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THE IMPACT OF SCOTTISH UNIVERSITY RESEARCH ON SCOTLAND'S ECONOMY

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Summary

Scotland has a vibrant university sector which is internationally renowned for research quality. The sector consists of 19 higher education institutions including two, the University of Edinburgh and the University of Glasgow, which are regularly ranked amongst the global top 100 universities.¹ In 2023/24 Scottish universities received £1.23 billion of income from public and private sources to support research and employed over 17,500 research staff. Accounting for approximately 12% of the UK's institutions, research funding and research staff, Scotland's university sector is strong relative to its population and GDP.

University research in general has been shown, theoretically and empirically, to deliver a wide range of economic and social benefits. These include:

- **Direct supply chain impacts:** To enable research activities to take place, universities employ researchers and purchase goods and services, which in turn supports revenue and jobs in other industries.
- **Productivity benefits:** Knowledge generated from research drives innovation, fuelling private sector firms to produce new or improved products or services, or reduce the costs of producing existing products or services, thereby increasing productivity and growth.
- **Local growth:** Universities' reputation and research output can attract firms to locate in the vicinity, driving local economic growth.
- **Social benefits:** Knowledge generated from research can contribute to improvements in health outcomes, environmental quality, public policy design, and cultural life. These benefits may not always result in greater economic output but are welfare-enhancing.

Universities' research can also increase their ability to obtain subsequent research funding that is won competitively at a national or international level. This leveraged research would be expected to go on to deliver the benefits listed above.

It is important for public policy makers to understand the size of the economic and social contribution that research makes, to ensure that public funds are allocated in the most effective way possible. Quantifying all these benefits, however, is notoriously difficult.

This report aims to provide further understanding of the productivity returns to university research in Scotland. We do so by setting out a conceptual framework for how university research may deliver economic benefits, and compiling evidence on the pathways through which university research might increase private sector productivity. We compare evidence for Scotland with that for the UK, to assess whether the pathways appear systematically different for Scotland. This helps build understanding of how returns to university research in Scotland may compare to returns to university research in the UK as a whole.

¹ [QS World University Rankings 2026: Top Global Universities | TopUniversities](#)

We also provide more detailed comparisons between Scotland and the other countries and regions of the UK. This is important to provide a more detailed understanding of how metrics vary across the UK, better contextualise comparisons, and highlight focused comparisons between Scotland and regions that are more similar to Scotland.

The analysis is based on metrics for each pathway evidenced from available secondary data sources and original bibliometric analysis, where comparisons between Scotland and other parts of the UK can readily be made. The metrics are used to compare the relative intensity of research output and strength of pathways from university research to the economy. They are descriptive and do not estimate causal productivity impacts or financial returns on research spending. They should be interpreted as evidence on where and how economic benefits may arise, and how these pathways may compare between Scotland and the rest of the UK, rather than as evidence on how large the productivity benefits are.

Key findings:

Scottish universities are strong at producing impactful academic output. Relative to research funding Scotland is more effective at producing these outputs than most other areas of the UK.



- Scottish universities published around 26,000 papers in 2024. The quality of these papers is globally high [see Figure 2]. Over the past five years for which data is available the average citation impact score is 1.61, meaning that Scottish papers are cited 61% more frequently than the global average.
- Scottish universities have produced 23 papers per million £ of research spending over the past five years for which data is available. This compares to less than 20 per million £ of research spending in the North West, London, the South East and East [see Figure 3].
- The average citation impact of Scottish academic output (1.61) is lower than in the 'golden triangle' (1.82 in the East, 1.77 in London and 1.69 in the South East) but similar to other areas including the North West (1.59) [see Figure 6].
- Scottish universities have produced 53.0 new patent family publications per £ million of research funding from 2018 to 2022, compared to 62.2 across the UK [see Figure 8]. However, an indicator of the 'strength' of those patents, the Derwent Strength Index, suggests that the impact of Scottish university patents is more similar to the UK average (with DSI scores of 46 and 47 respectively) [see Figure 9].



Scottish universities actively collaborate on research with local industry, suggesting the co-production of strategically important knowledge.

- Scottish universities had over 7,000 external research grants and contracts with industry, commerce and public corporations in 2023/24. Half of these

were from SMEs in Scotland, and a further 6% from larger businesses or other organisations in Scotland [see Figure 10].

- Scottish universities received 17.9% of their total research income from external research grants and contracts funded by industry, similar to the UK average (17.6%). Industry contracts make up a higher proportion of total research income in Scotland than in many other areas of the UK including the North West, London, the South East and East [see Figure 12].
- 4.6% of Scottish scholarly output involved industry co-authorship. This is higher than any area of the UK outside London (where 5.2% of papers involved industry collaboration) [see Figure 13].

Scottish universities have a higher intensity of interactions with local businesses than those in the UK as a whole.



- Scottish universities had over 12,000 consultancy interactions and over 6,000 instances of engagement on continuing professional development in 2023/24. The majority of these were with organisations based in Scotland (74% and 81% respectively) [see Figure 16].
- Scottish universities record around 25 interactions per £ million of research funding (covering consultancy, contract research and facilities and equipment services), compared with around 16 interactions per £ million across the UK. Only the North West of England has a higher level of interactions relative to research funding (27 per £ million) [see Figure 18].
- Those interactions yield less income for universities in Scotland than the UK average. Scottish university interactions with business and community services (including consultancy, contract research and facilities and equipment services) generated around £235,000 of income per £ million of research funding, while across the UK as a whole this was around £255,000 per £ million. This reflects broader differences in the scale of business innovation activity in Scotland as compared to the rest of the UK [see Figure 18].

Businesses in Scotland are less likely to engage in innovation than businesses in most regions of England, and Scottish business R&D spending is relatively low. However, universities are a more important support to the business innovation ecosystem in Scotland than elsewhere in the UK.



- 32.4% of Scottish businesses were innovation-active in 2020-22. This is lower than across the UK as a whole (36.3% of businesses) and lower than any English region [see Figure 21]. Business R&D was 1.4% of GDP in Scotland in 2023, compared to 2.0% across the UK [see Figure 20].

- However, Scottish businesses are nearly twice as likely as businesses in the UK overall to report information from universities as being highly important for their innovation activities (2.6% compared to 1.6%) [see Figure 24]. Universities are more important to businesses in Scotland than to businesses in any other country or region in the UK.
- Scottish businesses that do collaborate on innovation are more likely to collaborate with universities than businesses elsewhere in the UK (37.5% in Scotland compared to 32.5% for the UK as a whole). This is higher than any area in England, and is particularly true for small businesses (37.1% in Scotland compared to 31.2% for the UK as a whole) [see Figure 25].

Scottish universities have a track record at producing startups and spinouts that directly build on the knowledge generated in universities.

- There were 14 new spinouts from Scottish universities established in 2023-24, and 237 Scottish university spinouts active in that year. A further 410 startups were established, with 2,311 active startups [see Figure 27 and Figure 31].



- Over the past six years for which data is available Scottish universities have produced fewer startups and spinouts, per £ billion of research funding, than the UK average (218 compared to 492, and 13 compared to 19 respectively) [see Figure 28 and Figure 32].
- Average turnover, employment and external investment among Scottish university startups and spinouts was lower in 2023/24 than the average for UK university startups and spinouts. The UK average is skewed by high performing companies in the 'golden triangle', and Scottish startups and spinouts tend to perform better than those in English regions outside of the South [see Figure 30 and Figure 33].

This evidence indicates that Scotland's university research base compares well with the UK average on many of the dimensions considered. Comparisons with the North West of England are highlighted, as the North West is a region with some similarities, economically and geographically, to Scotland. Compared with the North West, Scottish universities are relatively strong at producing knowledge, collaborating on research, and engaging with industry.

University research plays a vital role in the Scottish innovation ecosystem. Scottish universities are strong at producing high-quality knowledge and innovation. Scottish universities work widely with businesses, exhibiting a higher intensity of interactions with local businesses than universities across the UK. These interactions have the potential to share knowledge and drive innovation. Businesses' perspectives in Scotland support the view that university research plays a key role in supporting business innovation. There are clearly active pathways through which university generated knowledge can reach industry and generate productivity benefits. These benefits are an important component of the return to spending on university research in Scotland.

The impact of Scottish university research on Scotland's economy

University research plays a vital role in the Scottish innovation ecosystem.

- Scottish universities are strong at producing high-quality knowledge and innovation.
- There are active pathways through which this knowledge can reach industry and generate productivity benefits and economic growth.

Knowledge creation

Transmission of generated knowledge to the private sector

Business innovation



Scottish universities are strong at producing impactful academic output

23 papers per £m of research funding compared to less than 20 per £m in North West, London, and South East.

Scottish papers cited **61%** more than the global average while UK papers are cited 50% more than the global average

53 new patent families per £m research funding in Scotland compared to 62 per £m in the UK



Scottish universities actively collaborate on research with industry

7,000+ external research grants and contracts with industry (half with SMEs in Scotland)

17.9% of Scottish universities' total research income is from industry (UK average 17.6%)

4.6% of Scottish papers co-authored with industry (higher than any area outside London)



Scottish universities have relatively frequent interactions with business

12,000+ consultancy interactions

6,000+ instances of engagement on continuing professional development

~25 interactions involving consultancy, contract research or facilities services per £m research funding in Scotland compared with ~16 per £m across the UK.



Universities are an important support for Scottish business innovation

Scottish business are nearly **twice as likely** to see information from universities as highly important for their innovation (reported by 2.6% in Scotland vs 1.6% across the UK)

37% of businesses that collaborate on innovation in Scotland do so with universities (32% across the UK)



Spinout and start up companies directly build on knowledge generated from Scottish university research

13 new spinouts and **218** new startups per £bn research funding in Scotland (compared to 19 and 492 for the UK as a whole)

1 Introduction

1.1 Scotland has a vibrant university sector which is internationally renowned for research quality

Scotland has a large and diverse university sector. The sector spans 19 institutions funded by the Scottish Funding Council, from its four “ancient” universities (Aberdeen, Edinburgh, Glasgow and St Andrews) to its technology-led and professionally focused universities (such as Strathclyde, Heriot-Watt and Glasgow Caledonian).² University world rankings contribute significantly to an institution’s global reputation. Scottish universities feature strongly in the 2026 QS World University rankings, with the University of Edinburgh and the University of Glasgow, ranked 34th and 79th respectively.³

In 2023/24, Scottish universities employed over 17,500 research staff and received £1.23 billion of income from public and private sources to support research,⁴⁵ with SFC providing just under a quarter of that total.⁶ The Scottish university sector accounts for approximately 12% of the UK’s institutions, research funding and research staff. Given Scotland accounts for approximately 8% of the UK’s population and GDP, it “punches above its weight” in terms of both scale and quality.

The sector is internationally renowned for research quality. An assessment of the 2021 Research Excellence Framework (REF) evidence points to breadth of high-quality outputs and impacts across subjects: 85% of research submitted from Scottish universities was rated “world-leading” or internationally excellent, and 87% of Scottish Impact Case studies were rated “outstanding” or “very considerable” for reach and significance.⁷

The sector’s research strengths reflect both depth in traditional disciplines and targeted national assets. In particular, Scotland’s REF submission mix is relatively strong in Engineering and Physical Sciences compared with the UK average.⁸

1.2 The need for further evidence on the returns to Scottish university R&D

Research and development (R&D), including that done by universities, is widely recognised as a key driver of productivity and long-term economic growth. By expanding the stock of

² The Scottish Funding Council does not fund research at the Open University Scotland, as the Open University receives research funding from Research England, but it does provide funding for Knowledge Exchange.

³ [QS World University Rankings 2026: Top Global Universities | TopUniversities](#)

⁴ [HE academic staff | HESA](#)

⁵ [Research grants and contracts | HESA](#)

⁶ [Funding body grants | HESA](#)

⁷ [Results and submissions | REF 2021](#)

⁸ [Results and submissions | REF 2021](#)

knowledge, research enables the development of new products, services, and production processes, and improves the efficiency of existing ones. University research is particularly important in this regard, as it often underpins foundational advances that shape industries over time, even where the pathway from discovery to application is uncertain or protracted.

It is important for public policy makers to understand the size of the economic and social contribution that research makes, to ensure that public funds are allocated in the most effective way possible. Quantifying all these benefits, however, is notoriously difficult.

Scottish university research can be expected to deliver a wide range of economic and social benefits:

- **Direct supply chain impacts:** To enable research activities to take place, universities employ researchers and purchase goods and services, which in turn supports revenue and jobs in other industries.
- **Productivity benefits:** Knowledge generated from research drives innovation, fuelling private sector firms to produce new or improved products or services, or reduce the costs of producing existing products or services, thereby increasing productivity and growth.
- **Local growth:** Universities' reputation and research output can attract firms to locate in the vicinity, driving local economic growth.
- **Social benefits:** Knowledge generated from research can contribute to improvements in health outcomes, environmental quality, public policy design, and cultural life. These benefits may not always result in greater economic output but are welfare-enhancing.

Scottish universities' research can also increase their ability to obtain subsequent research funding, including that won competitively at a national or international level. This leveraged research would be expected to go on to deliver the benefits listed above.

Estimates of the economic impact of Scottish university research from the Fraser of Allander Institute suggest that Scottish Funding Council (SFC) funding of £286m in 2019/20 supported over 8,500 full-time equivalent (FTE) jobs and £400m in gross value added (GVA) in the Scottish economy.⁹ In total university research funding supported 34,070 FTE jobs and £1,570m in GVA. This analysis covers only the first of the list of benefits set out above.

Social benefits are hard to quantify, but existing work provides a good illustration of their existence and qualitative importance. For example, analysis of the Research Excellence Framework 2021 case studies by RAND highlighted societal impacts in areas such drug discovery, the marine environment, museums, and cultural heritage.¹⁰

There are as yet no direct estimates of the impact of Scottish university R&D on private sector productivity. There are several studies that have sought to quantify the private sector

⁹ [The economic impact of university research funding | FAI](#)

¹⁰ [Stevenson et al \(2023\) Impacts of Research from Scottish Universities: Analysis of the REF 2021 Impact Case Studies](#)

productivity benefits arising from publicly conducted R&D in the UK as a whole.¹¹ These use econometric approaches to estimate the relationship between various definitions of public R&D and private sector productivity. Most recently, Frontier Economics estimated the return to R&D conducted in and funded by the public sector in the UK, exploiting industry level data for the period 1998-2019.¹² That work estimated that, on average, a £1 investment in public R&D conducted in the UK could be expected to increase total UK private sector productivity by around £0.40 per year six years after the investment is made. However, it is not possible to implement the same econometric techniques for Scotland as were used for the UK-wide analysis. The detailed industry-level data required – on productivity, business R&D, and interactions between firms and the public sector – are not available for Scotland.¹³ Furthermore, even if sufficient data were available, attributing a causal impact to Scottish university research as distinct from university research in the rest of the UK would pose additional challenges.

In the absence of Scottish-specific estimates, London Economics have calculated an estimate of the UK productivity benefits of Scottish university research by assuming that the returns to UK productivity from public R&D conducted in Scotland are the same as the returns to public R&D conducted across the UK.¹⁴ They use the rate of return estimate for research council funded R&D from a study by Haskel and Wallis (2010) and the rate of return estimate for R&D conducted by the public sector (research councils, the higher education centre and central government) from a study by Haskel et al (2014) and apply these to Scottish university research funding from UK Research Councils and other sources respectively. Their combined estimate is that on average £1 invested in Scottish universities' research activities generates an additional £5.40 of productivity spillovers across the UK economy. This is largely driven by the high rate of return (12.7%) assumed for research council funded R&D.

Other research suggests that the rate of return to the UK economy may be higher for Scottish university research than UK university research as a whole. The Fraser of Allander Institute have pointed to the different nature of research carried out in Scotland, with more Research Excellence Framework outputs in science, technology, engineering and maths (STEM) fields as compared to other areas of the UK.¹⁵ They also note that Scottish universities have a relatively high proportion of research council funding from the Medical Research Council and point to some estimates that indicate a higher return to MRC funding as compared to that of the other Research Councils. Until now, however, it has remained an important open question

¹¹ [Haskel and Wallis \(2013\)](#); [Haskel et al. \(2014\)](#); [Goodridge et al. \(2015\)](#)

¹² [Returns to Public Research and Development - GOV.UK](#)

¹³ These are not simple data gaps that are easy to fill. The Office for National Statistics invests considerable resource in collecting these data for the UK through a variety of large-scale surveys and it would be infeasible to boost the samples of Scottish firms sufficiently to enable robust statistics at the level of industry granularity required.

¹⁴ London Economics (2022), [The economic impact of Scotland's university research activity](#).

¹⁵ [The economic impact of university research funding | FAI](#)

whether the average return to UK productivity from Scottish university research differs to the average from UK university research as a whole.

1.3 Approach of this paper

This report aims to further understanding of the productivity returns to university research in Scotland. Since it is not possible to use the econometric approaches adopted UK-wide, we adopt a different approach.

