Research Bulletin 26/2 | Innovate UK Support & Northern Ireland Life Sciences

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Summary

Innovate UK (IUK) is the principal national support agency for business-led Research, Development and Innovation (RDI) activities. RDI activities are a key driver of long-term productivity growth[i] which is a key objective of the Department for the Economy's Economic Vision[ii] and the NI Executive's Programme for Government.[iii]

Using participant level data on IUK awards, this Research Bulletin provides an analysis of historic trends in IUK support in Northern Ireland (NI). Linkage of the data to the Companies House registry permits analysis of trends by key industries. The final part of this paper looks at trends in IUK support to the Life Sciences sector and the potential for this to translate into wider knowledge spillovers in the rest of the economy.

Introduction

Innovate UK is a constituent body of UK Research & Innovation (UKRI), which is responsible for providing financial and technical support to business led RDI activities.[iv] IUK funding is typically awarded via open competitions, subject to an independent expert assessment of the viability and commercial potential of a project relative to others.[v] [vi]

Competitions can range from broad, flagship innovation support and knowledge transfer initiatives, to funds designed to address a specific commercial or technical issues relevant only to one market. IUK publishes detailed participant level data of awards that it has granted since its founding in 2004.[vii] [viii]

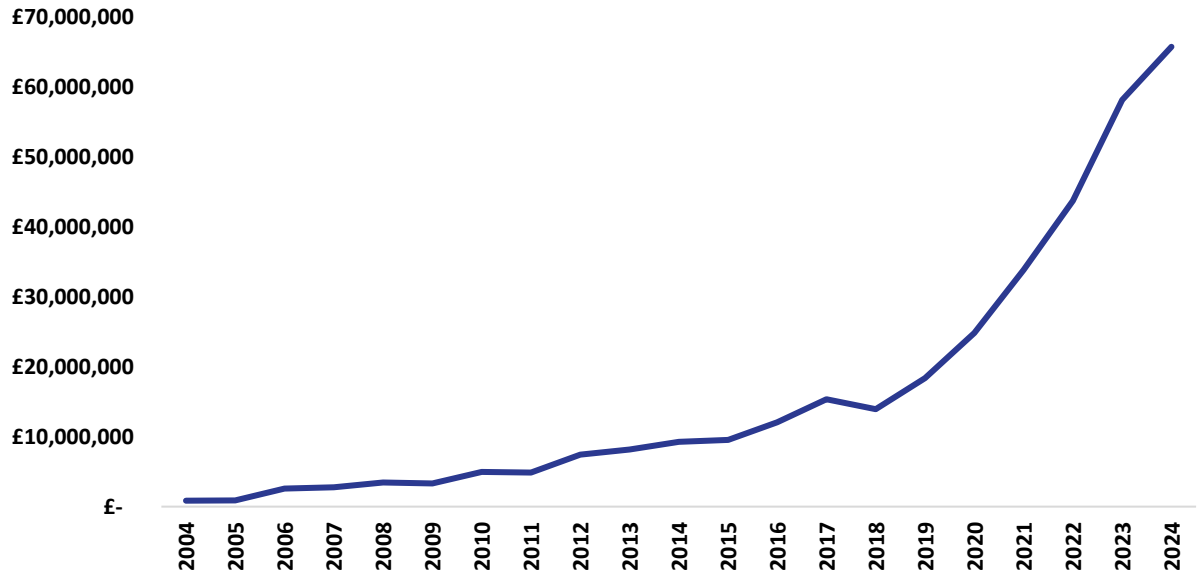
IUK's core budget has increased significantly since 2018, and UKRI is in the process of transitioning towards a new funding model which will place more emphasis on support to RDI activities with commercial potential, over curiosity-driven research.[ix] Together with current constraints on NI Executive finances,[x] these changes mean that IUK funding is likely to become a more important source of funding for Northern Ireland RDI activities.

Analysis of historical trends in IUK support can help to identify areas of comparative advantage and as such, design a complementary local policy response to changes in UKRI's funding model. This will ensure that available funding for future Northern Ireland RDI activities is both maximised and well-aligned with NI Executive priorities.

Headline Trends

Projects funded by IUK can vary in duration and a relatively small number of long-term supported projects can significantly affect total funding in any given financial year. To better illustrate trends in historical IUK support, we pro-rata the value of funding offers[xi] over the calendar years that supported projects take place. This is shown in Figure 1 below.

Figure 1: Value of Innovate UK Offers of Funding to NI Registered Participants (2024 Prices)



Source: Innovate UK Funded Projects Since 2004.

The value of IUK offers to NI participants has increased significantly since 2004, peaking at just under £65.8mn in 2024. The uptick from 2018 to 2024 coincides with a period of sustained growth in IUK's core budget. Between 2018 and 2024, the value of funding offers increased by 29.7% (in real terms) on an annual average basis.

Funding offers to small and medium sized businesses (SMEs) were the predominant driver of this growth, increasing from £3.1mn in 2018 to £28.5mn in 2024. The growth in funding for SMEs mirrors trends for the UK as a whole. Between 2018 and 2024, the growth in SME offers accounted for about half (47.0%) of total growth in the value of all IUK offers.

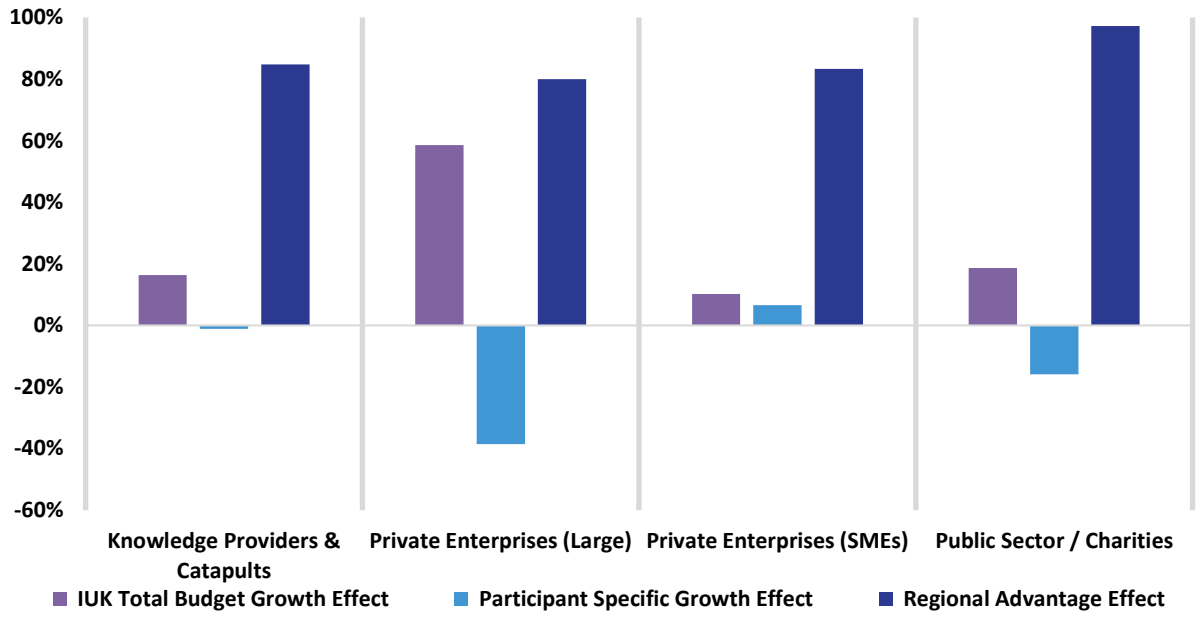
Compared to the UK as a whole, SMEs account for a larger share of total IUK funding offers in NI (43.4% in 2024 vs 36.3% for the UK as a whole). This is consistent with other evidence which highlights the particular importance of SMEs to NI's R&D ecosystem. Between 2022 and 2024, SMEs accounted for 45.7% of total business R&D expenditure in NI[xii], around 10 percentage points more than their share of UK spending.[xiii]

