and outcomes explain why small advanced economies have a performance edge over their larger counterparts, as well as helping to explain the variation across small advanced economies.

Small advanced economies have an edge in terms of overall R&D spending as a share of GDP. For 2021, small advanced economy R&D spending was 2.7% of GDP, relative to 2.4% for the large advanced economy group (and 2.5% for the full OECD).

Over the next two pages, the performance of a number of small advanced economies<sup>vii</sup> is illustrated across four innovation metrics, with graphs showing the following:

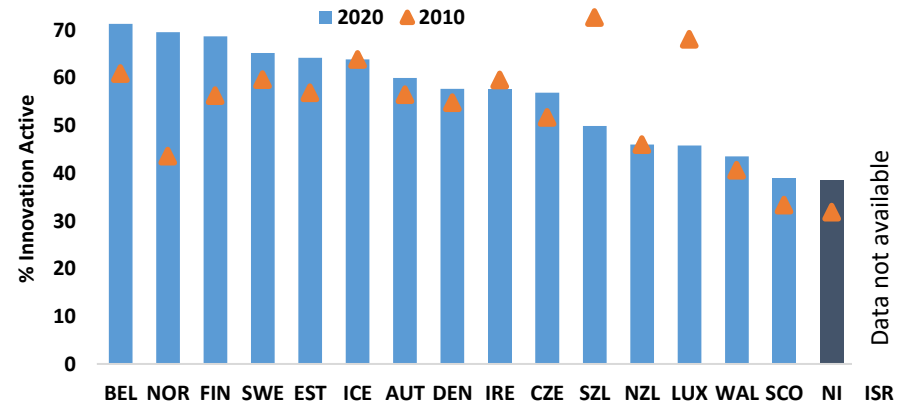
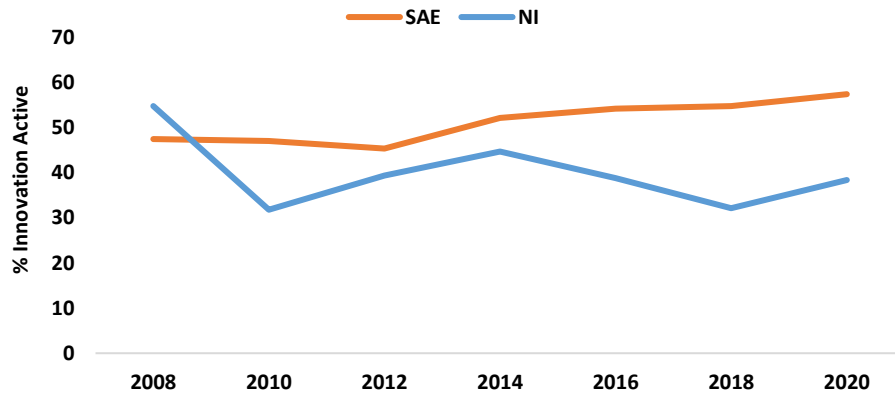
- **Gross Expenditure on R&D as a Percentage of GDP** – Northern Ireland lags slightly behind the small advanced economy (SAE) average, even after upwards revisions from ONS and NISRA, having recently amended their methodology in relation to R&D expenditure. Any comparisons with historic years should keep this in mind – namely for Scotland, Wales and Northern Ireland. Israel, Sweden and Switzerland perform well on this R&D measure. The Republic of Ireland is somewhat disadvantaged on this metric, with its relatively high GDP level. There is a big gap between high and low R&D spenders across the small advanced economy group. Small economies with weaker innovation performance (such as New Zealand) tend to lag on a range of economic outcomes.
- **Innovation Active Enterprises as a Percentage of Total Enterprises** – The Nordic countries tend to perform well in terms of innovation activity, with Estonia also good. Scotland, Wales and Northern Ireland perform less well, but comparability issues exist between figures for the UK regions (BEIS / ONS data) and other small advanced economies (mainly taken from Eurostat data).
- **Percentage of Population (25-64) with Tertiary Level Education (Level 5-8) [ISCED]** – Innovation can only happen given a workforce with the requisite skills (absorptive capacity) and “highly skilled individuals are key for the invention of new technologies, and for establishing and managing high performing businesses. More general workforce education... enables the diffusion of technologies and productivity enhancing practices through the economy.”<sup>viii</sup> Small advanced economies have tended to improve gradually on this indicator over the last decade, with Northern Ireland following this upwards trend. All figures have been taken from OECD, including Northern Ireland. Caution should be taken in respect of the most recent years’ data, which may be less reliable / accurate. Furthermore, as countries have different educational systems, it is difficult to match qualification and skill levels in one country or region with those in another.
- **Labour Productivity (US\$ Per Hour Worked)** – Northern Ireland has lagged behind the small advanced economy average on this indicator for many years, with Luxembourg, Norway and Denmark the top three performers. Estonia, Czechia, New Zealand and Israel stand out as having relatively low productivity when compared to the rest of the small advanced economies analysed.