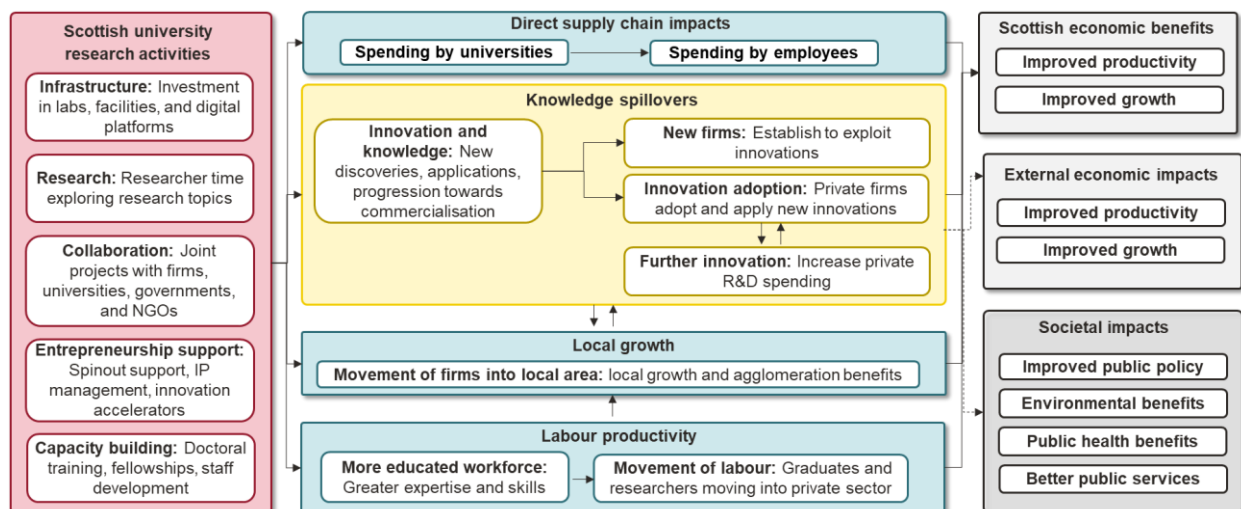
We start by setting out a conceptual framework for how economic benefits may derive from university research spillovers. We then compile evidence on the pathways through which university research might drive increases in private sector productivity. We compare the evidence for Scotland with that for other parts of the UK, to assess whether the pathways appear systematically different for Scotland compared to the rest of the UK. This helps build understanding of how returns to university research in Scotland may compare to returns to university research in the UK as a whole.

The focus is on the direct economic spillovers of university research – increased innovation, productivity, and economic growth – rather than wider social returns. The analysis is based on metrics for each pathway where comparisons between Scotland and other parts of the UK can readily be made. The findings therefore offer a partial, but nevertheless valuable, overview on which more detailed comparisons and analysis could be built in future.

A conceptual framework for returns to university research

The conceptual framework is illustrated in Figure 1. This was developed and validated with the input of stakeholders who are expert in the Scottish university landscape.

Figure 1 Conceptual framework of economic impacts from university research



Source: Frontier Economics

The main route through which university research is expected to drive economic benefits is through the **production of new knowledge and innovation**. This can be used or built on by private sector firms to produce new or improved products or services (*product innovation*) or reduce the costs of producing existing products or services (*process innovation*), thereby increasing productivity and growth.

To experience such benefits, private firms must be aware of the new knowledge produced by university research, and **adopt or apply that knowledge**. There are various routes through which this can happen, for instance:

- University research may be produced in direct collaboration with industry;
- Private sector firms may become aware of research outputs through publications, or through interaction with the universities on other research or non-research activities (such as consultancy, use of university facilities, or continuous professional development services).

Alternatively, universities or researchers can look to directly commercialise their innovations through **establishing new firms** – startup or spinout companies.

University research, and the knowledge generated, can also **stimulate firms to undertake private R&D**. This may be direct (e.g. through co-funded research) or indirect (e.g. if research output stimulates private firms to explore an area further with particular commercial application in mind). This private R&D could then be expected to have further productivity benefits, as there is extensive literature on the benefits of private R&D spending.¹⁶

University research may also give universities and their local area a positive reputation that **attracts firms to locate in the vicinity**. This has implications for local economic growth (for example, benefits for the Scottish economy if firms locate in Scotland rather than England). There may also be productivity benefits if firm location decisions result in a greater geographical concentration of activity (agglomeration) than might otherwise have been the case.¹⁷

Finally, university research is likely to **increase the human capital** of funded researchers, increasing their skills and experience, and making them more productive. This would increase labour productivity in the private sector if these researchers move to work in the private sector.

University research could also result in an increase in universities' ability to obtain subsequent research funding and thus deliver further research activities (which then has economic benefits through the pathways set out above). This feedback mechanism is not illustrated in Figure 1.

¹⁶ See Frontier Economics (2023) [Rate of return to investment in R&D](#) for a recent review of the literature.

¹⁷ For example, a report from the OECD (2020) estimated that a 10% increase in employment density of a city in Great Britain increases city productivity by 0.9-1 percent. Donovan et al (2022) conducted a meta-analysis of agglomeration studies and found effects to be smaller but still positive.

Evidence on the pathways to economic returns

In this report we provide quantitative evidence on metrics relating to a variety of these benefit pathways. We illustrate the extent of Scottish university activity and performance, including how this might have changed over time. Wider contextual information is also collated where available.

- Section 2 explores knowledge production by Scottish universities.
- Section 3 explores direct collaboration on research between universities and businesses.
- Section 4 examines other forms of interaction between universities and firms, as indicators of channels through which knowledge generated through university research can reach the private sector.
- Section 5 examines business R&D and firms' perceptions of the importance of university research for their R&D.
- Section 6 explores university startups and spinouts.
- Section 7 summarises the findings and the implications for the overall return to Scottish university research.

The quantitative evidence is drawn from bibliometrics and descriptive analysis of publicly available secondary data sources. These data sources and the methodology employed are described in more detail in Annex A .

Bibliometrics is the analysis of data derived from academic publications and their citations. Bibliometric data for this project is sourced from the databases underlying the Clarivate Web of Science™. We use this data to produce new evidence on Scottish research publications – those with at least one author affiliated to a Scottish institution.

Secondary data are drawn from a variety of sources. Much of the data we analyse comes from the Higher Education Statistics Agency (HESA), including finance data for HE providers (research income and sources of research income), and business and community interaction data for HE providers (business and community engagement and spinouts and startups). In addition, we examine data from the Scottish Funding Council (knowledge exchange metrics), the UK Innovation Survey (business innovation and related perspectives), and data from the Office for National Statistics (business R&D, business composition, and regional demographics).

There are some aspects of the conceptual framework that we do not explore in detail:

- The direct supply-chain impacts of university research. These have been considered in previous work by the Fraser of Allander Institute.¹⁸
- The leveraging of additional private R&D. This is discussed briefly in Section 5.

¹⁸ [The economic impact of university research funding | FAI](#)

- The impact on labour productivity. There is a lack of good data on the movement of researchers between universities and the private sector (in Scotland or the UK), and a lack of evidence on whether being employed in university research has a greater impact on an individual's skills and labour productivity than alternative employment.
- The impact of universities on firm location decisions. This is discussed briefly in Section 7.
- The impact of research on universities ability to access further research funding through competitive channels.

Geographical comparison of evidence

Across all the benefit pathways we consider, we make comparisons between metrics for Scotland and the same metrics for the UK as a whole. This is valuable to further understanding of how the productivity returns from Scottish research might compare to estimates of returns from UK-wide research.

UK-wide performance, however, hides substantial regional variation.¹⁹ We therefore also present regional analyses, examining how metrics vary across the countries and regions of the UK. Table 1 provides some summary metrics for the countries and regions of the UK to aid understanding of different comparisons made throughout the report.

Table 1 2023 summary statistics for UK regions

	% of UK institutions	% of UK research funding	% of UK GDP	% of UK population	GDP per capita	% small enterprises
Scotland	10.8%	12.9%	7.3%	8.0%	£ 37,146	10.2%
London	24.1%	23.2%	22.2%	13.3%	£ 68,029	7.5%
South East	10.2%	14.8%	14.1%	13.9%	£ 41,230	8.2%
East of England	6.0%	9.4%	8.2%	9.5%	£ 35,392	8.4%
North West	8.4%	8.3%	9.7%	11.1%	£ 35,605	9.1%
South West	7.2%	5.8%	7.5%	8.5%	£ 35,579	9.1%
North East	3.6%	3.0%	2.8%	4.0%	£ 28,599	10.3%
West Midlands	6.0%	5.5%	10.3%	8.9%	£ 32,038	9.1%
East Midlands	5.4%	4.1%	5.6%	7.3%	£ 31,394	9.1%
Yorkshire and the Humber	7.8%	7.2%	6.6%	8.2%	£ 32,584	9.7%
Wales	7.2%	3.9%	3.3%	4.6%	£ 29,303	9.2%
Northern Ireland	2.4%	1.9%	2.3%	2.8%	£ 32,957	9.1%

Source: Frontier Economics; UK Learning Providers; HESA; ONS; NOMIS

Notes: '% small enterprises' is the proportion of total enterprises within region with 10-49 employees

¹⁹ In particular, the East of England, the South East and London form a 'golden triangle' within which exists world-leading concentration of institutions. This includes Oxford, Cambridge, Imperial and UCL, four of the top nine in the 2026 QS World University Rankings. These regions also benefit from the clustering of businesses and economic activity around London, which has a GDP per capita twice as high as the UK average. As a result, institutions across these regions perform better than the rest of the UK across almost all the metrics this paper assesses. A UK average can hide this skew in performance.

Given Scotland's diverse economic, academic, and geographical landscape, there is no other country or region that is a perfect comparator. English regions also do not act within the same constitutional framework of a devolved nation.

At £37,146, Scotland has the highest GDP per capita of all regions outside the 'golden triangle'.²⁰ Much of this economic activity is concentrated in Scotland's densely populated central belt between Glasgow and Edinburgh, where its largest universities are located and where financial services and high-value manufacturing are particularly strong. Beyond the central belt, economic activity is spread across a range of urban centres and rural areas. In particular, cities in North East Scotland, most notably Aberdeen, play a central role in Scotland's energy economy, while rural and coastal areas continue to host important energy assets and supply chains.

The North West of England is generally the most useful regional case study comparator for Scotland in this report. It shares several features with Scotland that are likely to matter for the productivity returns to research funding. Its GDP per capita is £35,605, close to Scotland's £37,146, and it accounts for 9.7% of UK GDP compared with Scotland's 7.3%. It also has a reasonably similar institutional footprint, with 8.4% of UK institutions compared with Scotland's 10.8%, and a broadly comparable business base on one measure, with small enterprises making up 9.6% of firms compared with 10.6% in Scotland. Like Scotland, much of its economic activity is concentrated along a major urban corridor in which its largest universities are located. In both cases, these areas combine research-intensive universities with concentrations of advanced manufacturing, financial and professional services, and life sciences activity.^{21 22} This makes the North West a useful benchmark for comparing Scotland with a region that has a broadly similar economic and institutional profile outside the 'golden triangle'.

However, the comparison is not exact. The North West receives a smaller share of UK research funding than Scotland, 8.3% compared with 12.9%, despite accounting for a larger share of UK GDP, suggesting a less research-intensive university sector. It is also more populous, accounting for 11.1% of the UK population compared with Scotland's 8.0%, and it does not share Scotland's stronger energy specialism. The North West should therefore be treated as a helpful benchmark rather than a direct counterfactual.

The South West and the North East also make reasonable comparators in specific contexts, with the South West having a similar academic landscape, and the North East having a similar business composition.

²⁰ The 'golden triangle' regions refers to the South East, East of England and London, which together encompass the high-ranking research-intensive universities in Oxford, Cambridge and London.

²¹ However, the precise sectoral mix differs. Scotland's strengths are more closely tied to lightweight manufacturing, photonics, space and the energy transition, whereas the North West has stronger specialisms in advanced materials and health-related manufacturing ([Manufacturing - SG](#); [Economy - GMCA](#))

²² [Regional gross value added \(balanced\) by industry: all ITL regions - Office for National Statistics](#)

2 Innovation and knowledge production by universities

Key findings

Scottish universities have a strong track record of creating new knowledge and innovation from their research activities.

- Scottish universities published around 26,000 papers in 2024, with output broadly stable over the last decade [see Figure 2].

Relative to research funding Scotland is more effective at producing papers than most other areas of the UK.

- Scotland produced 23.2 publications per £ million of university research funding since 2018. This is higher than most UK regions, including the 'golden triangle' [see Figure 3].

Scottish university publications are highly impactful by global standards.

- Scottish university publications are cited by other papers 61% more frequently than the global average. This is a slightly higher average citation impact score (1.6) than most UK regions outside the 'golden triangle' [see Figure 6].
- 16% of Scottish papers are in the top 10% of cited papers in their field, this is also slightly higher than most regions outside the 'golden triangle' [see Figure 6].

Scottish universities have produced fewer patents relative to research funding than the UK average but the impact of patents that are produced is just as strong.

- Scottish universities have produced 43.4 new patent family publications per £ million research funding since 2018, compared to 50.4 across all UK universities [see Figure 8].
 - A measure of patent 'strength', the Derwent Strength Index (DSI), suggests that the impact of Scottish university patents is just as strong as the UK average [see Figure 9].
-

New knowledge and innovation produced by university research is the key expected driver of economic returns. This research output increases the stock of knowledge firms can draw on, increasing the likelihood of downstream innovation and resulting productivity gains.

There are many examples of Scottish university research generating new knowledge that provides beneficial impacts for the private and public sectors.²³

To quantify and benchmark university knowledge creation in Scotland as compared with the UK we examine metrics relating to two common proxies for knowledge creation:

- **Academic publications:** The publication of research findings in peer-reviewed journals, conference proceedings and other scholarly outputs is a core mechanism through which universities disseminate new knowledge.

²³ See the examples in [SFC \(2023\) The bedrock of university research: SFC's Research Excellence Grant](#)

- **Patents:** The filing of patents represents the formal protection of the intellectual property a university created through research. However, it should be noted upfront that not all commercially valuable knowledge is patented, and institutions may vary in their approaches to whether and how IP arising from research is protected.

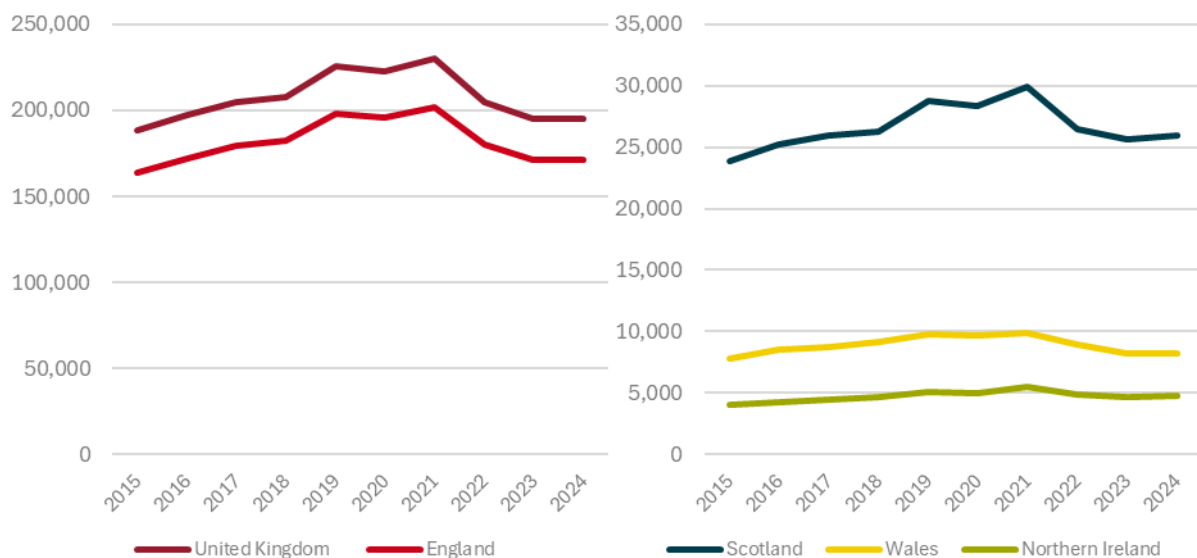
2.1 Academic publications

Publications are the most visible and widely comparable output of university research. They provide a record of intellectual contribution, signal research quality through peer review, and allow findings to be scrutinised, replicated and built upon by others. Bibliometric indicators, such as citation counts and citation impact scores, can offer insight into the influence and reach of research outputs. While not all impactful research is highly cited, publication activity remains a central indicator of the scale, visibility, and academic influence of knowledge creation.

Academic output

Authors affiliated with Scottish universities published around 26,000 papers in 2024, up from 24,000 in 2015. Figure 2 shows that Scottish output increased gradually over the period up to 2021, before falling back to around the level of publications seen in 2018. A similar pattern is also observed for other parts of the UK.