There is also some evidence that IUK funding to NI SMEs has been more resilient compared to other UK regions. Between 2021 and 2022, the value of all IUK funding to SMEs fell by £155m, with NI being one of

only two UK regions to defy this trend. Over this period, NI's share of all UK SME offers increased from 2.3% to 3.1%.

Given the significant growth in IUK's budget since 2018 and the ongoing shift in national policy focus towards small business led innovation,[xiv] it is useful to understand how much of the growth in IUK support to NI can be explained by these two factors. Figure 2 plots the results of a shift-share decomposition[xv] of the growth in funding offers from 2018 to 2024, split by different participant types.

Figure 2: Shift Share Decomposition in Value of IUK Offers (2018 – 2024); NI: By Participant Type



Source: DfE analysis of IUK funded projects since 2015/16 – 2024/25.

The decomposition shows what proportion of growth in offer values has been driven by three different components. The proportion explainable by the general increase in IUK's budget growth is due to national shifts in funding towards different participant types and a 'regional advantage' effect. The regional advantage effect is the dominant contributor to growth in funding across all participant types.

Some recent IUK competitions restrict their eligibility to activities that take place in NI[xvi] (the Northern Ireland Life & Health Sciences Launchpad[xvii] being an example). These types of IUK competition are much less common compared to those without a geographic focus[xviii] and account for a modest share of total funding (around 7.2% in the financial year 2024/25).[xix]

Analysis of participant level award data indicates that growth in offers to SMEs has primarily been driven by firms that have previously received an offer of IUK funding rather than a broadening base of participants. In 2018/19 around 28.0% of the value of offers to SMEs were made to firms that had previously received some

form of IUK support, rising to 76.6% in 2024/25. Over the same period, the median value of offers to prior recipients increased from around £109,000 to £241,000.

This suggests that the bulk of regional growth in IUK funding is due to improved competitiveness amongst NI applicants, either due to improved viability and impact of their own projects or through selecting into more impactful, high-potential collaborations with other participants. There are other potential explanations of regional growth, such as increases in the number of applications, however without access to application-level data it is not possible to substantiate their impact.

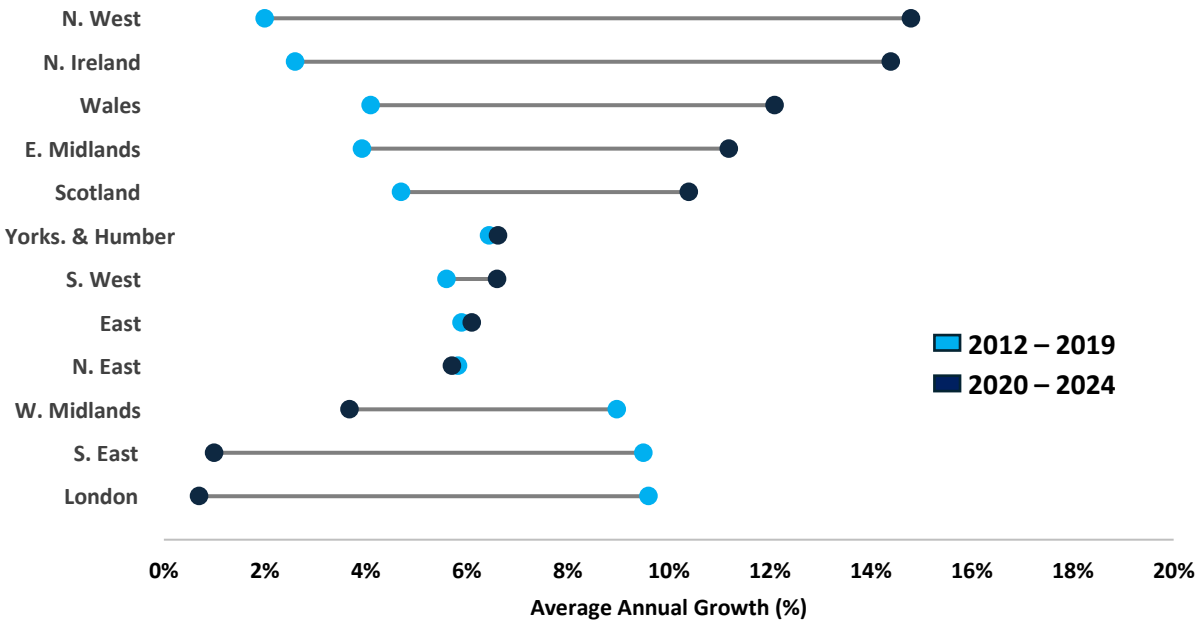
The conclusion that NI's recent growth in IUK support has been underpinned by a small cadre of 'repeat customers' coheres with wider trends in regional RDI activity. Between 2018 and 2022, the business innovation activity rate fell from 38.0% to 32.0% [xx] and the number of R&D companies fell from 1,182 in 2022 to 831 in 2024.[xxi]

UK Regional Performance

NI's share of the pro-rata value of all IUK funding offers has increased steadily since 2018; rising from 0.9% to 2.8% in 2024, twice the region's share of all UK business R&D expenditure (1.4%).[xxii] In line with the role of increased competitiveness amongst NI SMEs, their share of total IUK funding to small businesses has grown faster than average, from 0.9% in 2018 to 3.4% in 2024.