Figure 1: Gross Expenditure on R&D as % of GDP



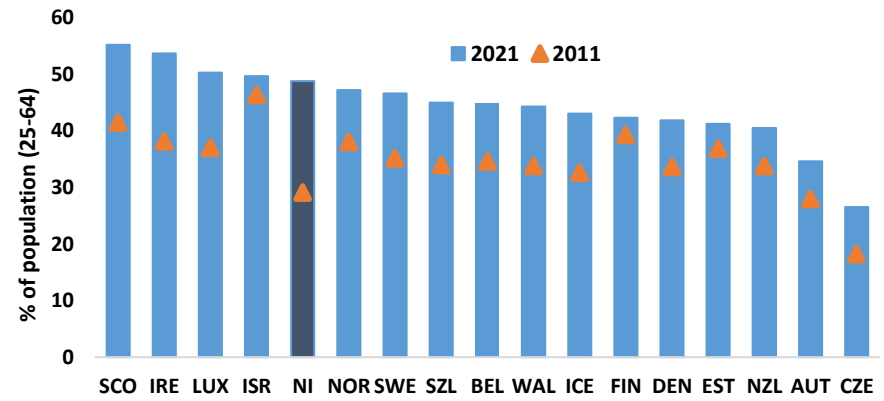
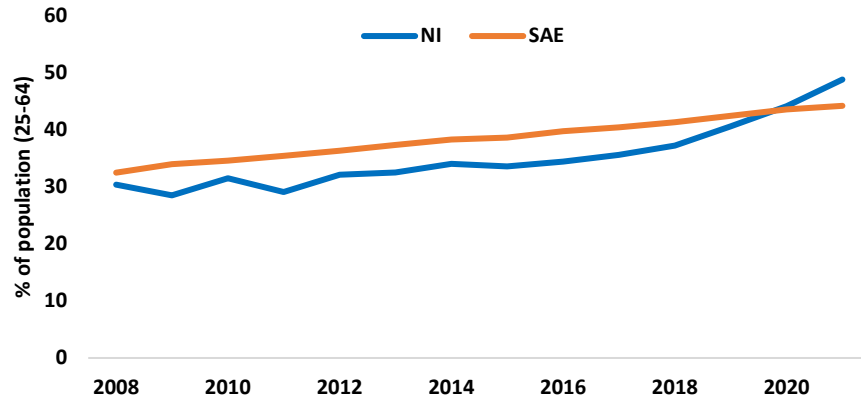
Sources: OECD<sup>ix</sup>, NISRA<sup>x</sup>