Figure 2 Number of publications produced annually by academic institutions (2015-2024)



Source: Clarivate; Frontier Economics; Web of Science

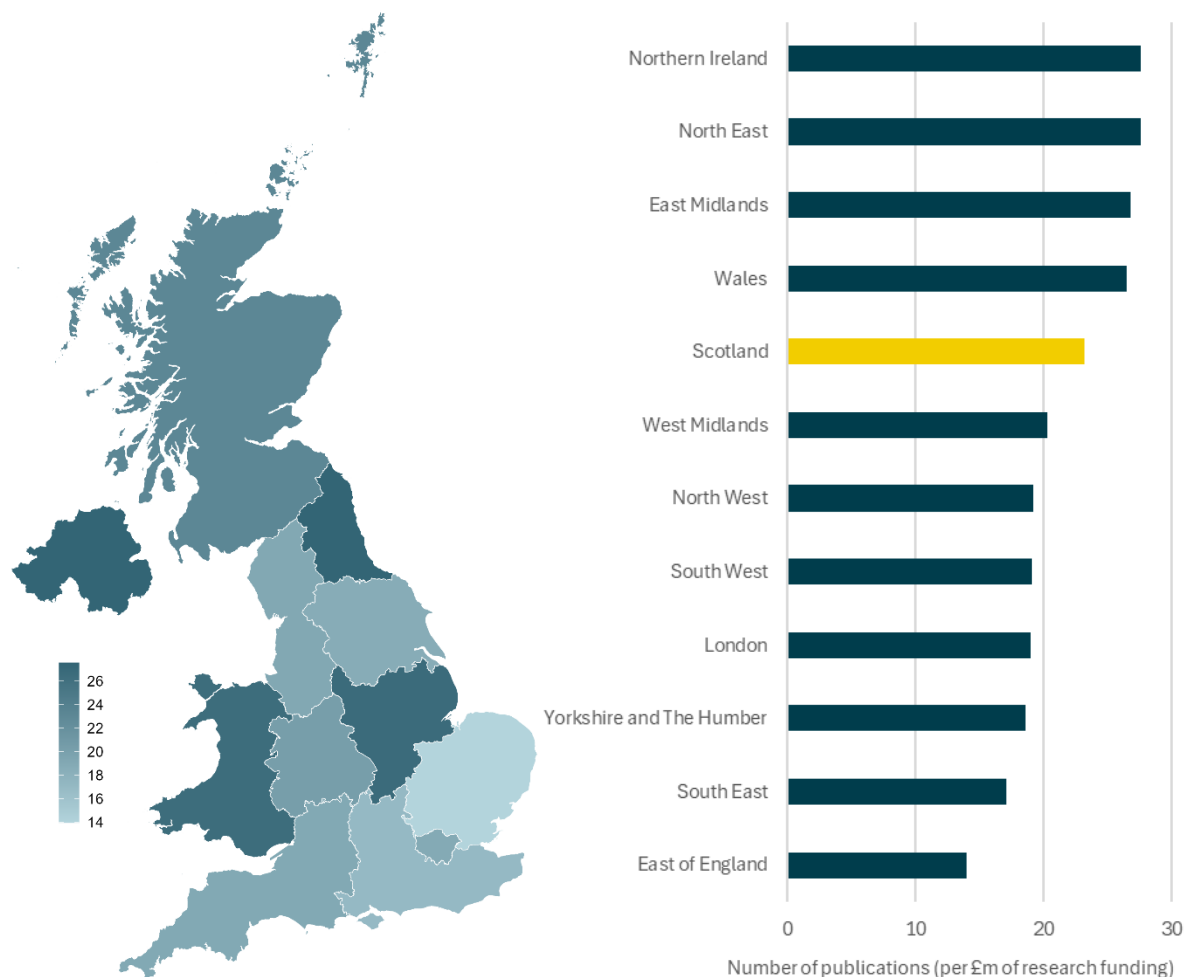
Note: Publications are associated with a country if at least one co-author is affiliated with a university in that country. An individual paper may therefore be associated with multiple geographies.

To understand the relative effectiveness of Scottish universities at producing new knowledge (as proxied by academic publications), it is important to account for the different level of

spending on research. We calculate the total academic output per £ million of total research funding over the past five years for which data is available. This is not a perfect normalisation, as academic output is rarely published in the year in which research is funded, but it gives an approximation to how the effectiveness of institutions compares.

On this basis, Scotland produced 23.2 papers per £ million of research spending over the past five years for which data is available. Figure 3 illustrates how this compares across the countries and regions of the UK. Scottish universities produce more publications per unit of research income than universities in most regions of England. This includes the 'golden triangle', the North West and the South West. Scotland's public research inputs are therefore being translated into a relatively large stock of accessible knowledge that can, in principle, be drawn on by firms.

Figure 3 Average number of publications produced in UK nations annually, per £m of research funding (2020-2024)



Source: Clarivate; Frontier Economics; Web of Science

Note: UK and England bars omitted to avoid misleading interpretation due to double counting of publications where multiple regions contribute

One nuance is that publications are often co-authored across institutions and geographies. Between 2015 and 2024, 21.8% of papers with a Scottish academic author involved collaboration with co-authors elsewhere in the UK, and 58.8% involved international collaboration. This means that Scottish research is frequently produced as part of wider UK and global research networks. That is a strength, because it supports research quality, but it also means the benefits of knowledge generated are likely to be spread geographically rather than concentrated in Scotland.²⁴

Accounting for subject

Regional comparisons of research output may be affected by different research specialisms. Publication behaviour differs across disciplines: some fields publish frequently through journals and conference proceedings, while others disseminate knowledge through alternative routes such as books, software, standards, clinical trials, or confidential industry collaboration. The cost of producing a publishable output can also vary materially between, for example, laboratory-based biomedical research and desk-based social science. The subject composition of research in a region therefore matters. A region with a higher concentration of publication-intensive disciplines, or disciplines that are lower cost, could appear more productive on this metric even if underlying research effectiveness for any given subject area is the same.

Figure 4 illustrates the proportion of academic publications between 2015 and 2024 that can be categorised into different subjects for both Scotland and the UK. The data suggest that Scotland's subject mix is broadly similar to the UK at a high level, which reduces the risk that the headline comparisons are driven purely by composition effects. The largest differences are that Scotland has a somewhat greater publication focus on Biosciences and Physics, and a lower focus on Clinical Medicine, than the UK average.²⁵

²⁴ [Wang et al \(2020\)](#), for example, find that international collaboration leads to higher citation counts, and that publications with international co-authorship lead to higher citations from abroad.

²⁵ This comparison suggests smaller differences in subject focus between Scotland and the rest of the UK than the Fraser of Allander (2023) report on the economic impact of research funding in Scotland. This may be because that report focussed on a narrower measure of academic output (Research Excellence Framework case studies) or because that report focussed more on the rank of Scotland within regions of the UK rather than the level in Scotland as compared to the UK average.

Figure 4 Subject focus of academic output (% of publications that relate to a subject area), 2015-2024

HESA Cost Centre	Scotland	UK	Relative focus
101 Clinical medicine	21.8%	23.1%	-1.3%
112 Biosciences	19.1%	16.7%	2.5%
114 Physics	10.7%	9.1%	1.6%
119 Electrical, electronic & computer engineering	6.6%	6.2%	0.4%
121 IT, systems sciences & computer software engineering	6.5%	6.9%	-0.3%
111 Earth, marine & environmental sciences	5.6%	4.6%	1.0%
113 Chemistry	5.3%	5.5%	-0.2%
124 Geography & environmental studies	5.2%	4.4%	0.8%
104 Psychology & behavioural sciences	5.1%	5.9%	-0.9%
115 General engineering	4.7%	4.4%	0.3%
105 Health & community studies	4.6%	4.7%	-0.2%
117 Mineral, metallurgy & materials engineering	3.6%	4.3%	-0.7%
122 Mathematics	3.3%	3.5%	-0.1%
103 Nursing & allied health professions	3.3%	4.1%	-0.8%
133 Business & management studies	2.4%	2.9%	-0.5%
132 Sociology	2.4%	2.9%	-0.5%
139 History	2.3%	2.9%	-0.6%
110 Agriculture, forestry & food science	2.0%	1.2%	0.8%
128 Politics & international studies	2.0%	2.4%	-0.4%
135 Education	1.8%	1.8%	-0.1%
120 Mechanical, aero & production engineering	1.6%	1.9%	-0.3%
107 Pharmacy & pharmacology	1.5%	1.7%	-0.2%
129 Economics & econometrics	1.4%	2.1%	-0.6%
123 Architecture, built environment & planning	1.4%	1.7%	-0.3%
137 Modern languages	1.4%	1.6%	-0.2%
109 Veterinary science	1.4%	0.7%	0.7%
127 Anthropology & development studies	1.3%	1.6%	-0.3%
106 Anatomy & physiology	1.3%	1.5%	-0.2%
142 Theology & religious studies	1.2%	0.9%	0.3%
130 Law	1.2%	1.4%	-0.3%
141 Philosophy	1.1%	1.1%	0.0%
118 Civil engineering	1.0%	0.9%	0.1%
116 Chemical engineering	0.9%	0.9%	0.0%
131 Social work & social policy	0.9%	0.9%	-0.1%
108 Sports science & leisure studies	0.6%	0.8%	-0.2%
126 Archaeology	0.6%	0.6%	0.0%
138 English language & literature	0.5%	0.6%	-0.1%
143 Art & design	0.5%	0.5%	0.0%
144 Music, dance, drama & performing arts	0.5%	0.7%	-0.2%
134 Catering & hospitality management	0.4%	0.5%	-0.1%
125 Area studies	0.4%	0.6%	-0.2%
102 Clinical dentistry	0.4%	0.4%	-0.1%
140 Classics	0.2%	0.2%	0.0%
145 Media studies	0.2%	0.3%	-0.1%

Source: Clarivate; Web of Science

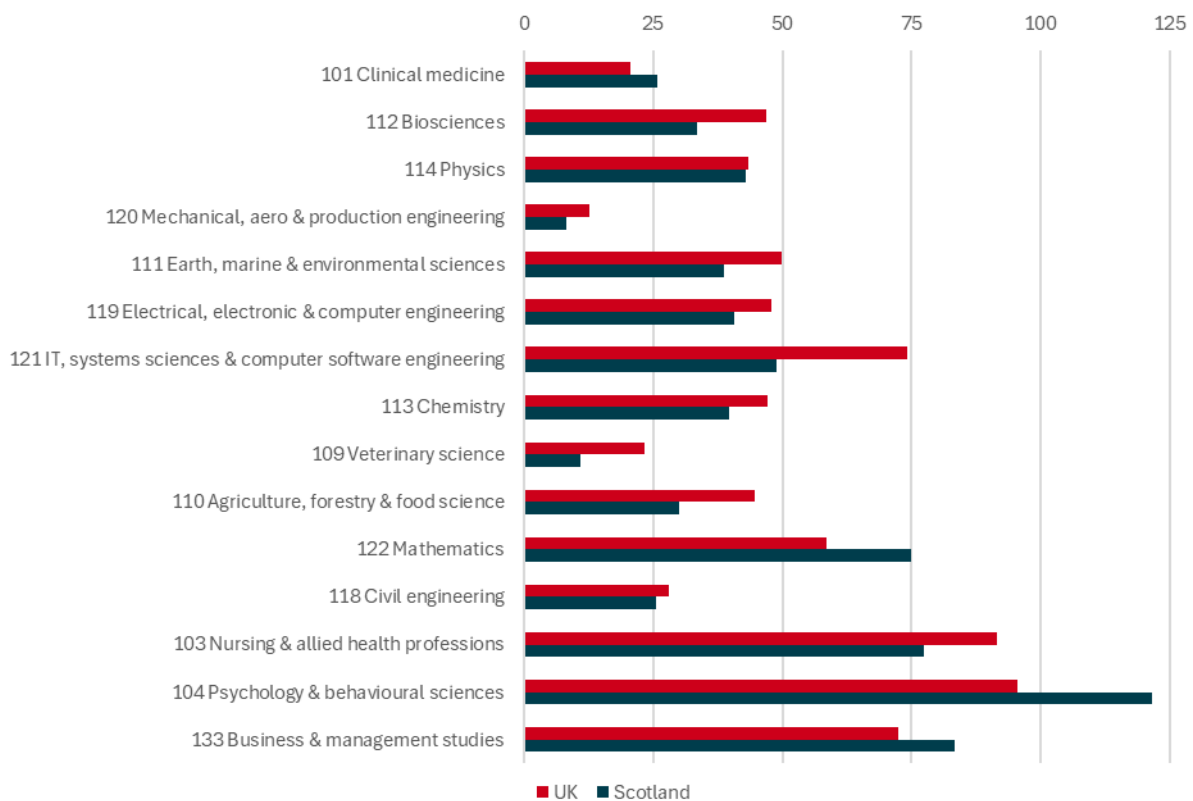
Notes: Only cost centres that account for at least 1% of Scottish or UK output are included. Publications can be categorised under more than one cost centre. HESA cost centres are used to define subjects to facilitate comparison with funding amounts.

To test whether subject mix is materially affecting the conclusions, we compare publications to research funding within subject. The funding measure used here excludes funding body grants, which comprise of funding from national public funding bodies, such as SFC in Scotland. This is because such grants cannot be allocated cleanly to subject areas. Funding body grants comprise of 25% of UK research funding (23% in Scotland).

Figure 5 shows significant variation across subject areas in papers produced per £ million of research funding. Scotland appears relatively effective in some subjects and less effective in others, which is consistent with differences in research practice, capital intensity, and publication norms. This variation also suggests where more granular analysis could add value in future. For example, examining the link between subject-level publication outcomes and the industrial structure in Scotland could help identify where the strongest potential spillovers to Scottish businesses are likely to arise.

Overall, however, it does not appear that the headline comparison of Scottish and UK research effectiveness at producing academic publications is unduly affected by differing subject specialisms.

Figure 5 Average number of papers produced per £m of research funding (2020-2024)



Source: Clarivate; Web of Science

Notes: Top 15 cost centres by research funding in Scotland, excluding the ~25% of funding which comes from funding body grants. Publications can be categorised under more than one cost centre.

Academic impact

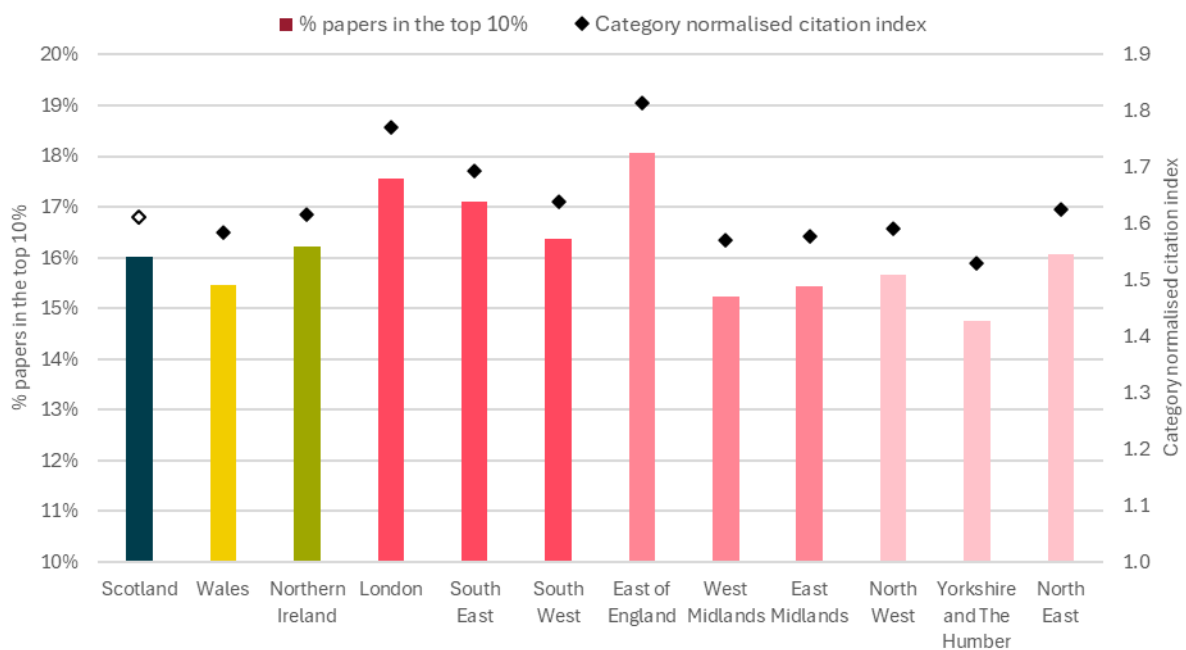
When assessing productivity spillovers, it is important to consider whether published knowledge is adopted by other researchers and, ultimately, by innovators in the private sector. We therefore complement the volume measures with indicators of citation impact, which provide one signal of how far Scottish outputs shape subsequent research.

Scottish university publications are highly cited by other papers relative to the global baseline. Over the past five years the average citation impact score is 1.61, meaning Scottish papers are cited 61% more frequently than the global average. 16% of Scottish papers are in the top 10% of cited papers in their field. This is consistent with Scotland's strong global research reputation.

These measures compare favourably with the UK average. Over the same period, UK publications have an average citation impact score of 1.50, and 15.1% are in the top 10% most cited. Taken together with the output measures above, this suggests that Scottish universities are not only producing a large volume of published research findings relative to total funding, but are also producing findings that are influential by global standards.

Figure 6 shows the regional pattern. Scottish publication average impact is below the 'golden triangle' regions (London, the South East and the East of England), but is comparable with other English regions. This includes the North West, which has a citation impact score of 1.59 and 15.6% of papers in the top 10% of most cited papers.