Analysis of UK regional trends can further contextualise NI's recent performance in attracting IUK support. Figure 3 plots annual average rates of growth in the pro-rata value of IUK offers for UK regions from 2012 to 2019 and from 2020 to 2024.

Figure 3: AAR Growth in Pro-Rata Value of IUK Offers by UK Region



Source: DfE analysis of Innovate UK funded projects since 2004.

Average annual growth in NI IUK offers has accelerated significantly since the pandemic. From 2020 to 2024, NI had the second highest rate of growth in the value of IUK offers (albeit from a low base), behind only the North West of England. At the same time, there has been a shift away from areas that have historically been major recipients of IUK funding. London's annual average growth in the value of IUK offers fell from 9.6% over 2012 to 2019, to just 0.7% since 2020.

Although the Greater South East of England[xxiii] still accounts for over a third of total IUK funding offers, this share has declined since 2018 (40.7% to 35.7%), suggesting that the recent profile of IUK activities has become more regionally diversified.

Trends by IS-8 Industry

IUK awards and transparency data do not record the main economic activities of participants as standard. Through linkage of the awards data to the Companies House registry[xxiv] (via The Data City[xxv]), we can assess recent trends in IUK support to enterprises by industry.

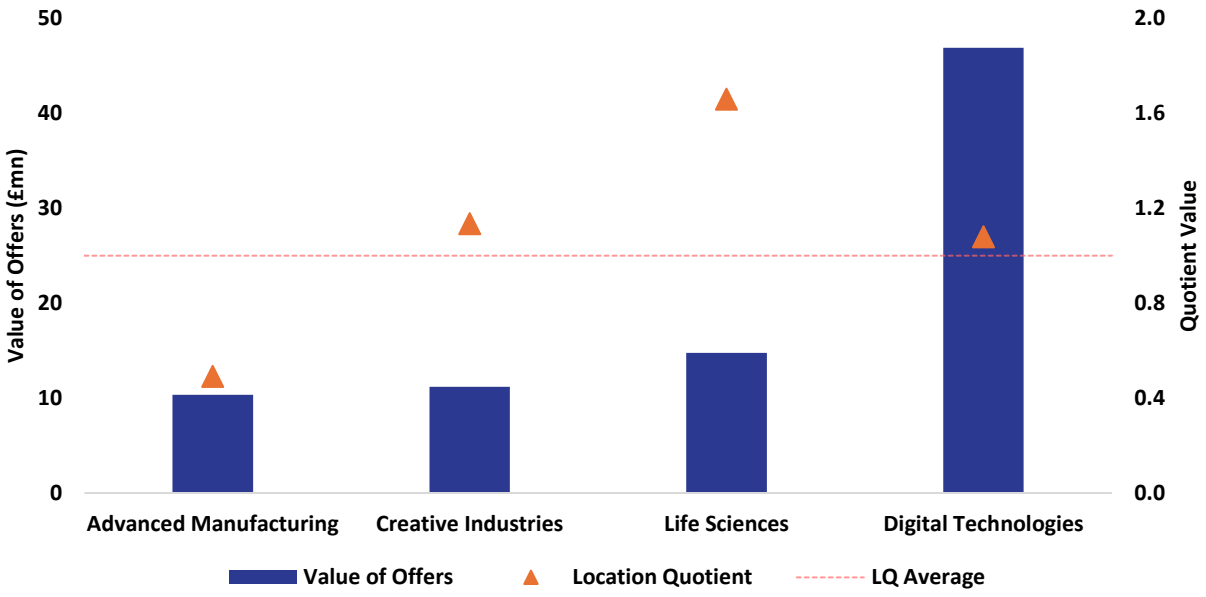
As part of ongoing efforts to align public RDI funding with the objectives of the UK Modern Industrial Strategy,[xxvi] IUK support is becoming more targeted towards key industries designated as important for UK economic growth (IS-8 sectors).[xxvii] Given that these industries are likely to benefit from increased future support, it is useful to understand the prior extent of IUK funding to these sectors and whether any sectors might represent a particular area of specialisation for NI.

IS-8 sectors are distinct from DfE's own Priority Sectors[xxviii] which are industries that have been designated as key drivers of local economic growth. There can be a high degree of overlap between DfE's priority sectors and their nearest IS-8 equivalent.

IUK has identified six of the eight Industrial Strategy sectors as within their competence. These are: Advanced Manufacturing, Clean Energy, Creative Industries, Digital Technologies, Defence and Life Sciences. We define these industries based on the UK Government's SIC07 proxy definitions[xxix] (see Annex). This may exclude certain activities in 'frontier industries' which form part of the larger sector but are difficult to accurately measure through use of the SIC07 classification system and as such, estimates in this section should be viewed as approximate.

The Defence and Clean Energy sectors are excluded from this analysis due to the nature of these activities cutting across a wide range of SIC07 classifications. Figure 4 shows the value of IUK offers (to enterprises) by selecting IS-8 sectors in NI from Competition Years 2022/23 to 2024/25.

Figure 4: IUK Value of Offers to IS-4 Industries in NI (2022/23 to 2024/25) & Location Quotients



Source: DfE analysis of Innovate UK funded projects 2015/16 to 2024/25 and Companies House Registry data.

Digital Technologies were by far the most supported IS-4 sector within IUK's current policy focus, with the value of offers amounting to over £46.9mn, around 56.3% of offered funding to all IS-4 industries. However, this may reflect the fact that the definition is much broader compared to more specialised sectors like Life Sciences and Creative Industries. Life Sciences were the next most supported IS-4 at £14.8mn in offered funding.