Figure 2: Innovation Active Enterprises as % of Total Enterprises



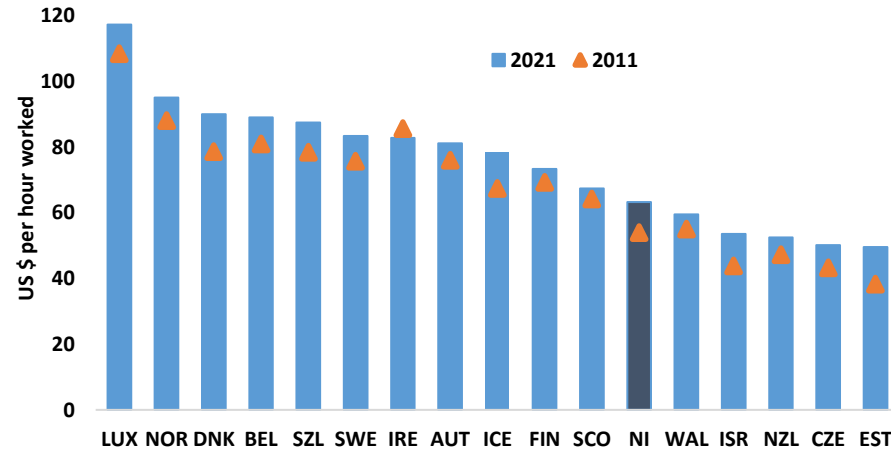
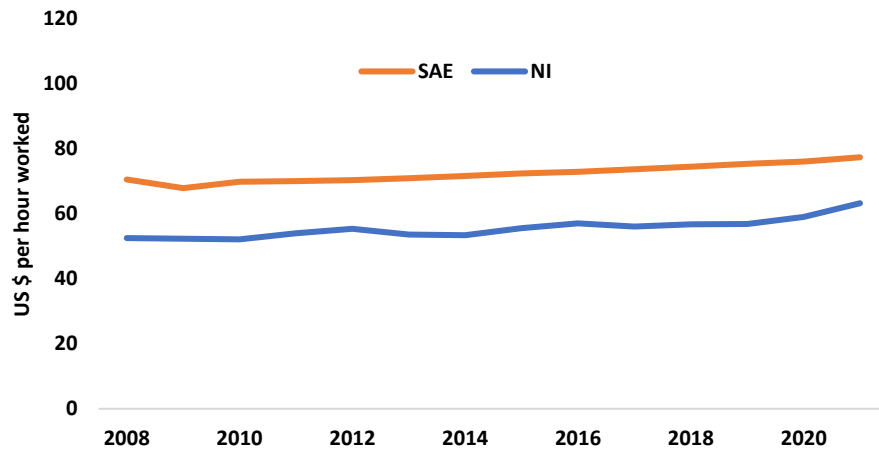
Sources: Eurostat<sup>xi</sup>, Gov.uk<sup>xii</sup>, Stats.govt.nz<sup>xiii</sup>

Figure 3: Percentage of Population (25-64) with Tertiary Level Education (Level 5-8) [ISCED Approach]



Source: OECD<sup>xiv</sup>

Figure 4: Labour Productivity (US\$ Per Hour Worked)



Sources: TED<sup>xv</sup>, ONS<sup>xvi</sup>

Of course, innovation needs to be defined broadly. Innovation extends beyond investing in R&D and technology, to include branding and design, the development of new business models, and so on. Different small economies perform better on different measures: Israel and Taiwan are technology intensive economies; whereas Switzerland, Denmark, and the Netherlands have strengths in technology but are also very good at extracting a premium for goods and services through well-developed brands and design.

According to the Department for the Economy's 10X Delivery Plan (July 2023) innovation is "doing something different that creates value". In its most basic form, innovation simply means the development of creative ideas into new products, services or ways of doing things. Whilst innovation includes areas like emerging technologies, and digital advancements, it also includes process improvements, data and analytics, skills and talent, flexible delivery and introducing new more agile ways of working, to name a few.<sup>xvii</sup>

Broadly-defined measures of innovation (such as the Global Innovation Index, and relevant pillars of the World Economic Forum's Global Competitiveness Index) show that small advanced economies perform strongly relative to their larger counterparts. Interestingly, there is a close mapping between R&D spending levels (an input measure) and broader innovation performance suggesting that high performing small advanced economies invest across multiple dimensions of innovation.