Figure 6 Average CNCI and proportion of papers in the top 10% (2020-2024)



Source: Clarivate; Web of Science

2.2 Patents

Patents are a more selective indicator of knowledge production and can help to identify research outputs with direct commercial relevance. By granting time limited legal protection for inventions that are novel and useful, patents indicate the possibility of commercial returns through licensing, spin out formation, or incorporation into existing business activity.

However, not all commercially valuable knowledge is patented. Recent policy discussions have also placed greater emphasis on open research and more open approaches to IP, particularly for publicly funded knowledge, on the grounds that restrictive protection can in some cases slow diffusion and follow-on innovation.²⁶

Further, patenting propensity varies substantially across disciplines, and universities may differ in their approach to intellectual property management and commercialisation. Direct financial returns from licensing and related IP activities are also typically modest and concentrated in a small number of institutions and cases.²⁷

Patent data, like data on academic publications, should therefore be interpreted as one lens on knowledge production, rather than a comprehensive measure of economic value.

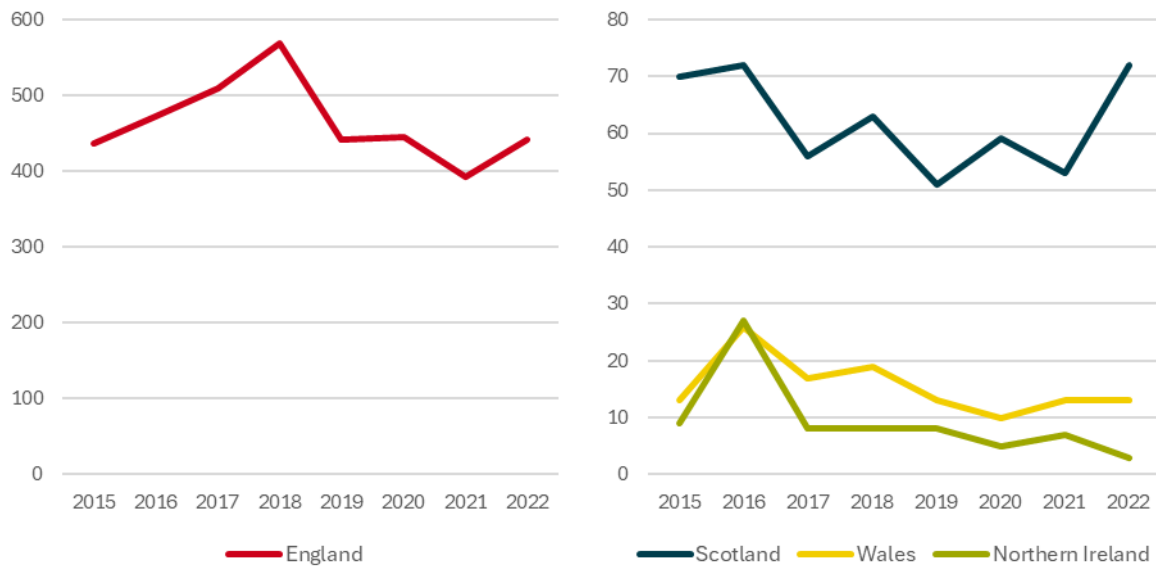
We focus on patent families, which group related filings across jurisdictions and can be interpreted as unique inventions. Scottish universities were associated with 496 patent families first published over the period 2015-2022.

Figure 7 illustrates how the number of patent families published has changed over time. Patent publication is more volatile than academic publications and therefore differences over time should be interpreted carefully. There do not appear to be strong or persistent trends in patent publication in Scotland or England over this period.

²⁶ [Ensuring open research – UKRI](#)

²⁷ As demonstrated in Figure 16.

Figure 7 Number of patent families published (2015-2022)

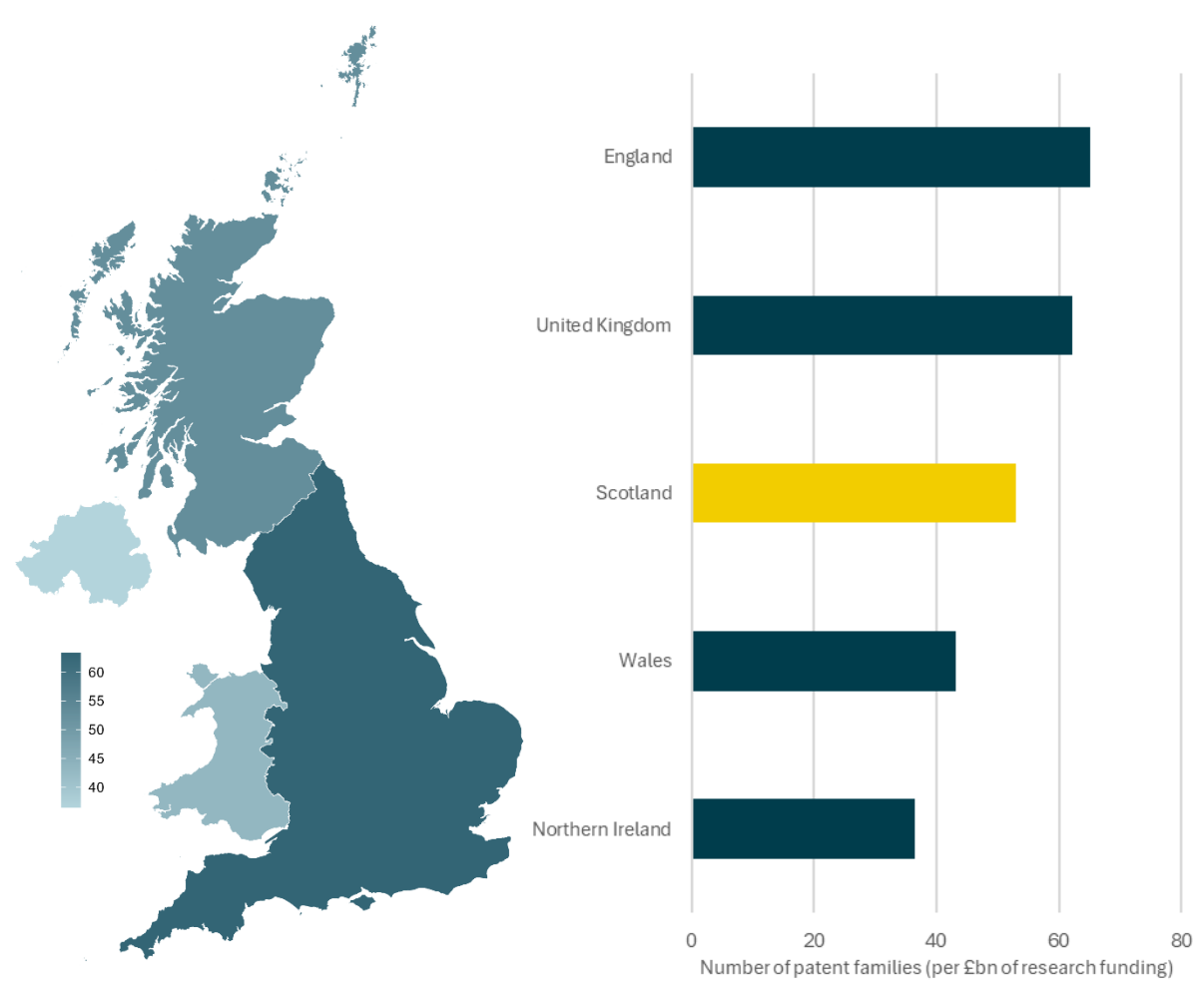


Source: Clarivate; Derwent World Patents Index.

Notes: In the charts above the year represents the 'earliest priority date'. This is the earliest filing date associated with an invention, typically the first time it was filed anywhere in the world. It is the best proxy for when the underlying invention was created.

To compare the relative effectiveness of Scottish research at producing patents, as compared with the UK overall, it is again important to control for the different level of research spending between countries. Figure 8 therefore normalises patent families by total university research spending over the past five years for which data is available. On this basis, Scottish universities have produced fewer patent families than the UK overall, at 53.0 per £ billion of research funding compared with 62.2 for the UK. This suggests that Scotland's research base has lower tendency to generate patentable inventions. However, this does not necessarily imply weaker underlying research quality. For example, it may reflect variation in the commercial strategy of universities in each area of the UK.

Figure 8 Average patent families produced per £ billion of research funding (2018-2022)



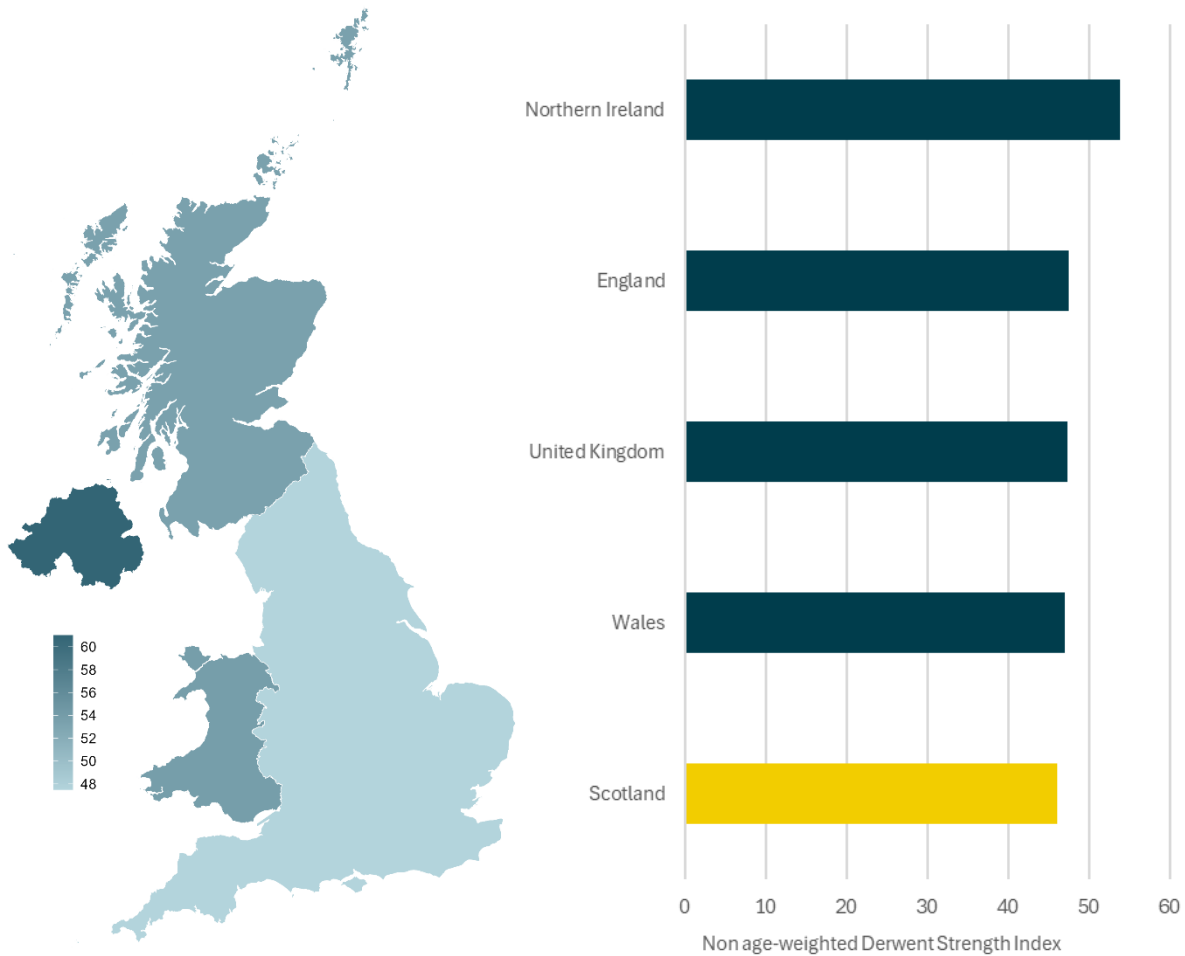
Source: Clarivate; Frontier Economics; Web of Science

For returns to research, an important question is not only how many patents are produced, but whether those patents represent high-value inventions that can be commercialised or adopted by firms.

To shed light on the likely significance of patented inventions, we draw on the Derwent Strength Index (DSI), a metric developed by Clarivate that captures several features associated with patent ‘strength’. These include citation performance, breadth across technology classes, and the extent of international filing. While no single metric can fully measure commercial value, the DSI provides a useful way to compare the relative quality and potential influence of patent portfolios across geographies.

Figure 9 illustrates that the average DSI for Scottish university patents published over the past ten years for which data is available is similar to that for all UK university patents (46 as compared to 47). This suggests that where Scottish universities generate patents, they generate patents of comparable strength to the UK benchmark.

Figure 9 Average Derwent Strength Index by Country (2015-2024)



Source: Clarivate; Frontier Economics; Web of Science

Notes: The Derwent Strength Index reported is not weighted to account for the amount of time remaining each patent at the time of the analysis.

2.3 Summary of innovation and knowledge production

The production of new knowledge and innovation is a key first step in the main pathway through which university research generates economic returns through productivity improvements. We have examined two proxies for universities’ production of new knowledge and innovation: academic publications and patents.

Scotland’s university research base appears strong at generating knowledge. Relative to research funding Scotland is more effective at producing papers than most other areas of the UK, and Scottish publications have higher impact than most UK regions outside of the ‘golden triangle’ (including the North West). This does not appear to be driven by significant subject area differences between Scotland and the rest of the UK.

Scottish university patent output is slightly below the UK average, but this could be driven by different preferences for intellectual property protection as much as differences in the extent to which research generates commercially relevant knowledge. The strength of Scottish patents is comparable to the UK average.

However, the production of new knowledge does not guarantee that productivity gains will be made downstream by businesses. The extent of Scottish economic benefit will depend on how effectively knowledge is disseminated and absorbed by firms, and on whether the relevant firms are located in Scotland. The dissemination of knowledge to businesses is explored in the next sections.

3 University and business collaboration on research

Key findings

Scottish universities actively collaborate on research with industry, suggesting the co-production of strategically important knowledge.

- Scottish universities had over 7,000 external research grants and contracts with industry, commerce and public corporations in 2023/24. Half of these were from SMEs in Scotland, and a further 3% from larger businesses in Scotland [see Figure 10].
- The proportion of university research funding from external grants and contracts funded by industry has modestly grown across the UK from 17.5% to 18.5% between 2017/18 and 2023/24, and has grown slightly faster in Scotland (to 19.4% from the same base) [see Figure 11].
- Scottish universities received 17.9% of their total research income from external research grants and contracts funded by industry over the period 2017/18 to 2023/24. This is similar to the UK average (17.6%), and similar to or higher than many other areas of the UK including the North West and the 'golden triangle' regions [see Figure 12].

Industry co-authorship is more common in Scottish university publications than universities from almost all UK regions.

- 4.6% of Scottish scholarly output involved industry co-authorship. This is higher than any area of the UK outside London (where 5.2% of papers involved industry collaboration) [see Figure 13].
-

New knowledge generated through university research can only be built on or used by private sector firms if they are aware of it. Direct collaboration on research between a university and business provides one such channel through which knowledge generated through university research can reach the private sector. Such research collaboration reduces information barriers, aligns research with business needs, and enables tacit knowledge transfer that is hard to capture in publications alone. The economic benefits from this can arise both through improved products and processes in the partner firm and through wider diffusion as results are shared.

In Scotland, intermediary organisations help initiate and sustain collaboration through SFC-funded infrastructure and targeted innovation investment. Interface, for example, is an SFC-funded hub that helps businesses and other organisations access expertise and talent from Scottish universities, and showcases partnership models across sectors. These brokerage functions can be particularly important in an SME-heavy economy, where firms may lack the capacity to navigate the university landscape unaided.²⁸ Alongside Interface, SFC funds four

²⁸ [Case Studies | Knowledge Connection | Interface Online](#)

Innovation Centres that operate across Scotland to link academic expertise with key sectors, support industry-led problem solving, and develop skills and training for future researchers and knowledge exchange professionals. SFC presents the centres as a means of fostering transformational collaboration between universities, colleges and business, strengthening innovation and entrepreneurship in priority sectors, and supporting jobs and economic growth.²⁹

We explore and benchmark university–business collaboration in Scotland using two complementary metrics that capture both inputs and outputs:

- **University income from external research grants and contracts:** the extent to which businesses fund university research.
- **Industry collaboration on academic publications:** the extent to which collaboration results in jointly authored research publications.