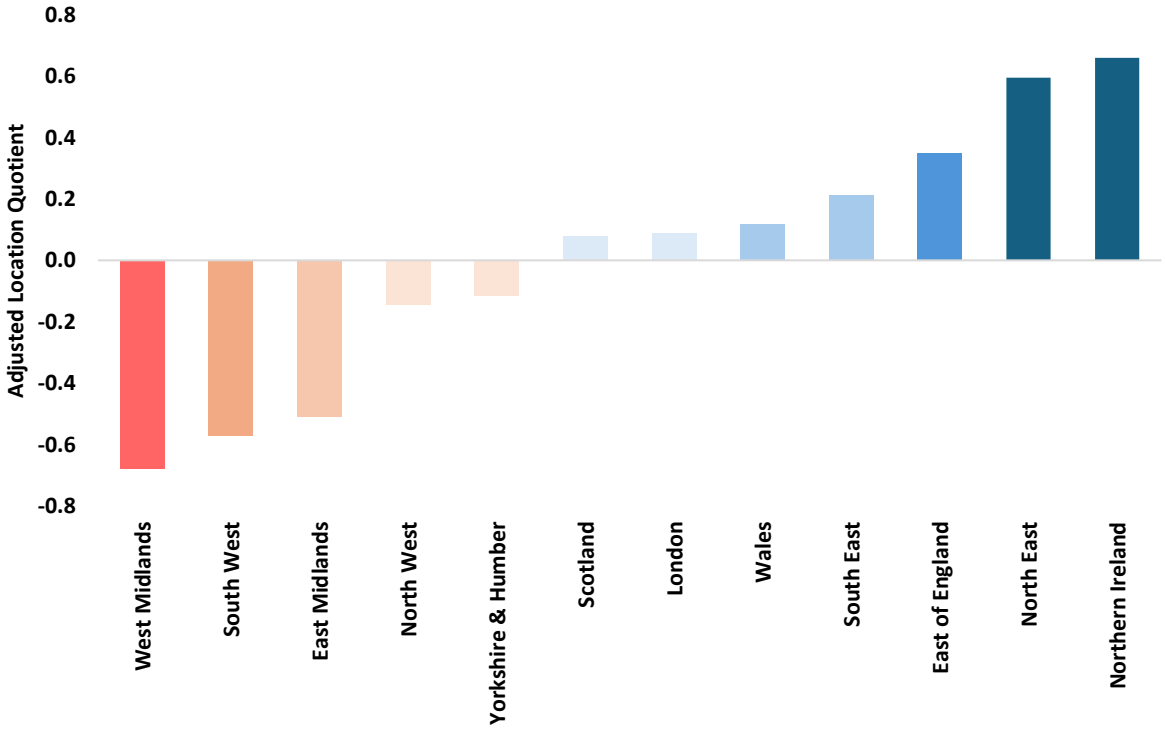
Figure 4 also plots Location Quotients for each industry. These statistics measure an industry's share of regional IUK funding compared to their share of national funding.[xxx] As IUK awards are typically

competitive and open to application from any UK region, they can be read as an indicator of which IS sectors NI has a particular comparative advantage in.

The results suggest that Life Sciences are a particular area of specialisation for NI within IUK's current priority industry policy focus. The Location Quotients for the Digital Technologies and Creative Industries sectors also suggest an over-concentration of funding, although not to an exceptional degree. The results for the Life Sciences sector are upwardly affected by recent IUK competitions that are specifically designed to benefit NI-based Life Sciences activities (e.g. Launchpad and New Innovators in Life & Health Sciences Northern Ireland).[xxxi]

These competitions account for around a fifth of the value of offers to the sector, but the over-concentration of IUK funding persists even after excluding them from sector totals. Figure 5 plots adjusted Location Quotients[xxxii] for IUK funding offers to Life Sciences enterprises by UK region. A negative signifies an under-concentration of IUK funding to the sector and a positive value suggests an over-concentration / specialization in Life Sciences RDI activity.

Figure 5: Adjusted Location Quotient – IUK Value of Offers (Competition Year Basis) to Life Sciences SICs by UK Region



Source: DfE analysis of Innovate UK funded projects 2015/16 to 2024/25 and Companies House Registry data.

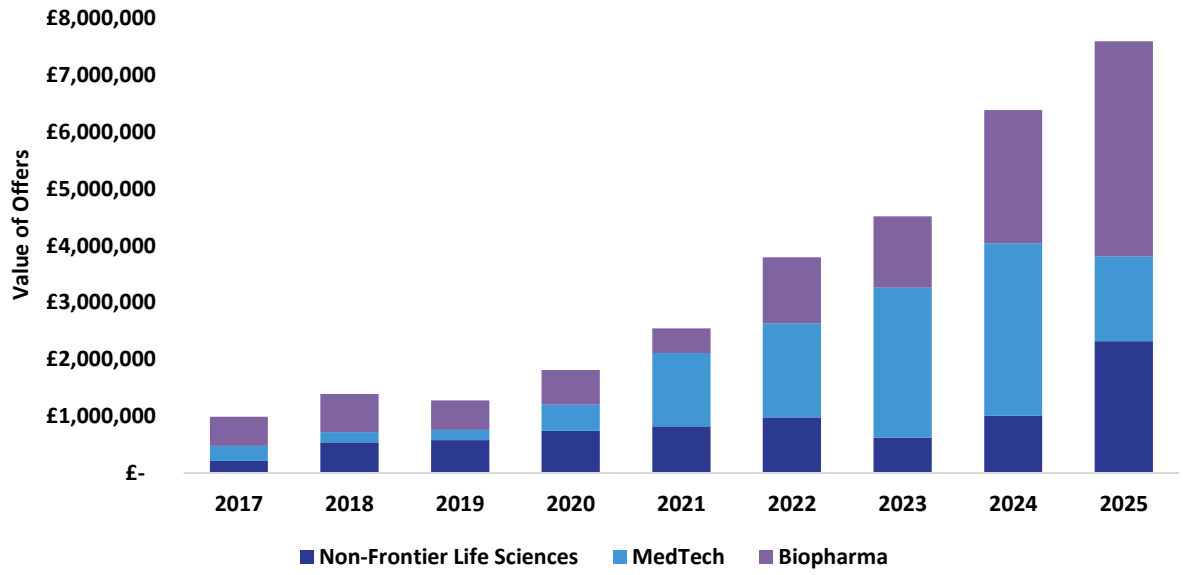
From 2022/23 to 2024/25, Northern Ireland had the largest relative concentration of IUK funding to Life Sciences SIC07 sectors. This supports the conclusion that the industry represents a key area of

comparative advantage in nationally focused IUK competitive funding. Given this apparent degree of specialisation, it is worth exploring recent trends in IUK support to the sector in more detail.

Innovate UK and Northern Ireland Life Sciences

Figure 6 shows the pro-rata value of IUK offers to NI registered enterprises that fall within the UK Government definition of the Life Sciences activity. This includes enterprises that sit within a list of SIC07 designations (see Annex) and firms in 'frontier industries', advanced and cutting-edge sub-sectors within the Life Sciences sector. Frontier Industry participants[xxxiii] are identified based on The Data City's proprietary Real Time Industry Classification (RTIC) system.[xxxiv]

Figure 6: Pro-Rata Value of IUK Offers to Life Sciences SIC07 Enterprises and Frontier Industry Firms



Source: DfE analysis of IUK awards data, Companies House Registry & Data City RTICs.