### **Why Does Innovation Matter in Small Advanced Economies?**

Innovation matters in small advanced economies in ways that are different to large economies, largely because of the importance of externally-oriented sectors.

#### **Externally-oriented sectors**

Externally-oriented activities are the productivity growth engine of small advanced economies. Without at-scale expansion into international markets, the ability of small economies to generate strong productivity growth is deeply constrained. Indeed, all episodes of above-trend growth rates in small advanced economies are due to periods of strong growth in externally-oriented sectors.

This is the context in which innovation matters: developing positions of competitive advantage in global markets is commonly built on innovation and knowledge (exceptions include where the economy has a substantial natural resource endowment). Without strong innovation performance, this competitive advantage is hard to acquire and sustain – it is not innovation intensity *per se* that matters for economic performance, but what it allows small economies to do in terms of developing competitive advantage.

Externally-oriented sectors are the key transmission mechanism between improved innovation investment and improved economic outcomes. Indeed, without improved international performance it is unlikely that

investment in innovation will deliver much upside. International performance (exports, outward FDI) is a useful overall measure of underlying innovation performance.

The importance of innovation for economic outcomes can also be seen in the time series variation of economic performance. Substantial, sustained improvements in per capita income are associated with sustained investment in innovation as it supports the developments of new strengths in the economy – and a rotation in the export structure towards knowledge intensive goods and services (including value driven by branding and other intangibles), which tend to be rapidly growing categories.

Finland is a good example of a small economy whose economic transformation from the early 1990s was based on heavy, sustained investment in innovation. In contrast, small advanced economies that have low levels of R&D intensity have experienced much less change in their export structures – and weaker productivity performance. New Zealand is an example of weak investment in innovation and weak innovation outcomes contributing to poor overall economic outcomes.

### **Domestic Sectors**

In small advanced economies, there is often a strong productivity gap between domestically and externally-oriented economies. Domestic sectors (retail, construction, and so on) tend to have particularly low productivity because of the absence of scale as well as weak competitive intensity. This means reduced incentives to adopt or develop new technologies, business models, and so on. This drags on overall economic performance; and can add to the overall cost structure of the economy (in turn, reducing the competitiveness of external sectors).

Given the weak productivity position of many domestic activities in small economies improving the innovation performance of large domestic sectors can make important contributions to overall productivity. However, the structural constraints of a small domestic market will continue to weigh, which will constrain the available productivity upside from innovation in the domestic economy.

## **II: Small Advanced Economy Approaches to Innovation Policy**

The centrality of innovation to small advanced economy performance means that innovation policy is also central to economic strategy in high-performing small advanced economies. Governments get involved in advanced economies – particularly in small advanced economies – because market-based incentives are not enough. There is evidence of substantial spillovers into the economy from R&D activities, which means that research and innovation activities are under-supplied by the market.<sup>xviii</sup> Firms also benefit from being in a high-innovation environment, but individual firms don't price these benefits.

There are several different ways in which small advanced economy governments support innovation, and these are discussed in the paragraphs below.

## **Funding**

Governments provide fiscal support to encourage innovation across the economy. The case for government support is even stronger in small economies, because of the specific challenges these economies face. The limited scale of domestic markets in small advanced economies makes the economics of investing in research and innovation more challenging: these investments are often risky and have a significant fixed cost component. Government support for business R&D is particularly important in small advanced economies to compensate for these constraints.