3.1 University income from industry-funded external research grants and contracts

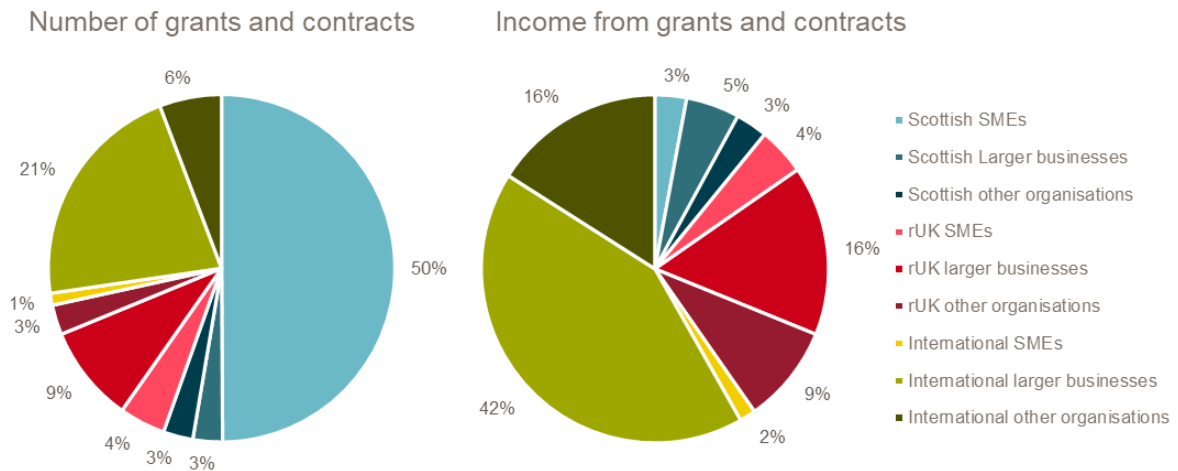
Industry-funded research grants and contracts demonstrate that businesses value university research and are willing to pay to shape it. Knowledge exchange data collected by the Scottish Funding Council indicates there were over 7,000 instances of industry, commerce or public corporations providing external research grants and contracts to Scottish universities in 2023-24.³⁰ In total these grants and contracts provided over £177 million in income, having increased from £120 million in 2020-21.

It is important to note that not all these grants and contracts to Scottish institutions were from businesses in Scotland. Figure 10 shows that half (50%) were from SMEs located in Scotland and 3% from larger businesses in Scotland. By value, only 8% of the income from these grants and contracts was from businesses located in Scotland. Over half (60%) was from organisations located outside the UK. This will have implications when thinking about whether the productivity benefits arising from university research accrue to the Scottish economy (by increasing the productivity of firms in Scotland) or the wider UK economy (by increasing the productivity of firms elsewhere in the UK) or indeed globally.

²⁹ [Innovation Centres - Scottish Funding Council](#)

³⁰ [KE Metrics 2023-24 | SFC](#)

Figure 10 Scottish universities' industry-funded external research grants and contracts (2023/24).



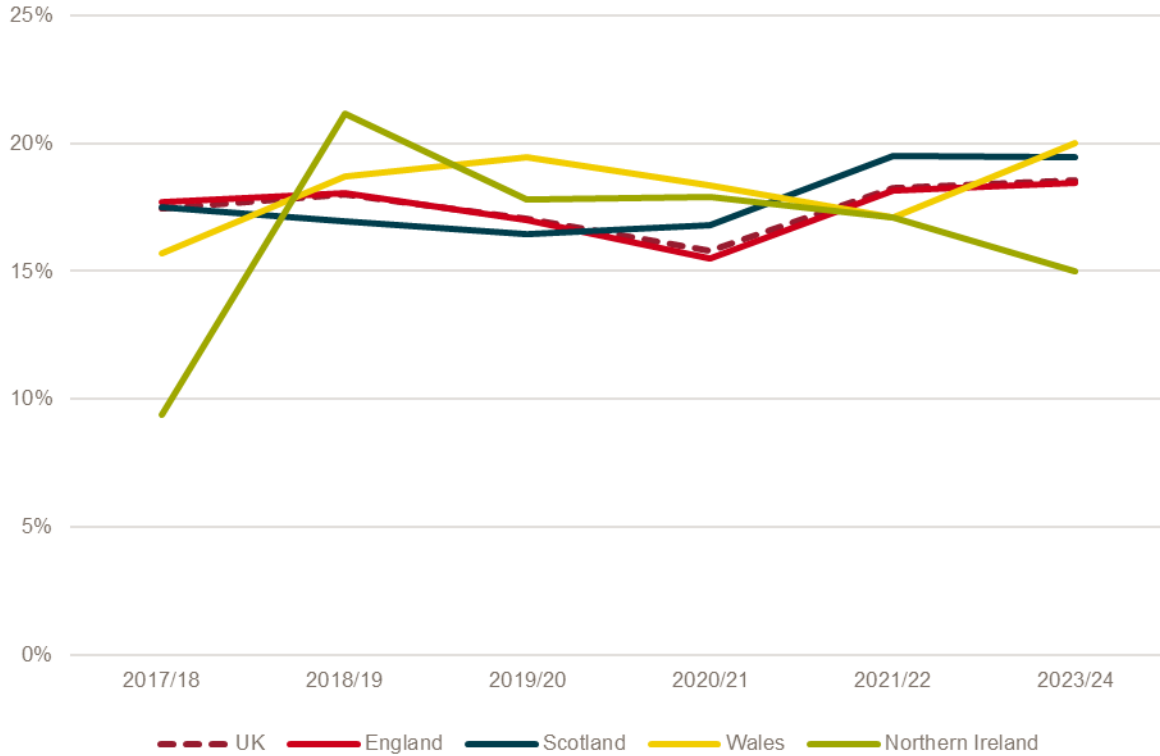
Source: Frontier Economics; Scottish Funding Council KE Metrics 2023-24.

Notes: External research grants and contracts from industry, commerce and public corporations.

For UK-wide benchmarking, we use data from the Higher Education Statistics Agency (HESA) on research grant and contract income from industry, commerce or public corporations, which we refer to as 'private external research income'. This data is collected on a consistent basis across UK institutions, but is not directly comparable with the SFC knowledge exchange dataset because definitions differ. We therefore use each dataset for what it is best suited to: SFC data to understand the composition and geography of engagements in Scotland, and HESA data to compare Scotland with other UK nations and regions.

'Private external research income' has increased slightly as a share of total research income in both Scotland and the UK over recent years, with a greater increase in Scotland. Figure 11 shows it has risen in Scotland from around 17.5% to over 19.4% between 2017/18 to 2023/24, while the UK overall rose to 18.5% from the same base. This divergence is in part because there has been a more rapid increase in total research income in the UK than in Scotland, but also because Scotland has seen a greater increase in industry income than the UK. This suggests Scottish universities have strengthened their collaboration with businesses over time, which should support the likelihood of research producing strategically relevant knowledge that is taken up by firms.

Figure 11 Research grants and contracts income from industry, commerce or public corporations (as a proportion of total research funding, 2017/18 - 2023/24)

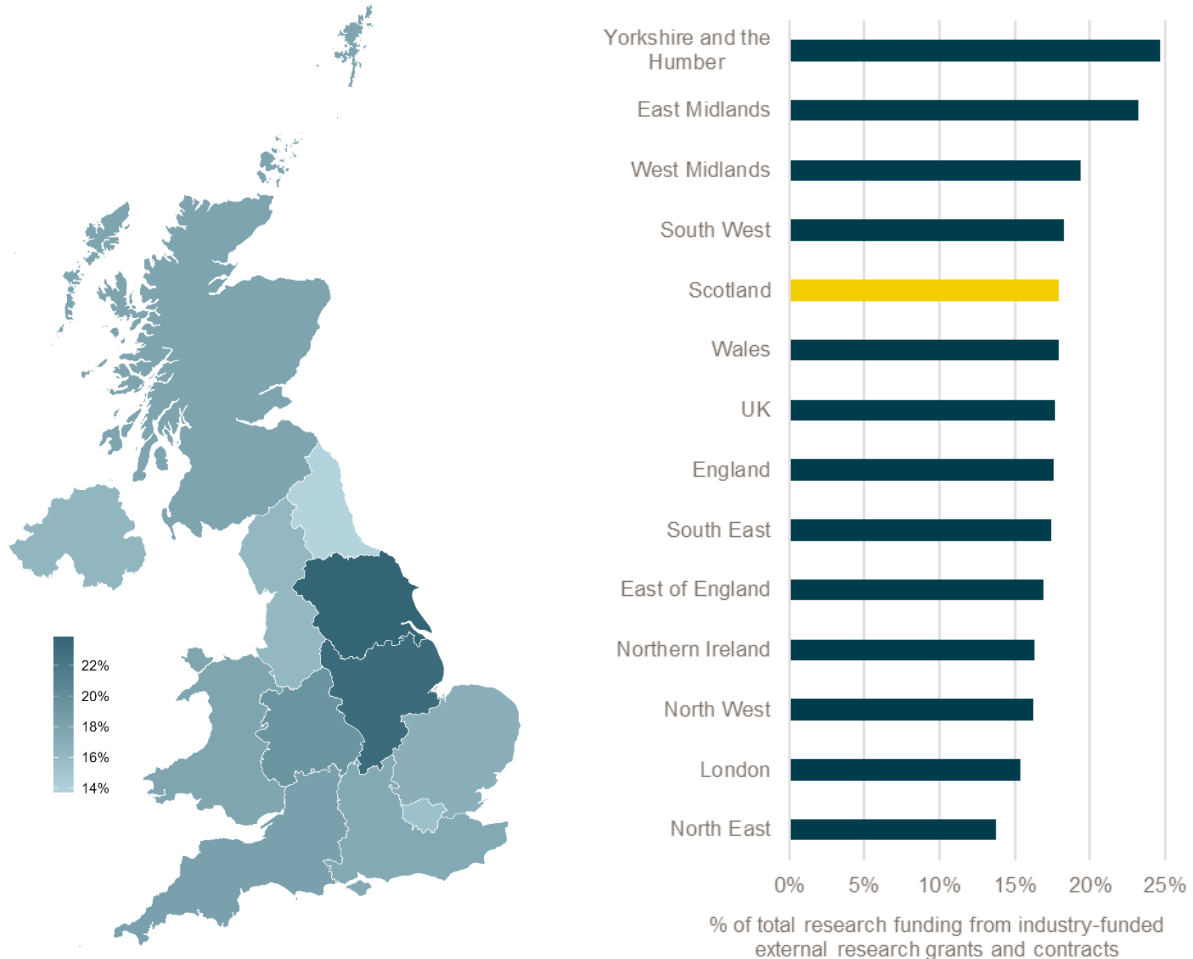


Source: Frontier Economics; HESA income sources data.

Notes: External research grants and contracts from industry, commerce and public corporations.

Figure 12 compares the proportion of total research funding from private external research income across the countries and regions of the UK. Over the last seven years for which data is available 17.9% of total Scottish research income accounted for by research grants and contracts has come from industry, commerce or public corporations. This is similar to the UK average (17.6%). Industry contracts make up a similar or higher proportion of income in Scotland than in all areas of the UK except for Yorkshire and the Humber, the East Midlands, the West Midlands and the South West. This is notably higher than in the North West, where 16.2% of funding comes from industry contracts. This suggests relatively good ties between Scotland's university research base and industry.

Figure 12 Average annual income from industry-funded external research grants and contracts by region (% of total research funding, 2017/18 - 2023/24)



Source: Frontier Economics; HESA income data

Notes: External research grants and contracts from industry, commerce and public corporations.

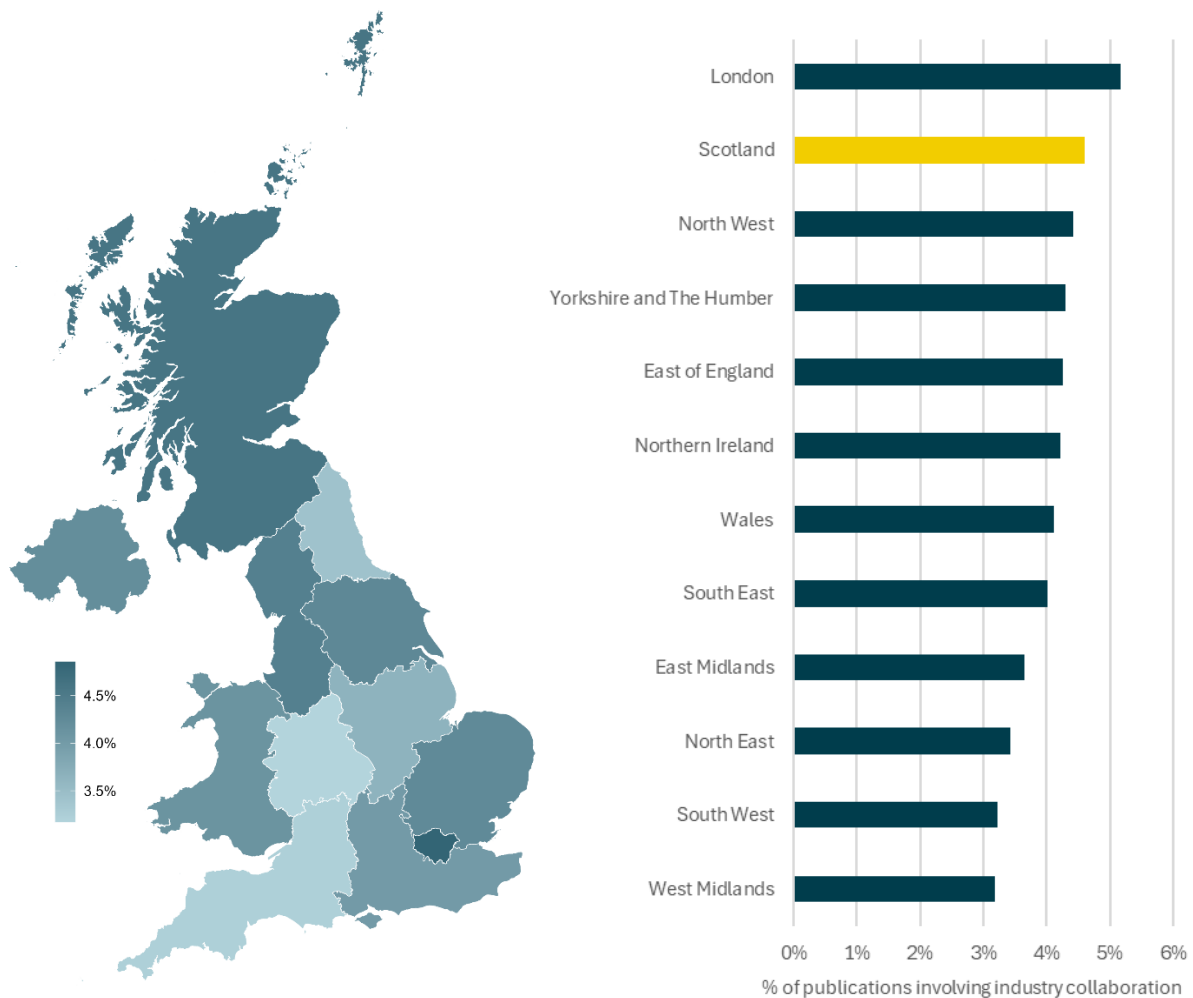
3.2 Industry collaboration on academic publications

Industry co-authorship of academic publications reflects cases where university and industry researchers jointly design and execute research and are willing to disseminate results through academic channels. This is not the only form of collaboration, as some industry partnerships result in confidential outputs rather than publications, but it provides a useful, comparable metric.

Scottish universities' publication record shows relatively strong engagement with industry by UK and global standards. Figure 13 shows that, between 2020 and 2024, 4.6% of scholarly output published by an author from a Scottish university was co-authored with an author from industry. This is greater than any country or region of the UK except London. It is also almost

twice the global average of 2.4% during the same period.³¹ This indicates that businesses are active participants in the Scottish research ecosystem, which can accelerate diffusion by embedding firms directly in research networks. The North West appears to have similarly high levels of industry collaboration, with 4.4% of publications produced involving industry collaboration.