The value of IUK offers (on a pro-rata calendar year basis) to NI Life Sciences enterprises has increased significantly since 2017, with annual average growth of 30.4%. The value of IUK offers as a proportion of total Life Sciences project costs amounted to an average of 72.9%.

As might be expected, IUK support to enterprises in the sector skews heavily towards specialised frontier activities with support to Biopharma and MedTech firms accounting for 70.7% of total industry funding on average. Biomedical Catalyst competition rounds[xxxv] and Strength in Places[xxxvi] awards are major sources of funding for both frontier sectors and the growth in Biopharmaceutical funding offers since 2023 partly reflects greater participation in recent regionally targeted initiatives (e.g. Launchpad – Life & Health Sciences NI).

As with the wider IUK recipient population in NI, awards to smaller businesses account for a large proportion of IUK funding to Life Sciences enterprises. Over the period 2017 to 2025 awards to SMEs

were around 64.6% of total awards offered to enterprises. The geographic distribution of awards is heavily concentrated in Belfast, with enterprises in the region receiving an average of 72.9% of the total value of funding offers to NI Life Sciences firms. This share has also increased over time from 34.3% in 2017 to 72.5% in 2025.

R&D performing firms have a tendency to co-locate,[xxxvii] particularly where firms operate in similar or adjacent markets. This helps to reduce costs by ensuring access to a shared pool of specialised labour or through supporting economies of scale in shared suppliers.[xxxviii] The high concentration of IUK funding to Life Sciences enterprises in Belfast would therefore not be unexpected, but it may have negative implications for how widely distributed the impacts of supported activity are.

Potential for Wider Knowledge Spillovers

The rationale for public support to private R&D activities is because social returns to R&D exceed private returns (around twice as high on average according to recent research).[xxxix] This is because of the effect of knowledge spillovers, where knowledge generated from R&D performed by one organisation benefits others [xl] (e.g. by facilitating the development of new products / services or by improving the efficiency of current production).

There is no universally accepted method for quantifying social returns to publicly supported R&D [xli] and doing so is beyond the scope of this research. We can however explore some of the factors that make knowledge spillovers more likely to occur in relation to IUK support for RDI activities in the Life Sciences sector.

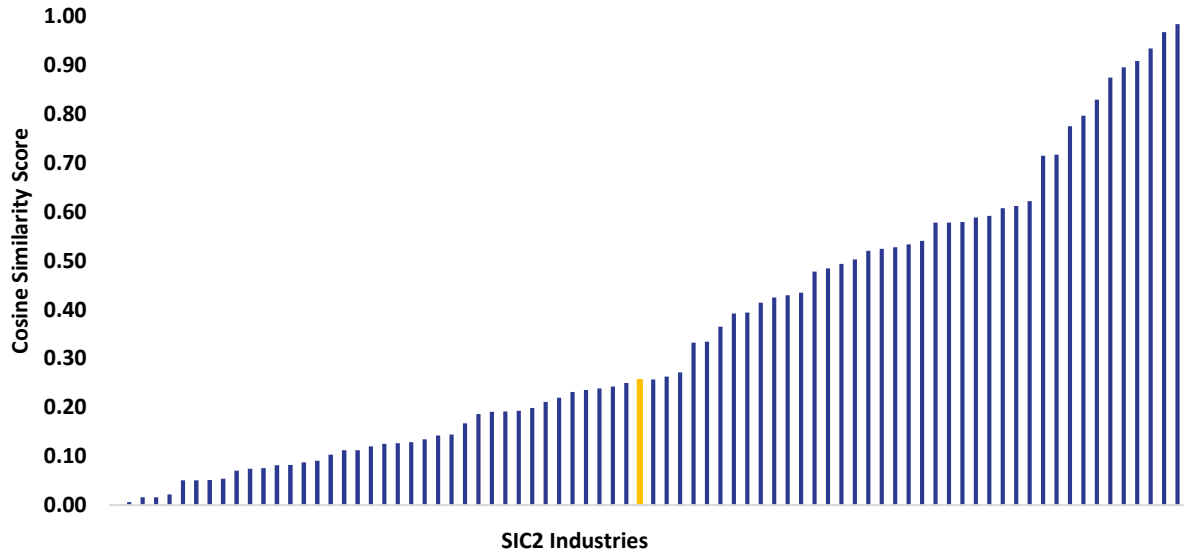
Benefiting from R&D performed by other organisations requires sufficient absorptive capacity. This refers to the receiving firm's ability to understand, internalize and apply external knowledge to their own production and processes.[xlii] Absorptive capacity is influenced by a number of factors including whether the firm is undertaking R&D itself, the capability of firm management and whether the workforce of the firm has the skills and knowledge needed to recognize and understand new, external knowledge.[xliii]

Generally, where the profile of skills and labour demand of a recipient firm is similar to the firm generating new knowledge, this is more likely to translate into positive knowledge spillovers.[xliv] Using data on employee jobs split by industry and occupation from the UK Annual Population Survey,[xlv] we can assess how specialised the occupational profile of the Life Sciences sector [xlvi] is compared to the wider economy. A highly dissimilar occupational profile suggests that the benefits of sector R&D activity are less likely to be widely externalized.

To understand the degree of labour specialisation in the sector we employ a dual framework. Figure 7 plots a cosine similarity distribution which measures how comparable the occupational distributions of other SIC2 industries are to that of the Life Sciences sector. A score of 1 means that the industry employs the exact same proportion of employees across different occupation types as the Life Sciences sector.

A Hirschman-Herfindahl (HH) index[xlvii] is used to measure the degree of internal occupational specialisation within the Life Sciences sector itself. A score of 0.25 or higher suggests a high degree of internal specialization.

Figure 7: Cosine Similarity - SOC2 Occupational Distribution Relative to Life Sciences (SIC2) Sector - 2025



Source: DfE analysis of UK Annual Population Survey data

The distribution shown in Figure 7 suggests that the occupational profile of the Life Sciences sector is highly distinct to that of most other industries. The median score of all industries was 0.26, highlighted in orange above. Only two SIC2 industries (Computer Programming and Consultancy' and 'Other Professional, Scientific and Technical Activities') have a resemblance above 95%. The HH Index score for the Life Sciences sector, which is distinct from the median was also 0.26, suggesting a high degree of internal specialisation. This is largely due to the very large share of employee jobs in Science, Research, Engineering and Technology professions (47.6% of total).