Indeed, government funding of R&D spending is slightly higher in small advanced economies than in larger economies. Government funding of R&D across small advanced economies is around 0.7% of GDP compared to an OECD average of 0.6%. Government funding is important to 'crowd in' broader private sector research funding in small advanced economies. Small economies will commonly have many small firms, which lack the financial resources (and relevant capabilities) to invest in R&D. The firm-level evidence shows consistently that large firms invest more in R&D than smaller firms. The implication is that government-funded R&D is particularly important in smaller economies.

There has been a marked shift in the way in which governments provide fiscal support to business R&D over the past two decades. The OECD 2020 Science, Technology & Innovation Outlook notes that "the measured R&D support policy mix has shifted towards a greater reliance on tax compared to direct support instruments".<sup>xix</sup> However, there is now concern that this lack of directionality from broad tax credits may have compromised the ability of governments to direct innovation support at economic and social priorities.

As a consequence, there is a growing focus on more targeted funding instruments (e.g. contestable grants, mission-oriented funds) that are given to specific firms or clusters of firms. This change in approach is relevant to small advanced economies. Their small scale means that they will often be focused on building competitive advantage in a limited number of innovation-intensive clusters in the economy. Although innovation is important across the economy, policy needs to have a more deliberate focus on the key growth engines of the economy. A disproportionate policy focus on a few clusters will be more likely to generate better innovation outcomes, and to crowd in private sector investment.

Providing grants or challenge funds around these priority clusters – or providing financial support for universities and research institutions to undertake research and innovation in these priority areas – is likely to be more important.



## **Research Universities**

Although business is the largest R&D actor in small advanced economies, higher education institutions play a significant role. About 25% of small advanced economy R&D spending is undertaken in higher education, a higher proportion than in larger economies. This reflects a different innovation growth model in small economies.

Indeed, one of the characteristics of small advanced economies that perform strongly in innovation outcomes is that they have world-class universities. On a per capita basis, small advanced economies have twice as many universities in the top 200 as larger advanced economies.

These universities and research institutions support the competitive strength of small advanced economies. They provide an ongoing stream of highly-skilled human capital to firms, which supports their competitiveness. And these world-leading universities also play an important role in the innovation ecosystem of key clusters in the economy, helping them to stay at the global innovation frontier. Firms will often collaborate on research and innovation projects, university research is more likely to be on topics of relevance to local firms, and so on. These institutions will commonly have strong linkages with the internationally oriented economic engines of the economy.

One interpretation of this is that small economy universities provide research critical mass in small economies, because of the relative lack of scale in the private sector. It may be the case that R&D in universities allows for scale in research to be achieved – as there will only be a few at-scale locations in a small economy context that can undertake cutting edge research.

## **Other Economic Policy Instruments**

Strengthening innovation, broadly defined, is about more than providing financial assistance. In small economies, with many firms that are relatively small, additional forms of support are required to deliver strong innovation outcomes. Innovation is a core focus of enterprise policy initiatives, with many enterprise policy agencies providing support (financial, advisory, capability building, network building) to client firms to help them develop broad innovation capabilities as part of their expansion journey. These initiatives can help firms to absorb new ideas and business models from elsewhere, as well as to develop new ideas.

Choices about economic structure can have a meaningful impact on innovation outcomes in small advanced economies. For example, some sectors have a higher R&D intensity than others: pharmaceuticals are more R&D intensive than agriculture, for example. It is encouraging that the key clusters or sectors in the 10X Delivery Plan (July 2023) document have high levels of innovation intensity: Life & Health Sciences, Agri-

Tech, Software & AI (including cyber), Advanced Manufacturing & Engineering, Low Carbon, FinTech/ Financial Services and Screen Industries (including Virtual Production).<sup>xx</sup>

FDI attraction efforts that focus on bringing innovation-intensive activities with spillover potential to Northern Ireland are also likely to have a meaningful impact on innovation outcomes. Attracting knowledge intensive FDI activities to Northern Ireland can help to provide critical mass, providing an anchor for the relevant clusters.