Figure 13 Average proportion of publications produced which involved industry collaboration (2020-2024)



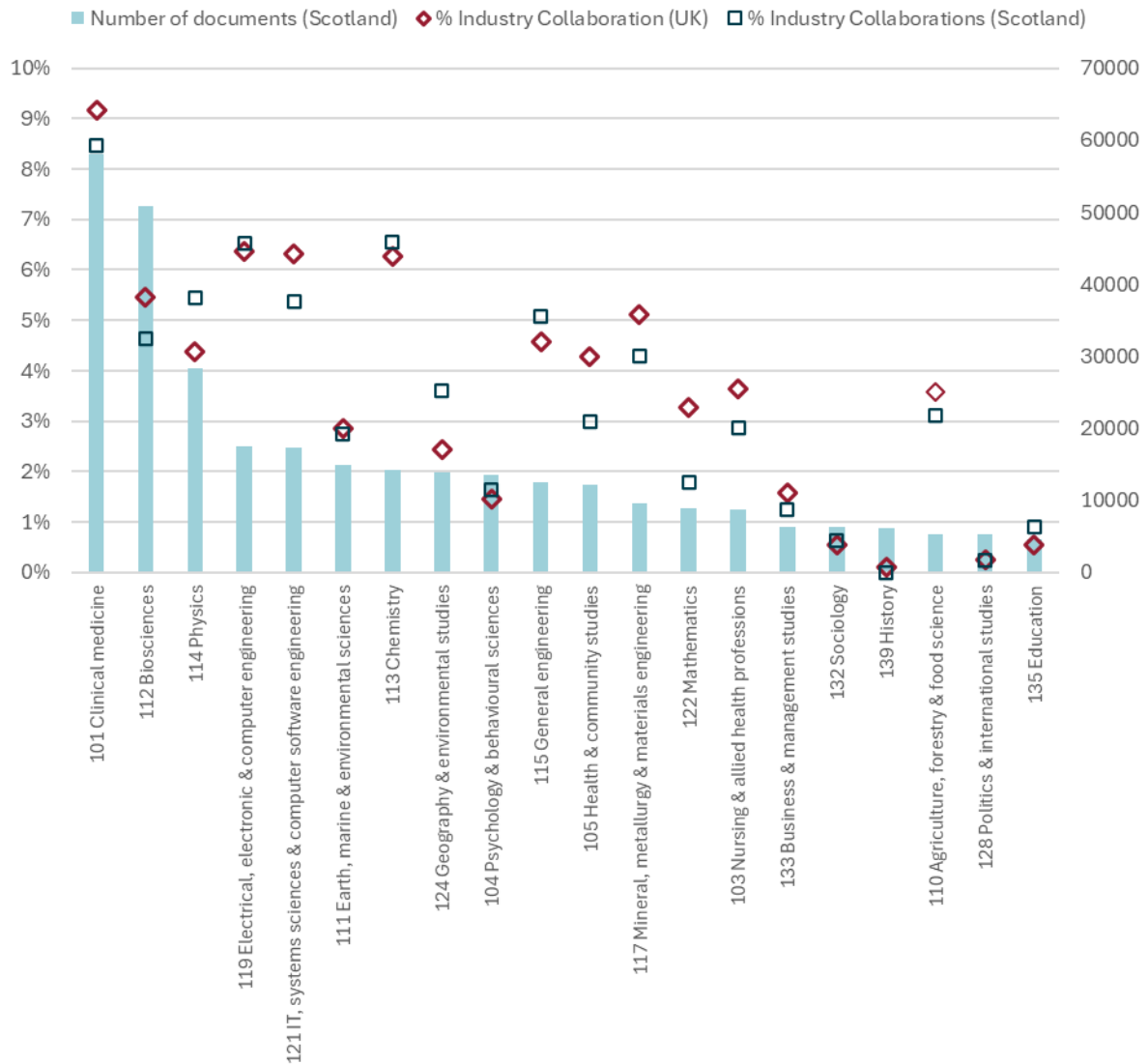
Source: Clarivate; Web of Science

Discipline-level patterns show collaboration rates vary substantially across subjects, but Scotland's relative performance is broadly consistent within subjects. Figure 14 shows industry co-authorship rates for the 20 subject areas in which Scotland produces the most publications. The large differences across subjects are expected given variation in publication

³¹ The [Scottish Research and Innovation Dashboard](#) produced by Elsevier, covering the years 2020 to 2024, also found that the share of scholarly output involving academic and corporate collaboration in Scotland was high by global standards, at 5.8% compared to a world average of 2.6%.

norms and industry engagement across subjects. Within each subject, however, the rates of industry collaboration are relatively similar for Scottish publications as the UK average.

Figure 14 Rates of industry collaboration by subject (2015-2024)



Source: Clarivate; Web of Science

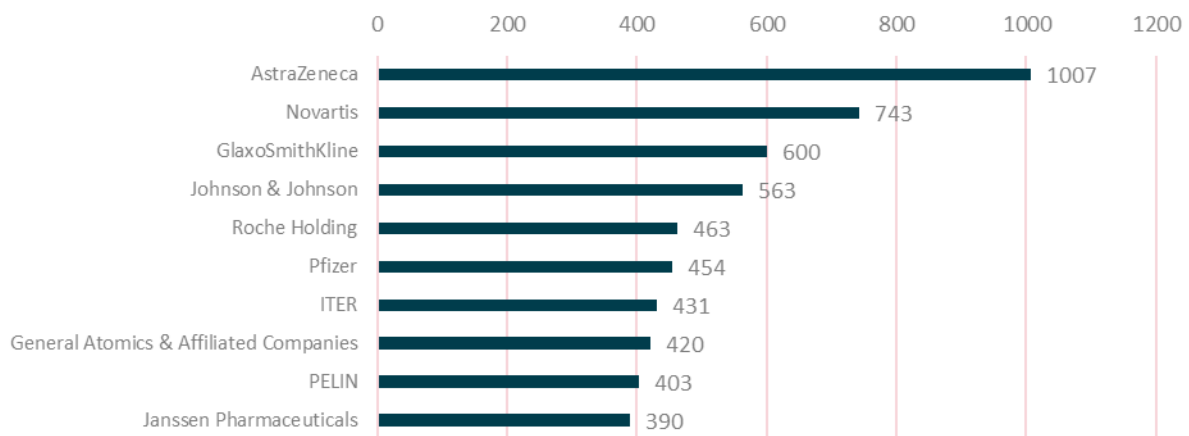
The variation in industry collaboration across subjects also points to industries where productivity spillovers from knowledge generated by universities may be most likely. Further analysis to explore the links between university subject area strengths and Scottish industrial strengths could be valuable to understand these connections between universities and the local economy in more detail.

Industry co-authorship in Scotland is shaped strongly by life sciences and pharmaceuticals, where collaboration and publishing are both common. Clarivate analysis finds that among the 30 businesses with the most co-authored papers with Scottish researchers, 21 are pharmaceutical companies. This reflects a high propensity to publish academic papers from

pharmaceutical research. It also embodies high rates of collaboration between business and universities to fund pharmaceutical research, which aligns with Scotland's strengths, shown by Figure 4.

The ten businesses with the highest number of publications co-authored with Scottish researchers are listed in Figure 15.

Figure 15 Top 10 business collaborators with Scottish universities, by number of co-authored publications (2015-2024)



Source: Clarivate; Web of Science

3.3 Summary of university and business collaboration on research

Across multiple indicators, Scottish universities appear well integrated into business-facing research activity. Industry-funded research income is broadly in line with the UK benchmark and significantly higher than in the North West. Industry co-authorship rates are among the strongest outside London. Together, these measures support the view that a material share of Scottish university research is being co-produced with businesses, which should increase the likelihood of strategic relevance and uptake by businesses.

The geography of collaboration matters for the how much of the productivity benefits arising from knowledge produced by universities accrue to the Scottish economy as opposed to the UK economy more broadly or international economies. The SFC knowledge exchange data suggest many engagements are with Scottish SMEs, but higher-value contracts often involve organisations outside Scotland and outside the UK, implying that some direct productivity benefits will accrue elsewhere even when research is conducted in Scotland. Future work that traces the location and sector of collaborating firms, and links collaboration to downstream innovation outcomes and Foreign Direct Investment, would help clarify how far these spillovers are being captured within Scotland. This would likely require new primary data collection on the firms that collaborate with universities.

4 Dissemination of university-produced knowledge through wider university interactions with businesses

Key findings

Scottish universities undertake a high volume of interactions with business and community services, relative to their research funding.

- Scottish universities had over 12,000 consultancy interactions in 2023/24. The majority (74%) of these were with organisations based in Scotland [see Figure 16].
- Scottish universities have seen increasing numbers of business and community service interactions (consultancy, contract research, and facilities and equipment services) over the past ten years while the numbers have declined elsewhere in the UK [see Figure 17].
- Scottish universities record around 25 interactions per £ million of research funding (covering consultancy, contract research and facilities and equipment services), compared with around 16 interactions per £ million across the UK. Only the North West of England has a higher level of interactions relative to research funding (27 per £ million) [see Figure 18].

Those interactions yield less income in Scotland than the UK average.

- The average value of a consultancy interaction in Scotland was around £3,700 compared to around £6,800 across the UK. For contract research the average value was £38,600 in Scotland compared to £45,100 across the UK.
- Scottish university interactions with business and community services (including consultancy, contract research and facilities and equipment services) generated around £235,000 of income per £ million of research funding, while across the UK as a whole this was around £255,000 per £ million [see Figure 18].

Scottish universities engage actively in providing Continuing Professional Development (CPD), but provide fewer learner days relative to research funding than other parts of the UK.

- Scottish universities had over 6,000 instances of engagement on continuing professional development in 2023/24. 81% of these were with organisations based in Scotland [see Figure 16].
 - Scottish universities receive less income from CPD and continuing education courses per £ million of research funding (around £61,900) than the UK overall (around £75,600). This is due to the fact they provide fewer learner days per £ million of funding (193) than the UK average (443), with Scottish universities receiving more income per learner day than the UK average [see Figure 19].
-

Aside from direct collaboration on research (discussed in Section 3), there are various other routes through which private sector firms may become aware of new knowledge or innovation arising from university research. This includes:

- **Direct interaction with a university:** Businesses may purchase services from universities. This may include consultancy or the use of university facilities. It may include universities delivering continuous professional development (CPD) training for the business' employees. It may also include the licensing of university intellectual property or consultancy services from subject matter experts at the university.
- **Broader dissemination of university research:** Businesses may gain sight of research outcomes through publications, conferences, trade fairs, or professional networks.
- **Recruitment:** Businesses may recruit employees who were previously involved with university research. This is particularly helpful for enabling the transfer of tacit knowledge not easily recorded in publications and patents.
- **Indirectly:** Knowledge spillovers can travel indirectly through supply chains and labour markets, as firms learn from other firms that have engaged with universities or hire staff with research experience. These secondary diffusion routes mean that the economic returns from university research can extend beyond the firms that interact directly with universities.

The benefits of interactions between universities and businesses have long been recognised. Knowledge Transfer Partnership (KTP) schemes, such as that currently operated by UK Research and Innovation, have been around for over 45 years, supporting interaction between businesses and universities to apply academic knowledge to business challenges. An independent evaluation of the 2,100 completed KTP projects between 2010 and 2020 found that they generated an additional £1.7 to £2.3 billion through business growth and higher earnings, implying a return of £4.20 to £5.50 in net economic benefits for every £1 of public and private investment.³² KTP projects help businesses by mitigating the risk of investment, addressing resource constraints, and addressing information failures by facilitating partners to focus on research that is of most strategic benefit to the business. KTP projects also benefit institutions by strengthening knowledge of industry challenges and ability to engage with business, leading to more industry-relevant research and teaching.

Many of the mechanisms for knowledge transfer listed above are hard to observe. It has not been possible to examine recruitment of university researchers or postgraduates into the private sector, for example, due to a lack of suitable data. This would be interesting to explore in future, should new data come to light.

Here we focus on indicators of direct interactions between universities and businesses that could indicate a mechanism for knowledge diffusion:

- **University and business community interactions:** We examine the volume and value of university-reported business interactions. This excludes direct collaboration on research, which is considered in Section 3.

³² [Knowledge Transfer Partnerships evaluation – UKRI](#)

In Section 5 we also examine perspectives of innovating business, which includes perceptions on the importance of various sources of information for innovation.

4.1 University business and community interactions

SFC provides the Knowledge Exchange and Innovation Fund (KEIF) to Scottish universities. This represents core, underpinning funding to support university capacity for knowledge exchange and innovation (KE&I), including activities undertaken alongside external partners (such as businesses).³³

To support allocation of this funding, SFC collects detailed information from Scottish institutions relating to KE activity and income metrics. This summarises important indicators of sector activity and includes information on the output of KE activity, including the type and number of organisations engaged with, and the resulting income from these engagements.

The SFC KE metrics, alongside HESA data, help inform the allocation of this funding and provide a rich source of evidence on the scale and nature of interactions.

Figure 16 uses SFC's KE metrics to illustrate the number of university-business interactions of different types across Scottish universities in 2023/24. As discussed in Section 3 there were over 7,000 external research grants and contracts with industry, commerce and public corporations.³⁴ Far more prevalent, however, were consultancy interactions.³⁵ Scottish universities reported over 12,000 consultancy interactions in 2023/24. There were also around 6,159 instances of engagement on Continuing Professional Development (CPD)³⁶ and 309 Licencing arrangements³⁷. A large majority of consultancy and CPD engagements were with Scottish organisations (81% and 74% respectively).

While external research grants and contracts are the largest source of knowledge exchange income, it is consultancy services that give Scottish universities the widest interaction with Scottish businesses, followed by CPD interactions. These touchpoints are therefore likely to be important conduits that support the diffusion of knowledge into the Scottish economy.

³³ [Knowledge Exchange and Innovation Fund](#)

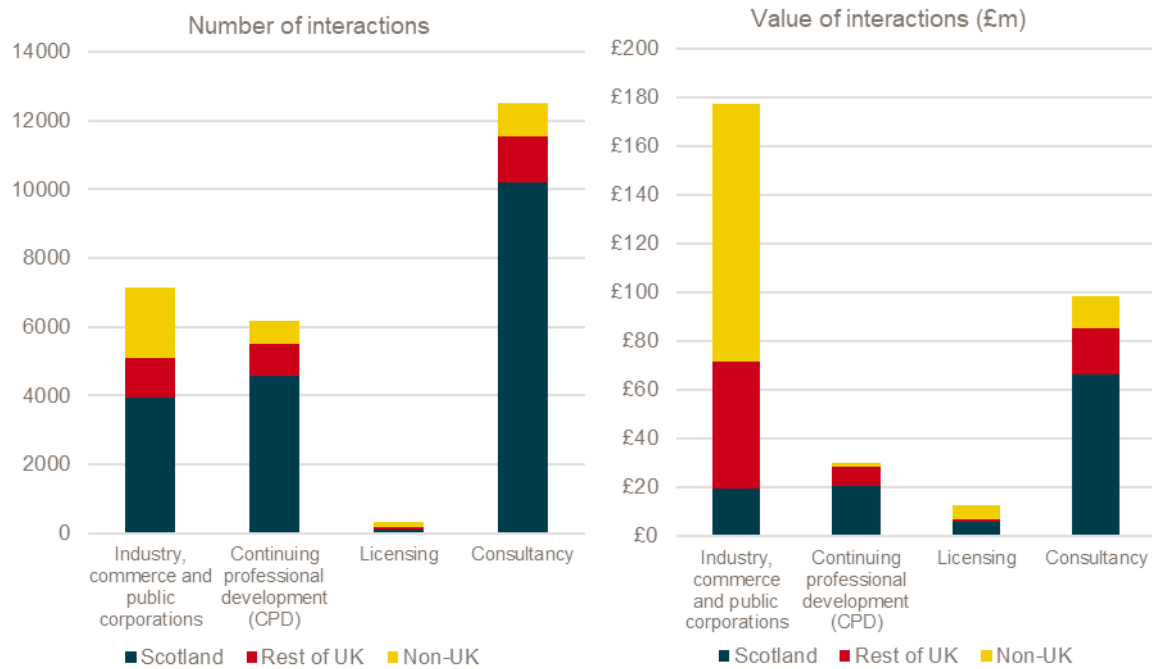
³⁴ KEIF data fields use HESA definitions. HESA defines this as income from research grants and contracts where the sponsor is a UK or non-UK business, industry or commerce organisation, or a public corporation. It covers funding for research projects carried out by the higher education provider under a specific agreement. It excludes consultancy and excludes income from charities, research councils or government bodies that are not classified as public corporations.

³⁵ Defined by HESA as the provision of expert advice and work, which while it may involve a high degree of analysis, measurement or testing, is crucially dependent on a high degree of intellectual input from the HE provider to the client (commercial or non-commercial) without the creation of new knowledge.

³⁶ Defined by HESA as training programmes for learners already in work who are undertaking the course for purposes of professional development/up-skilling/workforce development.

³⁷ Defined by HESA as income received by the higher education provider from the licensing of its intellectual property (IP), including patents, copyright, design rights, plant variety rights, know-how and other forms of legally protectable intellectual property.

Figure 16 Number and value of interactions between Scottish universities and external organisations (2023/24)

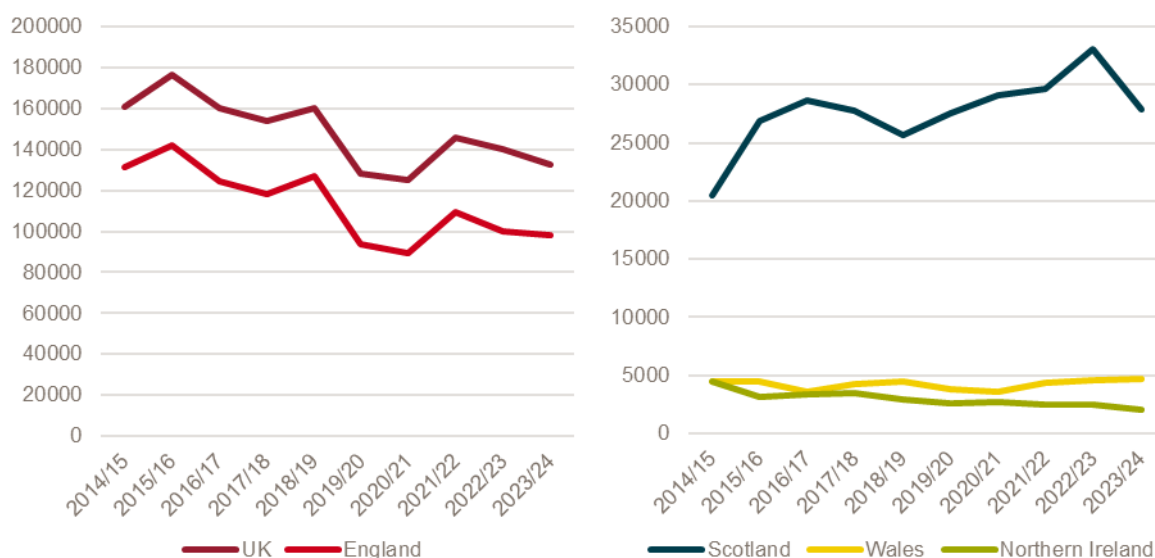


Source: Frontier Economics; Scottish Funding Council Knowledge Exchange Metrics 2023/24

To compare interaction patterns across the UK, we use the Higher Education Business and Community Interaction (HE-BCI) survey collected by HESA. HE-BCI provides a consistent framework for comparing UK institutions, but definitions do not map one-to-one with the SFC knowledge exchange metrics. We therefore use HE-BCI primarily to benchmark Scotland against other UK nations and regions.