These indicators suggest that R&D activity by the Life Sciences sector is less likely to produce widespread or diverse knowledge spillovers throughout the rest of the economy. The high degree of specialisation in narrow, knowledge intensive occupations indicate that receiving firms require a high concentration of overlapping specialist skills to effectively assimilate Life Sciences R&D outputs into

their own activities. The low resemblance of the sector's labour profile to other industries suggests that few parts of the economy possess these.

The structural pathways through which knowledge diffuses are also an important consideration in assessing the probability of spillovers from IUK supported R&D activity. The interaction between supply chain linkages and the R&D intensity of productive inputs is one such structural pathway.[xlviii]

Some industries are heavily reliant on knowledge intensive inputs from other sectors while also being significant suppliers of such inputs to other parts of the economy. R&D performed by such sectors is much more likely to result in positive knowledge spillovers through a dual effect of knowledge transmission to supplying industries and enhanced or lower cost inputs to purchasing sectors.[xlix]

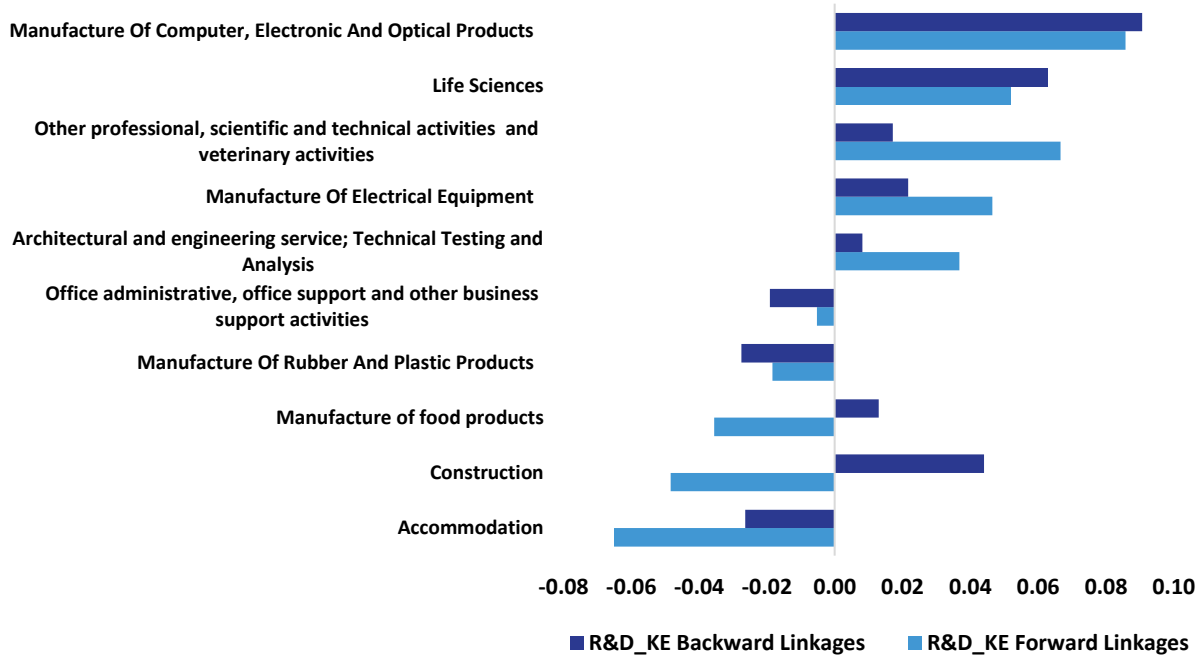
NISRA Analytical Input-Output tables measure the volume of transactions between different industries. This data is represented as a square matrix of purchases and sales from industry to industry. We have used the 2022 edition of this data to calculate Leontief and Ghosh Inverse matrices which map out the cumulative ripple effects that a change in one industry triggers across the entire supply chain.

Weighing both matrices by industry level R&D intensities transforms them from measures of purely monetary transaction flows to a measure of embodied R&D knowledge flows in the economy (the total direct and indirect R&D knowledge used within the production of outputs). For this analysis we use industry level R&D intensities for the UK, due to a lack of suitable NI-specific data.

The weighted inverse matrices are used to calculate R&D Knowledge Embedded Rasmussen Backward and Forward Linkages (RBL / RFL). These statistics respectively capture how intensively industries rely on knowledge generated by suppliers and how much an industry's own R&D activity 'pushes' knowledge through the rest of the economy. An industry with a higher-than-average RBL is relatively dependent on knowledge from suppliers in its production. A higher-than-average RFL signifies that the innovation / R&D outputs of a sector are heavily utilised by other industries.

Figure 8 plots adjusted, normalised R&D Knowledge Embedded RBLs and RFLs using 2022 data, for a selection of representative industries. An industry with a positive value has a higher-than-average R&D knowledge embedded linkage with the rest of the economy. As before, the Life Sciences sector is approximated as a composite of the 'Manufacture of Pharmaceutical Products' and 'Scientific Research & Development Activities' SIC2 sectors.

Figure 8: Adjusted, Normalised R&D Knowledge Embedded Rasmussen Linkages (2022)



Source: DfE analysis of NISRA Supply-Use Tables, ONS Business Expenditure on R&D & ONS Region by Industry GVA.

The NI Life Sciences sector is both relatively reliant on knowledge embedded inputs from other industries and a significant supplier of such inputs to other parts of the economy. This suggests that the industry is a major conduit for the flow of R&D generated knowledge. The Rasmussen linkages indicate the structural pathways through which knowledge transfers from industry to industry. High linkages suggest strong inter-industry knowledge flows which increase the likelihood of positive spillovers. However, as noted previously, this is conditional on the presence of sufficient absorptive capacity within receiving firms or industries. Given the low cosine similarity in occupational profiles, which indicates limited absorptive capacity on the receiving end, only a handful of industries are likely to be able to absorb and benefit from these knowledge flows.

There are limitations with this form of analysis. R&D Knowledge Embedded Rasmussen Linkages measure transactive volumes rather than the distribution of activity. Further analysis of results suggests that the NI Life Sciences sector is primarily reliant on a small number of R&D intensive supplier industries (including the Life Sciences sector itself). This tends to suggest that where R&D spillovers occur, they may be relatively localised to certain, knowledge intensive segments of the economy.

Some research also suggests that supply chain interlinkages tend to be more relevant channels of knowledge transmission for goods producing industries with highly specialised intermediate inputs.[I]

That is to say that the degree of linkage may be a more relevant vector of knowledge transmission for certain segments of the Life Sciences sector compared to others.