Other actions to support externally-oriented activity in Northern Ireland are likely to have a positive effect on research and innovation intensity. Externally-oriented firms need to be close to the innovation and productivity frontier in order to be able to compete successfully (and on a sustained basis) in international markets: this creates an incentive for these firms to invest heavily in research and innovation relative to firms focused on domestic markets.

International engagement is also a support in building innovation engagement. In small economies, knowledge diffusion happens through international engagement; little of the global stock of ideas, business models, and so on will originate in Northern Ireland. Firms will absorb these ideas from international competition and presence in global markets.

And lastly, innovation in small advanced economies tends to happen in dense clusters – where there are strong backward and forward linkages, deep pools of labour, supporting services, and the potential for substantial knowledge diffusion. An economy that is characterised by these deep clusters is likely to have much stronger innovation capabilities and performance.

Government action is required in a small economy context because there are constraints on the extent to which these clusters will emerge as a consequence of market forces. In large economies, these clusters are more likely to develop organically because critical mass can be reached in multiple areas. However, this is much less likely in small advanced economies. Choices will frequently need to be made in terms of which clusters to support: small economies cannot be good at everything and are often ‘doomed to choose’. In small economies, there will only be a limited number of areas in the economy where these clusters can develop at scale. This is a key reason for policy focus on strategic policy areas in small advanced economies.

This is why Northern Ireland’s strategic decision to focus around specific clusters / sectors is important. The functioning of these seven, innovation-intensive clusters / sectors will be central to Northern Ireland’s ability to deliver markedly better innovation outcomes. Northern Ireland policy should focus clearly on these high-innovation parts of the economy, attract innovation intensive firms in these areas to locate in Northern Ireland, and work to encourage greater depth and scale in the selected clusters.

## Recent Innovation Policy Developments in Small Advanced Economies

Over the past decade, there has been a generally increasing R&D share of GDP, although with variation across advanced economies. This reflects the increased appreciation of investment in innovation in driving performance. Indeed, the OECD reports that R&D spending was resilient through the pandemic despite the significant fiscal pressures.<sup>xxi</sup>

The centrality of innovation to economic performance is likely to strengthen further in the post-Covid environment. The pandemic has compressed the timelines for a transition to a digital economy, with substantial investments in automation and digital technologies to support remote working and e-commerce. Developing positions of strength in these activities will likely require additional investments in research and innovation.

Looking forward, this emphasis on innovation policy is likely to continue to strengthen. Developments in technology such as AI and automation mean that many firms will need to invest in innovative business models, as well as new goods and services, in order to retain a competitive edge.

In addition, emerging frictions on globalisation mean that firms need to strengthen positions of competitive advantage in order to offset the costs: there will be increased supply chain costs and inefficiencies in international trade, which means that small economy firms will need to be even more productive to compete. Other economies, from the US and EU to China, are investing substantial amounts in industrial and innovation policy – for both economic and political reasons – in order to position themselves to dominate key areas of the global economy.

There are some scale economies in terms of funding for research and innovation. Small advanced economies – and small economy firms – will need to over-invest, and to do so in a targeted manner behind areas of competitive strength in order to compete against the investments being made by these big economies.

Recent government policy statements suggest that innovation policy is receiving more emphasis in many advanced economies – including in small advanced economies. For example, Finland has committed to additional government funding in order to achieve a new target of R&D spending of 4% of GDP by 2030.<sup>xxii</sup> Singapore announced increased investment in R&D – and broader innovation policy support – as a core part of its recovery plan from the pandemic, and also in response to the changing global landscape. And many European governments are investing substantial amounts in innovation around the net zero transition in areas from green hydrogen to batteries.<sup>xxiii</sup>

Overall, small economies are strengthening their commitment to innovation policy and funding in order to respond to competitive and political pressures in the global system.