Scotland has bucked the broader UK trend of declining business and community service interactions (consultancy, contract research, and facilities and equipment services). Figure 17 used HESA HE-BCI data to show that the number of interactions has fallen over the past ten years for which data is available in English universities but has been broadly increasing in Scottish universities. This suggests either increasing demand from businesses for Scottish university services, increasing institutional focus on engagement, or both.

Figure 17 Number of business and community services provided, by country (2014/15 - 2023/24)



Source: Frontier Economics; HESA HE-BCI data

Notes: These business and community services provided relate to contract research, consultancy, and facilities/equipment

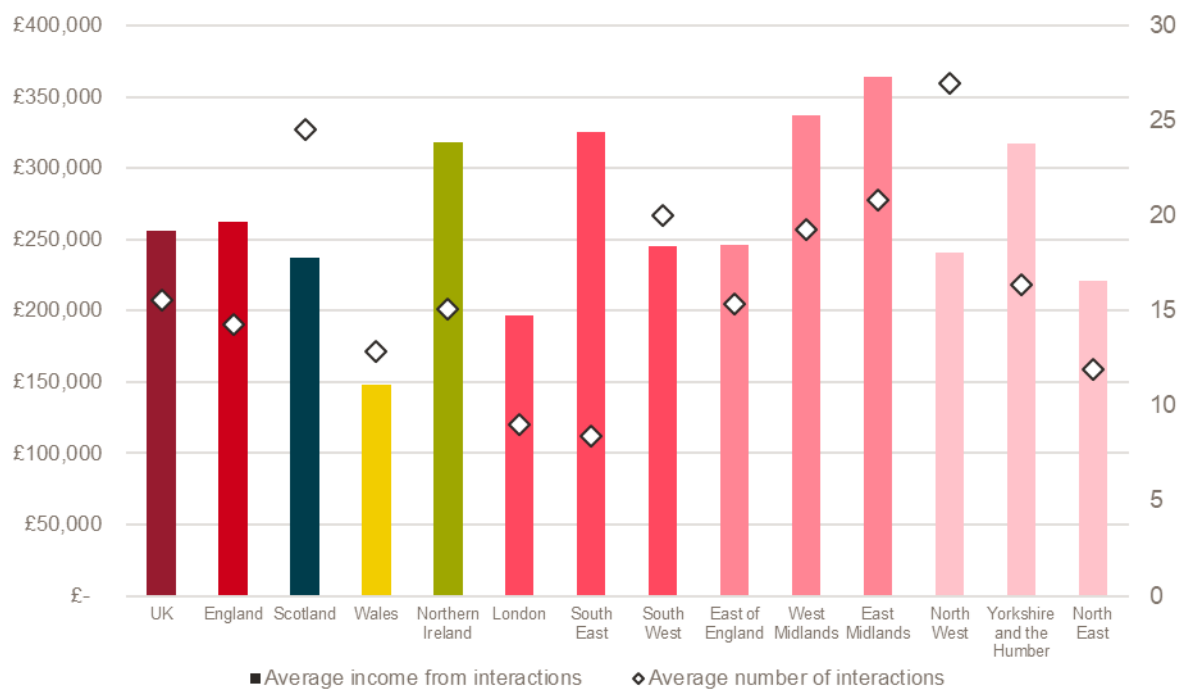
When adjusted for research funding, Scottish universities record notably high levels of business and community service engagement. To make comparisons between the level of business and community service interactions between Scotland and other countries and regions of the UK, we compare the total number of interactions over the past seven years for which data is available with the total research funding over those seven years. Figure 18 uses HESA HE-BCI data to show that the average number of business and community interactions per £ million of research funding was significantly higher in Scotland than all other regions of the UK except the North West. Such interactions are much less common relative to total research funding in London and the South East of England.

The comparison is different when the income from these business and community services relative to total research funding is compared, rather than the number of interactions. This is also illustrated in Figure 18. Scotland has a slightly lower level of income from these interactions relative to total research funding than the UK overall, but again similar to the North West. This indicates that Scotland (and the North West) have a higher number of lower-value engagements than other areas of the UK. For example, the average value of a consultancy engagement in Scotland over the period 2017/18 to 2023/24 was around £3,700 compared to an average of around £6,800 for the UK. For contract research the average value was around £38,600 in Scotland compared to around £45,100 across the UK.

The lower average value of business interactions is consistent with the greater prevalence of SMEs in Scotland (as illustrated in Table 1) and lower levels of business R&D more generally in Scotland, which is discussed in the next section.

When business interactions beyond research collaboration are used as a proxy for the potential flow of knowledge to businesses, the number of interactions is likely to be more relevant than the income those interactions generate. This is because universities are likely reaching more businesses, creating greater knowledge diffusion.

Figure 18 Average income from and number of business and community services interactions per £m of research funding (by region, 2017/18 - 2023/24)



Source: Frontier Economics; HESA HE-BCI data; HESA Research grants and contracts data; HESA Funding body grants data
 Notes: Business and community services interactions are “Consultancy”, “Contract research” and those relating to “Facilities and Equipment”.

Institution-level trends indicate this picture is not uniform across Scotland. The National Centre for Universities and Business’ State of the Relationship report 2025 examined changes in business collaboration income at the institutional level.³⁸ The report highlights that six institutions increased their business collaboration income over the past five years, while seven saw declines (and the remaining five had stable income). This variation suggests that institutional strategy, sector focus, and local business ecosystems likely influence outcomes, and may offer lessons on which approaches are most effective.

The amount of income received from Continuing Professional Development (CPD) and Continuing Education (CE) courses suggests they may be less impactful overall in generating commercial spillover effects than business and community services.³⁹ However, they still

³⁸ National Centre for Universities and Business (2025) [State of the Relationship report 2025](#)

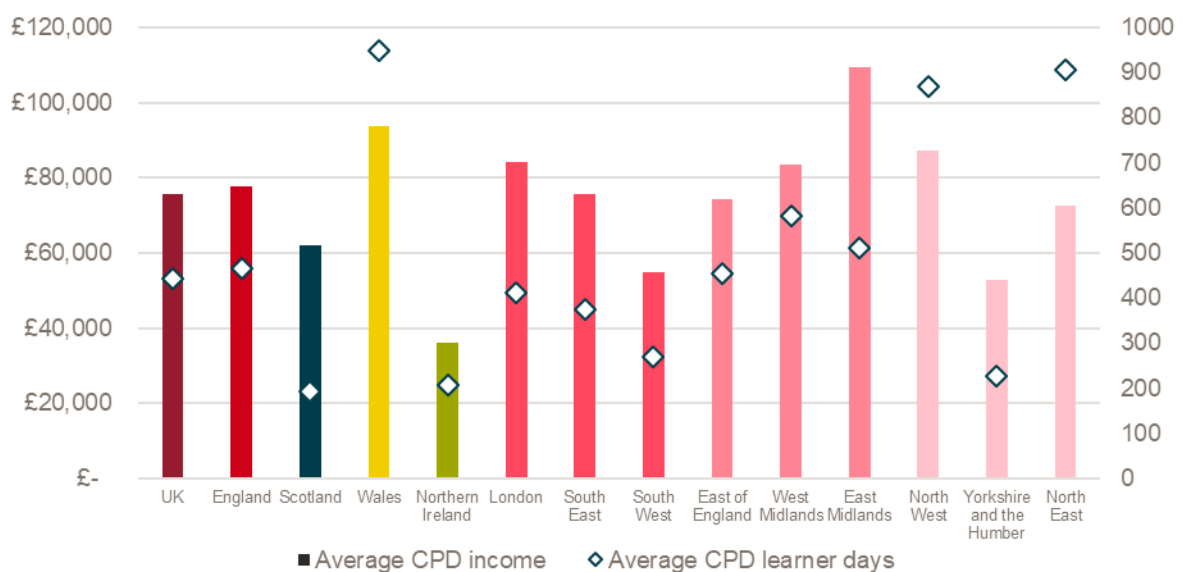
³⁹ CE courses can be defined as any courses which do not sit under the CPD umbrella and are not qualification-bearing, such that they would sit within student data.

represent a significant proportion of university income from business and community interactions and can still matter for productivity returns. CPD and CE courses may translate university expertise into workforce capability and can strengthen relationships that later support deeper research or innovation collaborations. For this reason, CPD and continuing education metrics provide a useful complement to the business and community services indicators.

When scaled by research funding, Scottish universities appear less active than the UK average in CPD and continuing education provision, albeit with higher income per learner day. To make comparisons between interactions relating to CPD and CE courses between Scotland and other countries and regions of the UK, we compare total income and learner days relating to these interactions over the past seven years for which data is available with the total research funding over those seven years. Figure 19 uses HESA HE-BCI data to demonstrate that Scottish universities receive a lower level of income from CPD and CE interactions than the UK average and most regions within the UK. It also shows that Scottish universities provide fewer learner days than all regions within the UK, with average days per £ million of research funding less than half the UK average.

These differences could reflect differences in provision models, capacity constraints, or the local demand for training from businesses. With more SMEs Scotland may have less business demand for CPD training, and the average business seeking CPD training may have fewer employees requiring learning. Nonetheless, expanding university provision of CPD and CE course represents a potential avenue for strengthening diffusion through skills and professional learning.

Figure 19 Average income from and learner days relating to CPD and CE interactions per £m of research funding (by region, 2017/18 - 2023/24)



Source: Frontier Economics; HESA HE-BCI data; HESA Research grants and contracts data; HESA Funding body grants data

Notes: CPD and CE interactions relate to Continuing Professional Development and Continuing Education courses

4.2 Summary of dissemination of university-produced knowledge

Scotland has comparatively high levels of university–business interaction once scaled by research funding, though the monetary value of those interactions is lower. The lower value is consistent with the greater prevalence of SMEs in Scotland (as illustrated in Table 1) and lower levels of business R&D more generally in Scotland, which is discussed in the next section. Scotland and the North West have similar levels of income from and volume of business and community interactions when scaled by research funding.

When examining income from and learner days relating to CPD and CE interactions, scaled by research funding, Scotland appears to have comparatively low levels of both compared to the rest of the UK. In this case it differs from the North West which maintains high levels of both.

The mix of frequent, lower-value interactions may support broad diffusion of knowledge to a relatively wide set of firms. Future work could seek to link these interactions to firm-level innovation and productivity outcomes, and explore the role of this university engagement in shaping commercial outcomes. This would likely require new primary data on firm-specific engagement with universities in a form that could be linked to existing time-series data sources on firm outcomes (such as those held by the ONS).

5 Business R&D and innovation

Key findings

Businesses spending on R&D is relatively low in Scotland and businesses in Scotland are less likely to engage in innovation than businesses in most regions of the UK.

- Scottish business expenditure on R&D was equivalent to 1.4% of GDP in 2023, compared with 2.0% for the UK as a whole, and 2.1% in the North West of England [see *Figure 20*].
- In Scotland 32.4% of businesses were innovation active in 2020 to 2022, compared with 36.3% across the UK. This is lower than any English region [see *Figure 21*].

However, universities are a more important support to the business innovation ecosystem in Scotland than elsewhere in the UK.

- Scottish businesses that innovate are almost twice as likely as businesses in the UK overall to report information from universities as being highly important for their innovation. 7.3% of innovating businesses in Scotland reported this over 2020-22, compared to 4.2% of businesses across the UK as a whole [see *Figure 23*].
 - Taking into account the proportion of businesses who are innovating, 2.6% of all Scottish businesses report information from universities as being highly important for their innovation, compared to 1.6% of English businesses [see *Figure 24*].
 - Scottish businesses that collaborate on innovation are more likely to collaborate with universities than businesses elsewhere in the UK (37.5% in Scotland compared with 32.5% for the UK as a whole, and higher than any English region) [see *Figure 25*].
-

Knowledge generated by university research feeds through into economic benefits if it is used or built on by private sector firms. It is the development of new or improved products or services, or reductions to the costs of producing existing products or services, which increase productivity and growth in the private sector.

The extent of business R&D is often used as a proxy for firms' ability to recognise, interpret and apply external knowledge to commercial ends. Firms undertaking R&D typically have skilled staff, established processes and technical infrastructure that make it easier to discover and exploit research outputs. However, it is not only formal R&D spending that matters, and businesses' ability to use external knowledge can also be supported by workforce skills, management practices, and participation in innovation networks.

Here we examine two sets of metrics that help benchmark business R&D and innovation between Scotland and the UK:

- **Business expenditure on research and development:** Business levels of spending on measured R&D.
- **Rates of business innovation:** The extent to which businesses are innovating and producing new or improved products and processes.

We also examine two metrics on business perceptions of the importance of universities to their innovation activities:

- **Business perceptions on the importance of various sources of information for their innovation:** This includes the importance of information from university and HE institutions.
- **Collaboration with universities among businesses who cooperate on innovation:** the extent to which innovative firms report collaborating with universities.

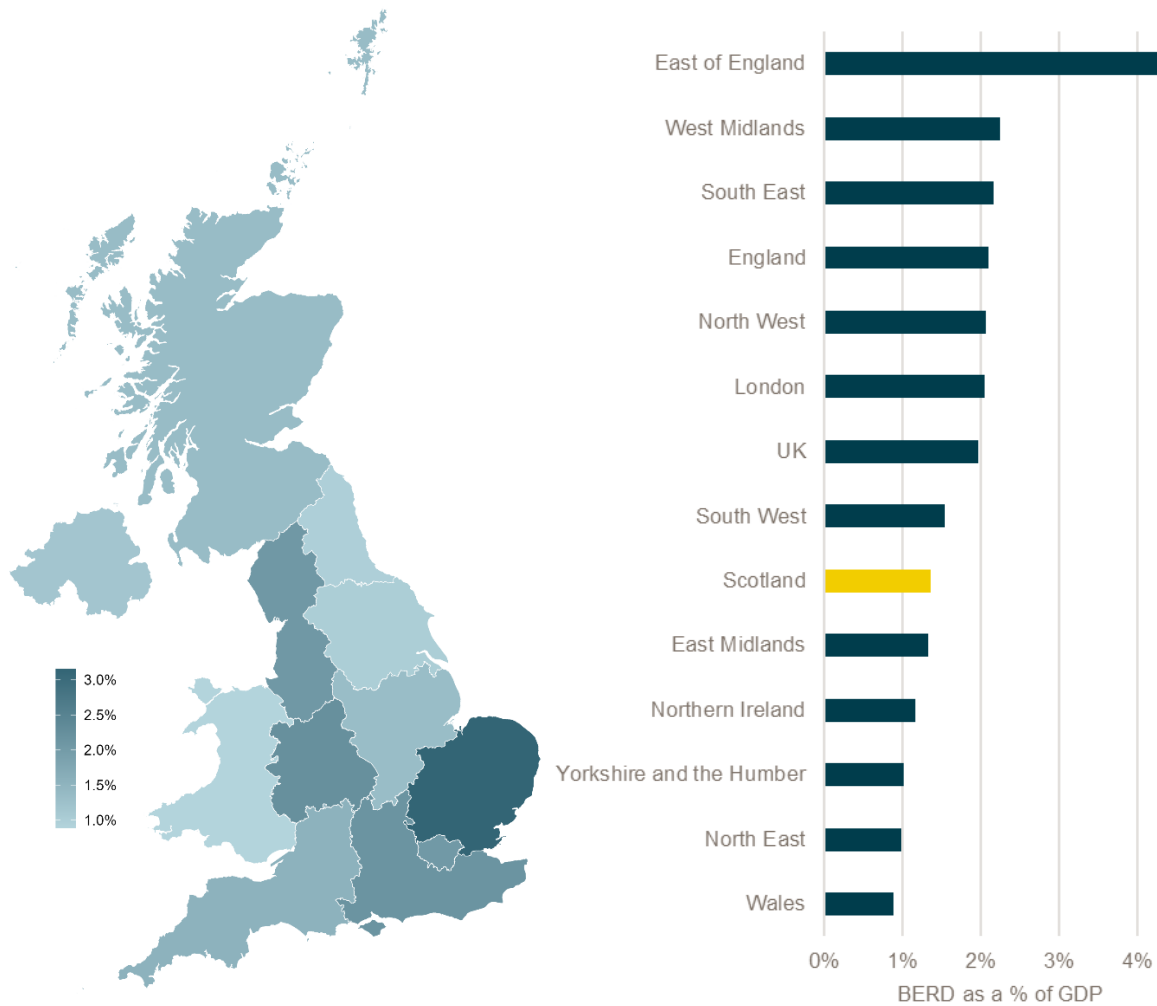
These indicators provide a high-level picture of the capability of Scottish firms to undertake innovation and the extent to which universities are perceived as an input to that innovation.