Conclusion

The value of IUK offers to NI has grown significantly since 2018, which analysis of participant level data suggests has been due to increased competitiveness of projects led by a small cohort of repeated applicants. While recent trends have been encouraging, there is a need to increase the pool of applicants selecting into and succeeding in IUK competitions, particularly if (as we suspect) a regular history of prior awards from IUK are a significant predictor of future funding drawdown. This will be necessary to sustain future growth in high potential RDI activities.

Detailed analysis of the IUK applicant population in NI is only possible with comprehensive application and awards data. DfE is in the process of concluding a Data Sharing Agreement with IUK which should facilitate access to such data in the future. This will allow for detailed analysis of differences in characteristics between successful and unsuccessful projects, participants and collaborations.

Analysis of awards data by industry suggests that NI has a particular advantage in the Life Sciences IS-8 sector. While encouraging, evidence concerning the potential scale and distribution of RDI spillovers from public support to the sector is mixed. The sector's labour profile is highly specialised compared to most of the NI economy suggesting that firms require a highly specific set of skills and experience to effectively integrate the knowledge that it produces.

On the other hand, analysis of R&D embedded supply chain flows suggests that the sector acts as a nexus for the flow and transmission of knowledge used in production. Effective transmission of new knowledge is an important pre-condition for RDI spillovers, although further analysis suggests that, where these occur, they may be relatively contained to a small number of knowledge intensive supplier and purchaser industries.

Making the most of Northern Ireland's advantage in the industry and IUK's support for it will require dedicated interventions focusing on absorptive capacity in other parts of the economy. This will require a detailed understanding of the exact skills demanded by the industry as well as the type of technology that it employs. These are key areas of focus for future research.

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[i] Productivity, Innovation and R&D - Productivity Institute
[ii] Minister's Economic Vison - Department for the Economy
[iii] Programme for Government 2024/27 - NI Executive
[iv] Research & Development Spending - House of Commons Library
[v] General Guidance - UKRI
[vi] Eligibility for funding and the assessment criteria used vary from competition to competition, but generally, where a project involves more than one participant, the lead participant must be an enterprise.
[vii] Innovate UK Funded Projects Since 2004 - UKRI
[viii] Excludes certain types of support – e.g. loans made on a commercial basis or with lower than market interest rates which are subject to different transparency and reporting obligations.
[ix] Budget Allocations for UK Research and Innovation - UKRI
[x] Oral Statement from the Finance Minister - Chancellor's Spring Forecast - 03 March 2026
[xi] The value of funding offers does not necessarily correspond to actual spending. These can differ due to project / participant withdrawals, changes in the scope of the project or lower than forecast eligible costs. At the aggregate level and over time, value of offers closely track actual expenditure.
[xii] Northern Ireland Research and Development Survey - NISRA
[xiii] Business Enterprise Research and Development, UK - ONS
[xiv] The value of Public R&D - DSIT
[xv] A Practical Guide to Shift Share Instruments - NBER
[xvi] This does not mean that funding is restricted to only NI entities. Participants from other UK regions are eligible provided that they are looking to expand their research activities or footprint in NI.
[xvii] Northern Ireland Life & Health Sciences Launchpad - Invest NI
[xviii] Geographical Distribution of Spend Data: FY 2019-20 and FY 2020-21 - UKRI
[xix] 'Region specific' competitions in this Competition Year include 'Launchpad – Life & Health Sciences Northern Ireland, New Innovators in Life & Health Sciences, Northern Ireland and Cyber Local Programme a-1019.
[xx] Northern Ireland Innovation Survey - NISRA
[xxi] 'BERD Spend Ownership Data - NISRA
[xxii] Business Enterprise Research and Development, UK - ONS
[xxiii] The Greater South East of England consists of the London, South East and East of England Territorial Level 1 Geographic units.
[xxiv] 'Get Information About a Company - Companies House
[xxv] Industry Engine Platform - Data City
[xxvi] The UK's Modern Industrial Strategy – Department of Business and Trade
[xxvii] Budget Allocations for UK Research and Innovation, UKRI (2025)
[xxviii] Defining Priority Sectors / Clusters - DfE
[xxix] Industrial Strategy Definitions List - Department of Business and Trade
[xxx] QCEW Location Quotient Details - U.S. Bureau of Labor Statistics
[xxxi] New Innovators in Life and Health Sciences - Innovate UK
[xxxii] Adjusted Location Quotients are derived by deducting 1 from the standard statistic. This rebases the statistic to zero (in other words, zero represents the UK average share of Life Sciences of all IUK funding to IS-4 sectors).
[xxxiii] Frontier industry participants can belong to any SIC07 designation, not just those the UK Government has identified as representing the Life Sciences sector. In practice, most frontier industry enterprises that have received an award from IUK tend to have at least one SIC designation within the UKG definition.
[xxxiv] Real Time Industry Data - Data City
[xxxv] Biomedical Catalyst - UKRI
[xxxvi] Strength in Places Fund - UKRI
[xxxvii] University Research and the Location of Business R&D - The Economic Journal
[xxxviii] The Effect of R&D Co-Location on Innovation Activities in Great Britain

[xxxix] Rate of Return to Investment in R&D - Frontier Economics
[xl] Spillovers from R&D and Other Intangible Investment - The Review of Income and Wealth
[xli] Research and Development: Relationship between Public and Private Funding - BEIS
[xlii] Absorptive Capacity: A New Perspective on Learning and Innovation
[xliii] Absorptive Capacity and Innovation in the Knowledge Intensive Business Service Sector - Economics of Innovation & New Technology
[xliv] The Skills Content of Recent Technological Change: An Empirical Examination - The Quarterly Journal of Economics
[xlv] Employment by occupation and industry section A-S, UK - ONS
[xlvi] As the data is only available at 2-digit industry level, we need to adopt a proximate definition of the Life Sciences sector. This definition includes SIC21 (Manufacture of Pharmaceutical Products) and SIC72 (Scientific Research & Development) which include the major components of the more detailed IS definition.
[xlvii] The Paternity of an Index - The American Economic Review
[xlviii] The Strength of Long Ties and the Weakness of Strong Ties: Knowledge Diffusion Through Supply Chains
[xlix] Knowledge Spillovers in the Supply Chain – Evidence from High Tech Sectors
[l] 'Productivity, Trade and the R&D Content of Intermediate Inputs - European Economic Review

Annex

Shift-Share Decomposition – Regional Growth in IUK Value of Offers

- This method breaks down growth in the value of IUK offers to NI registered participants into growth due to the increase in IUK's total budget, growth due to specific increases in the value of offers by participant type and growth due to specific 'regional advantage'.