### III. Implications for Northern Ireland

Northern Ireland's current state on innovation is mixed. There are some distinctive innovation capabilities around key clusters and in research universities. But Northern Ireland's R&D spending, which have been markedly revised up to 2.2% of GDP in 2021, remains below the small advanced economy average (2.7%).<sup>xxiv</sup> Overall, Northern Ireland lags on innovation performance. Although there are several areas of competitive strengths in externally-oriented sectors, these are not of a scale seen in many other small advanced economies.

Given Northern Ireland's aspirations for economic transformation (that were clear from the 10X Vision), this small economy experience demonstrates that significant improvements in innovation performance will be needed. Strengthening innovation performance has long been seen as important in strengthening Northern Ireland's overall economic performance. Many of the statements of strategic direction in 10X as well as the specific initiatives, are useful in this regard.

The urgency around this innovation agenda has increased given the changing global economic and political environment: from the need to compete with more aggressive industrial and innovation policy across many larger advanced economies – as well as the need to take advantage of Northern Ireland's distinctive position in the post-Brexit environment. Attracting investment needs to be based on a strong competitive advantage, which will generate strong innovation capabilities.

Greater government investment in R&D – financial support for businesses, funding for universities and other research institutions, as well as direct government R&D spending – is an important part of national innovation agendas across high performing small advanced economies. But aggressively increasing public R&D funding will be challenging for Northern Ireland, given its budgetary position.<sup>xxv</sup>

Opportunities for increased fiscal support of research and innovation should be seized where they exist, including from the City & Growth Deals and various Levelling Up initiatives. But to the extent that this funding is not available, additional structural responses will be needed to accelerate Northern Ireland's economic transformation. Consider a few areas for focus.

First, enterprise policy focused on strengthening innovation performance of firms that are expanding into international markets. As noted above, internationalisation is the key transmission mechanism for innovation policy to generate stronger economic outcomes. Without internationalisation, the benefits of innovation policy will be limited. Providing capability building, advisory support, and network building can be effective modes of strengthening innovation, broadly defined.

Second, strengthening the links between universities/research institutions and business – and strengthening areas of research strength that map against the selected priority clusters – should be a priority. Northern Ireland performs well on a per capita basis, with Queen’s University Belfast ranking in the top 200 Universities in the world.<sup>xxvi</sup> And both Queen’s University and Ulster University have specific areas of world-class strength, as well as a track-record in creating start-ups. These assets and capabilities should be leveraged as much as possible, prioritising relevant areas of research, as well as to support interaction between the research and business sectors. This will likely increase the extent of collaboration and deliver better innovation outcomes. In an economy of Northern Ireland’s size, these institutions have critical mass, international connections, and the ability to anchor clusters.

Third, make cluster development a key part of economic strategy – as has been signalled in the 10X Economy strategy. Choices about economic structure can have a meaningful impact on innovation outcomes in small advanced economies. For example, FDI attraction efforts should focus on innovation-intensive activities with spillover potential – and also try to extract commitments from these firms on undertaking innovation-intensive activity in Northern Ireland. Attracting knowledge intensive FDI activities to Northern Ireland can help to provide critical mass, providing an anchor for the relevant clusters.

This is why the strategic direction in 10X to focus on priority clusters is important. The functioning of these innovation-intensive clusters will be central to Northern Ireland’s ability to deliver markedly better innovation outcomes. Northern Ireland policy should focus clearly on these high-innovation parts of the economy, attract innovation intensive firms in these areas to locate in Northern Ireland, and work to encourage greater depth and scale in the selected clusters.

So far, 50 different actions have been outlined within the innovation pillar by the Department for the Economy in the 10X Delivery Plan. They have been categorised into four areas: Research & Development; Innovation Driven Enterprises; Comprehensive Innovation; Skills & Talent. However, the 10X Delivery Plan does stress that this is just a first stage of 10X innovation.<sup>xxvii</sup>

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- i [10X Economy - an economic vision for a decade of innovation \(economy-ni.gov.uk\)](https://economy-ni.gov.uk).
- ii [10X Delivery Plan 2023/24 \(economy-ni.gov.uk\)](https://economy-ni.gov.uk)
- iii [Measuring Success - 10X Metrics to achieve a 10X Economy \(economy-ni.gov.uk\)](https://economy-ni.gov.uk)
- iv [Measuring Success - 10X Metrics to achieve a 10X Economy \(economy-ni.gov.uk\)](https://economy-ni.gov.uk)
- v [10X Delivery Plan 2023/24 \(economy-ni.gov.uk\)](https://economy-ni.gov.uk)
- vi David Skilling, 'The relationship between exports, innovation, & productivity in small advanced economies: Implications for Northern Ireland', prepared for the Department for the Economy, March 2023.
- vii The small advanced economies used for comparison are: Austria (AUT), Belgium (BEL), Czech Republic / Czechia (CZE), Denmark (DEN), Estonia (EST), Finland (FIN), Iceland (ICE), Republic of Ireland (IRE), Israel (ISR), Luxembourg (LUX), New Zealand (NZL), Norway (NOR), Sweden (SWE), Switzerland (SZL), Scotland (SCO), Wales (WAL), Northern Ireland (NI).
- viii [Regional absorptive capacity report \(royalsociety.org\)](https://royalsociety.org)
- ix [Main Science and Technology Indicators \(oecd.org\)](https://oecd.org)
- x [NI Research & Development 2021 Detailed Results.xlsx \(live.com\)](https://live.com)
- xi [Statistics | Eurostat \(europa.eu\)](https://europa.eu)
- xii [UK Innovation Survey - GOV.UK \(www.gov.uk\)](https://www.gov.uk)
- xiii [Business operations survey: 2021 | Stats NZ](https://stats.nz)
- xiv [OECD](https://oecd.org)
- A) education and training -> education at a glance -> adult educational attainment and outcomes -> educational attainment and labour force status -> educational attainment of 25-64 year olds.
- B) education and training -> education at a glance -> subnational data -> regional education -> educational attainment of the population by age group.
- xv [Total Economy Database™ - Data | The Conference Board \(conference-board.org\)](https://conference-board.org)
- xvi [Regional productivity time series - Office for National Statistics \(ons.gov.uk\)](https://ons.gov.uk)
- xvii [10X Delivery Plan 2023/24 \(economy-ni.gov.uk\)](https://economy-ni.gov.uk)
- xviii Benjamin Jones and Larry Summers, 'A Calculation of the Social Returns to Innovation', NBER Working Paper 27863, September 2020.
- xix OECD, Science, Technology, & Innovation Outlook 2020, January 2021.
- xx [10X Delivery Plan 2023/24 | Department for the Economy \(economy-ni.gov.uk\)](https://economy-ni.gov.uk)
- xxi [Science, Technology and Innovation Outlook 2023 - OECD](https://oecd.org)
- xxii [Central government debt management – The national plan to raise R&D funding \(treasuryfinland.fi\)](https://treasuryfinland.fi)
- xxiii [Research Bulletin 22/8 - Integrating Sustainability into the 10X Agenda \(economy-ni.gov.uk\)](https://economy-ni.gov.uk)
- xxiv [Regional productivity time series - Office for National Statistics \(ons.gov.uk\)](https://ons.gov.uk)
- [NI Research & Development 2021 Detailed Results.xlsx \(live.com\)](https://live.com)
- xxv [Department of Finance statement on 2023/24 Northern Ireland Budget \(finance-ni.gov.uk\)](https://finance-ni.gov.uk)
- xxvi [Queen's University Belfast | World University Rankings | THE \(timeshighereducation.com\)](https://timeshighereducation.com)
- xxvii [10X Delivery Plan 2023/24 \(economy-ni.gov.uk\)](https://economy-ni.gov.uk)