- Each component is expressed as a percentage proportion of total growth in offer values by participant type. In other words, the sum of the three effects adds up to total growth.

$$\Delta \boldsymbol{VoO_{ir}} = (\boldsymbol{VoO_{ir}} \times \boldsymbol{g_n}) + ((\boldsymbol{g_{in}} - \boldsymbol{g_n}) \times \boldsymbol{VoO_{ir}}) + ((\boldsymbol{g_{ir}} - \boldsymbol{g_{in}}) \times \boldsymbol{VoO_{ir}})$$

Where;

- $\Delta \boldsymbol{VoO_{ir}}$= Growth in IUK offer values between 2018 and 2024 to participant type *i* in region *r;*
- $\boldsymbol{VoO_{ir}}$ = Pro rata value of IUK offers to participant type *i* in region *r* in 2018;
- $\boldsymbol{g_n}$ = National growth in the value of IUK offers from 2018 to 2024 across all participant types;
- $\boldsymbol{g_{ir}}$ = Regional growth in value of IUK offers from 2018 to 2024 to participant type *i;*
- $\boldsymbol{g_{in}}$ = National growth in value of IUK offers from 2018 to 2024 to participant type *i.*

Location Quotients – Comparative Advantage in RDI in IS-4 Sectors

- Location quotients measure how concentrated activity (in this context, publicly supported RDI activities) in a sector is in a region compared to nationally. In our analysis, the value of IUK offers to IS-4 industries are for Competition Years 2022/23 to 2024/25.

$$\left(\frac{\boldsymbol{IS\_VoO_{jr}}}{\boldsymbol{IS\_VoO_r}}\right) \div \left(\frac{\boldsymbol{IS\_VoO_{jn}}}{\boldsymbol{IS\_VoO_n}}\right)$$

Where;

- $\boldsymbol{IS\_VoO_{jr}}$ = The value of IUK offers to IS-4 enterprises in sector *j* in region *r;*
- $\boldsymbol{IS\_VoO_r}$ = The value of IUK offers to all IS-4 enterprises in region *r;*
- $\boldsymbol{IS\_VoO_{jn}}$ = The value of IUK offers to IS-4 enterprises in sector *j* nationally;
- $\boldsymbol{IS\_VoO_n}$ = The value of IUK offers to all IS-4 enterprises nationally.

Cosine Similarity – Labour Specialisation & Absorptive Capacity

- This method compares the degree of resemblance of an industries occupational distribution (the share of employee jobs by different professions) with that of the proximate Life Sciences sector.

$$\cos(\boldsymbol{\theta})\boldsymbol{j} = \frac{\sum_{i=1}^{n} \boldsymbol{A_i B_i}}{\sqrt{\sum_{i=1}^{n} \boldsymbol{A_i^2}} \times \sqrt{\sum_{i=1}^{n} \boldsymbol{B_i^2}}}$$

- **A** represents the share of occupation i of total employee jobs in the Life Sciences Sector. **B** represents occupation i's share of total employee jobs in industry j. These are multiplied together with the results summed to produce the inner product.

- The inner product is divided the square root of the sum of squares of the share of each occupation type i in the Life Sciences sector multiplied by the equivalent calculation for industry j (vector magnitudes). The resulting calculation produces a result of between 0 and 1.

- The closer the result is to 1, the more closely the occupational distribution of industry j resembles that of the Life Sciences sector. A highly resemblant sector requires the same type of broad labour input, suggesting that the industry is more likely to have the skills and experience

amongst its workforce to understand and assimilate R&D knowledge generated by the Life Sciences sector.

Knowledge Flow and Transmission Along Supply Chains
R&D Weighted Leontief Inverse

$$\boldsymbol{RD\_Leon^{-1} = (Id - RA)^{-1}}$$

Where:

- **Id** = A square matrix of industries where the main diagonal entries equal 1 and 0 elsewhere;
- **R** = A square matrix where the main diagonal entries correspond to industry level R&D intensities (at UK level) (Business Expenditure on R&D in 2022 divided by industry GVA). Off-diagonal entries equal 0. Pre-multiplied with A to produce an R&D weighted Matrix of Technical Coefficients (which shows how industries rely on R&D knowledge in their supply chains).
- **A** = An industry-by-industry matrix where elements represent the value of input from one industry required to produce one unit of output in another industry.

R&D Weighted Ghosh Inverse

$$\boldsymbol{RD\_Ghosh^{-1} = (Id - BR)^{-1}}$$

Where;

- **Id** = A square matrix of industries where the main diagonal entries equal 1 and 0 elsewhere;
- **R** = A matrix where diagonal entries correspond to industry level R&D intensities (at UK level) (Business Expenditure on R&D in 2022 divided by industry GVA). Off-diagonal entries equal 0. Post multiplied by B to produce an R&D Weighted Allocation Matrix which shows how other industries rely on the sector's R&D knowledge).
- **B** = An industry by industry matrix where individual elements represent the proportion of an industry's total output that is sold to another sector.

Adjusted R&D Embedded Rasmussen Backward Linkage

$$\boldsymbol{RBL_k = \left(\left(\sum_{i=1}^{n} RD\_Leon_{ij}^{-1}\right) \div \frac{1}{n}\sum_{=1}^{n}\left(\sum_{i=1}^{n} RD\_Leon_{ij}^{-1}\right)\right) - 1}$$

- The first element calculates the raw R&D embedded backward linkage for sector k by summing individual elements in column j across all rows (i) in the R&D Weighted Leontief Inverse.
- The second element normalises the raw linkage by dividing it by the average linkage across all sectors.
- Linkages are adjusted by subtracting 1 from the normalised value. A positive value indicates that the sector pulls more R&D knowledge through its supply chain (through purchasing inputs from other industries) than is average for the economy as a whole. Adjusted values are multiplied by 10 for presentation.

Adjusted R&D Embedded Rasmussen Forward Linkage

$$\boldsymbol{RFL_k = \left(\left(\sum_{j=1}^{n} RD\_Ghosh_{ji}^{-1}\right) \div \frac{1}{n}\sum_{i=1}^{n}\left(\sum_{j=1}^{n} RD\_Ghosh_{ji}^{-1}\right)\right) - 1}$$

- The first element calculates the raw R&D embedded forward linkage for sector k by summing individual elements in row i across all rows j in the R&D Weighted Ghosh Inverse.
- The second element normalises the raw linkage by dividing it by the average forward linkage across all sectors.
- Linkages are adjusted by subtracting 1 from the normalised value. A positive value indicates that the sector pushes more R&D knowledge through the inputs it sells to other industries than the average for the economy as a whole. Adjusted values are multiplied by 10 for presentation.