5.1 Business R&D and innovation

Business R&D expenditure as a share of GDP was 1.4% in Scotland in 2023,⁴⁰ lower than the 2.0% across the UK overall. Figure 20 illustrates that Scotland had lower business R&D as a share of GDP than most English regions including the 2.1% of the North West.

⁴⁰ This is the latest year for which ONS GDP data was available by ITL1 region.

Figure 20 Business expenditure on R&D (BERD), by country and region (as a share of GDP, 2023)



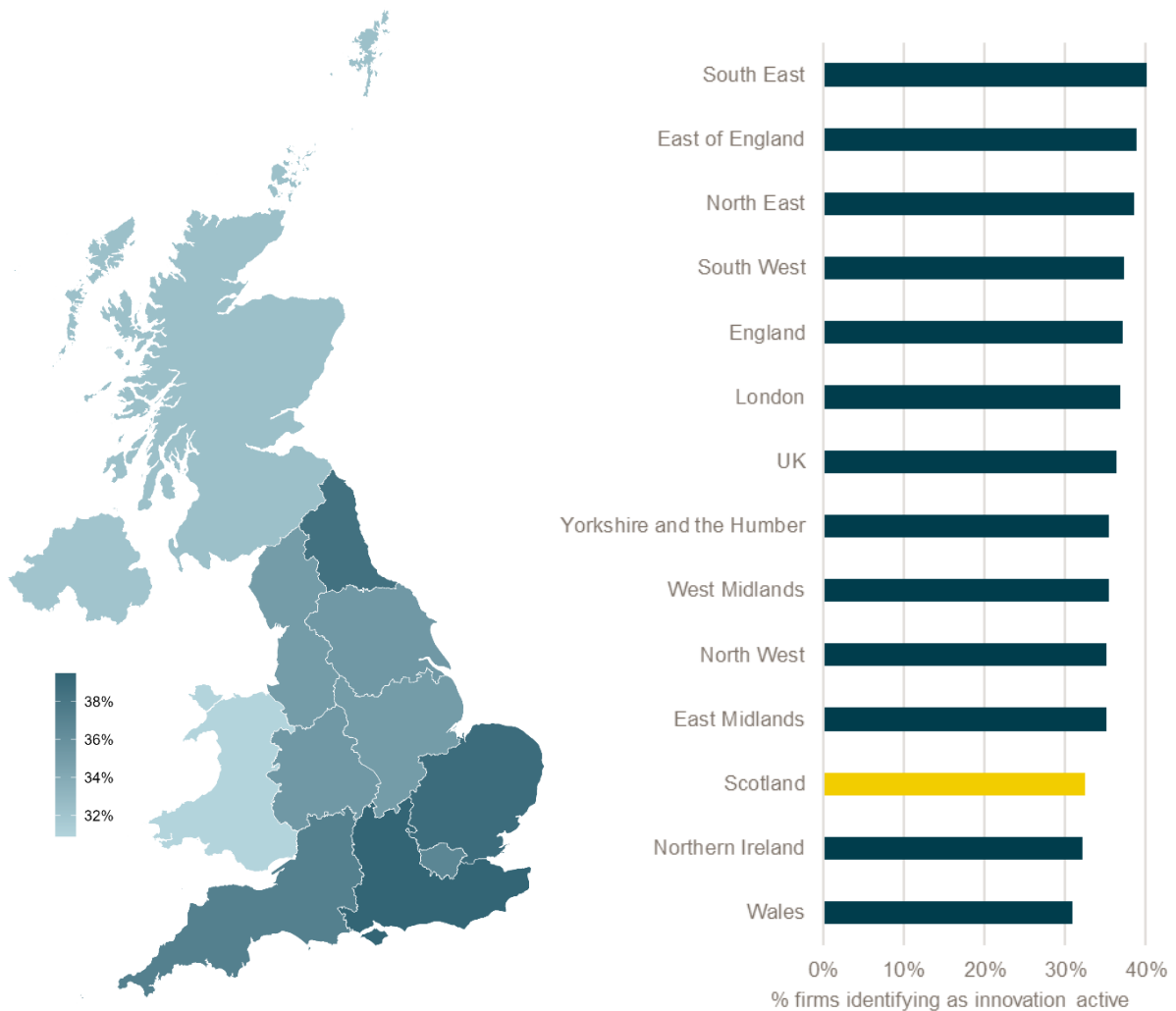
Source: Frontier Economics; ONS BERD data; ONS GDP data

Notes: Sub-national GDP figures are not currently available for 2024. Sub-national BERD figures are currently only designated as “Official Statistics” rather than “Accredited national Statistics” by the ONS, though the Office for Statistics Regulation has noted that the ONS has significantly improved the methodology used to estimate BERD statistics in 2022 and 2023.

In line with this, fewer businesses in Scotland report undertaking innovation activity than in the UK overall. Figure 21 shows that, between 2020 and 2022, 32.4% of Scottish firms were ‘innovation active’, meaning they introduced new or improved products, introduced new business processes, or were engaged in innovation projects that had not yet been abandoned. This indicator captures the *prevalence* of innovation across the business population, not the *scale* of innovation within innovating firms.

Scotland’s innovation-active share is below the UK average of 36.3%, and below every English region. This suggests that the gap is not solely driven by the ‘golden triangle’ regions.

Figure 21 Proportion of firms identifying as innovation active by country and region (2020-2022)



Source: Frontier Economics; UK Innovation Survey 2023

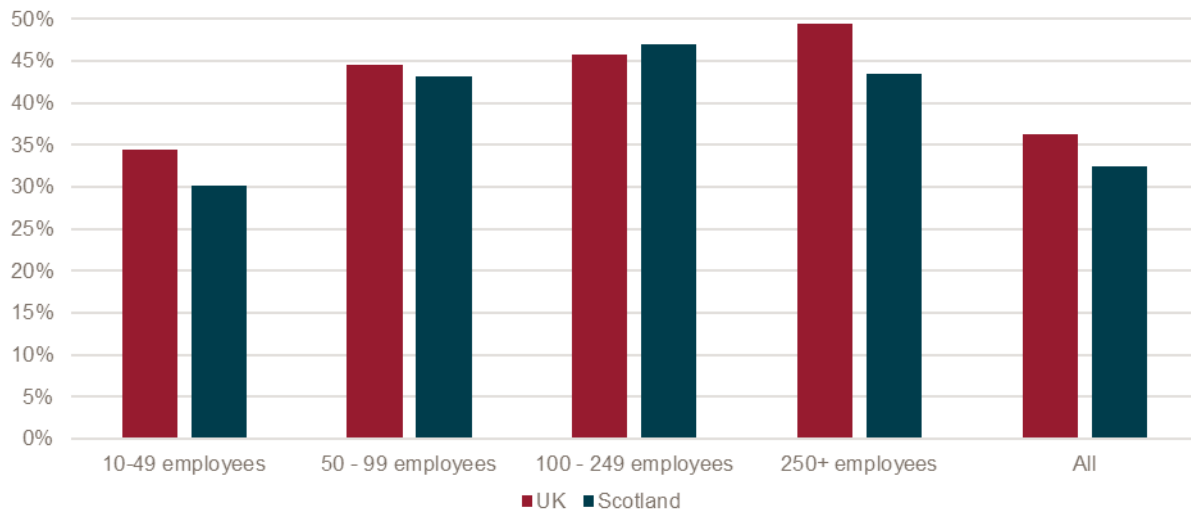
The business ecosystem in Scotland is different to other areas of the UK. Scotland has a slightly larger proportion of small businesses, for example, than other countries and regions (as was shown in Table 1), and small firms are less likely to be innovation active. However, Scottish Government analysis, summarised in Figure 22, indicates that, there is lower prevalence of innovation active businesses in Scotland across businesses of different sizes.⁴¹ Therefore, structural factors beyond size alone (such as sector mix, managerial capacity, and access to finance or skills) are also likely to play a role in differences in innovation rates.⁴² The same Scottish government analysis of UKIS data indicates that Scottish businesses who are not innovating are more likely than the UK average to report not innovating due to market

⁴¹ [Innovation Activity by Size - UK innovation survey 2023 – Results for Scotland](#)

⁴² BEIS (2021) “Businesses need access to finance to fund innovation activities” [Evidence for the UK Innovation Strategy](#)

conditions meaning they do not need to, the availability of finance, and a lack of qualified personnel.

Figure 22 Proportion of firms identifying as innovation active, by size (2020-2022)



Source: Frontier Economics; Scottish government UK Innovation survey 2023 – results for Scotland

While Scotland has lower business R&D and lower innovation than elsewhere in the UK, recent research by NIESR comparing the two suggests that R&D expenditure may be more effective at producing some forms of innovation in Scotland than in some other areas of the UK.⁴³ In particular, they find the return to business R&D investment in terms of product innovation and process innovation is higher in Scotland than in the North West of England.

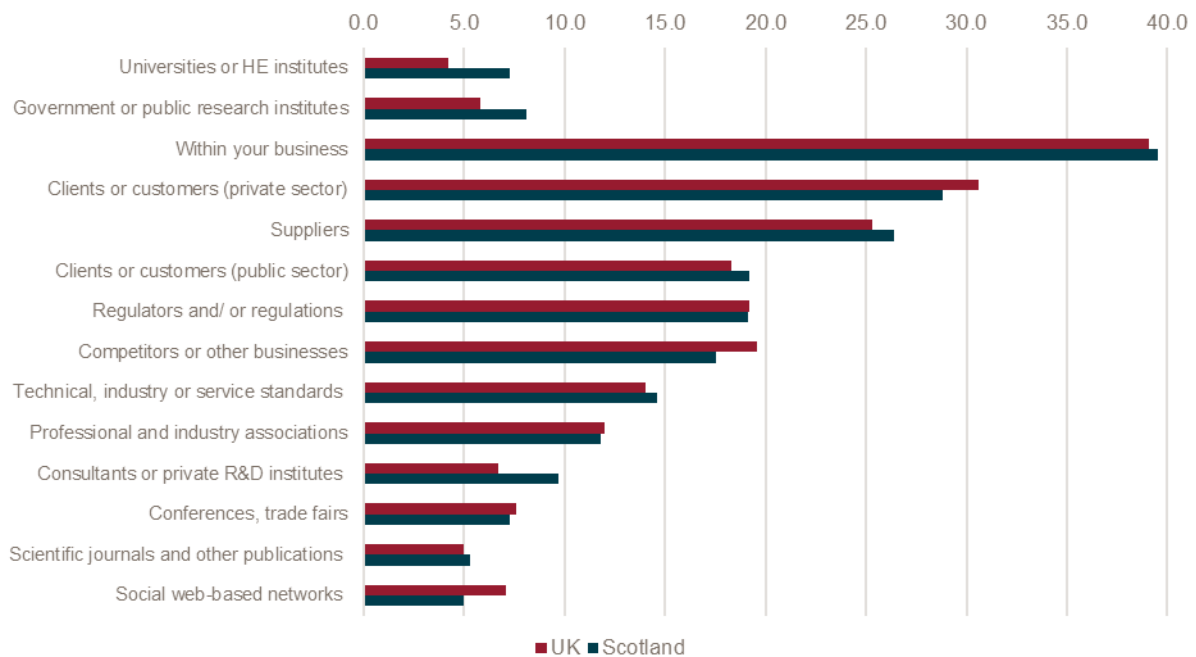
5.2 Business perceptions of the importance of universities for innovation

While business R&D and innovation activity is lower in Scotland, business perceptions suggest that university knowledge may be taken up more effectively by the smaller group of firms that do innovate.

The UK Innovation Survey asks innovating businesses to rate how important different information sources are for their innovation activities. Figure 23 illustrates the proportion of innovating businesses in Scotland and the UK overall who report various information sources as being “highly important” for their innovation. These perceptions do not quantify economic impact directly, but they do indicate which channels businesses themselves consider relevant when innovating. The proportion of businesses reporting information from universities or HE institutes as being “highly important” is particularly informative about potential knowledge spillovers from university research.

⁴³ [Understanding the Drivers of Innovation and Productivity across Firms, Regions and Industries in the UK - NIESR](#)

Figure 23 Sources of information reported as “highly important” for businesses’ innovation activities, innovating businesses (2020-2022)



Source: Frontier Economics; UK Innovation Survey 2023
 Note: Innovating businesses only.

Universities are a particularly important information source for innovating businesses in Scotland. 7.3% of innovating businesses in Scotland report information from universities as being “highly important”, compared with 4.2% across the UK as a whole. Taking into account the proportion of businesses who are innovating, this equates to 2.6% of Scottish businesses, and 1.6% of English businesses.

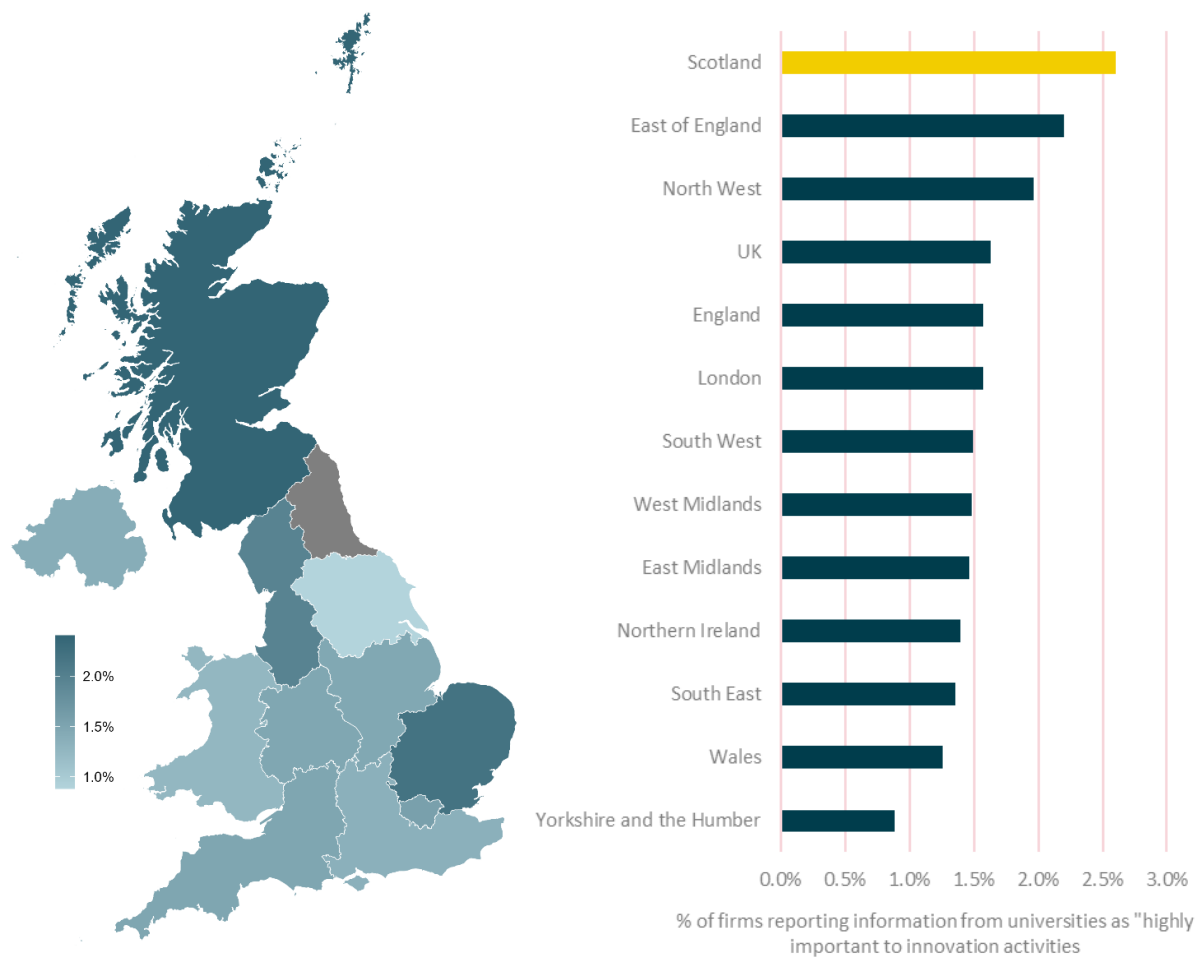
The proportion of businesses reporting scientific journals or other publications as “highly important” is also of interest, as this is indicative of one potential mechanism through which firms become aware of knowledge or innovations generated through university research. Scientific journals and other publications are reported as highly important at similar rates in Scotland and the UK overall. In 2020 to 2022, 1.9% of all innovating businesses in both Scotland and the UK reported this source as highly important for innovation. Taken alongside the stronger relative importance of universities, this suggests that direct or mediated engagement with universities (rather than reading papers alone) may be a key differentiator in how Scottish firms access knowledge.

Scotland stands out across UK regions in the importance businesses attach to universities as an information source. Figure 24 illustrates how the proportion of businesses reporting information from universities or HE institutes as being “highly important” varies across the countries and regions of the UK. This figure includes all businesses, not just innovating businesses. Scottish businesses report information from universities as being highly important more commonly than businesses in any other region. An interesting avenue for future work would be to understand these business perceptions in more detail, in particular the extent to

which Scottish businesses view information from Scottish universities specifically, as opposed to universities in general, as important to their innovation. This would likely require new primary data collection from innovating businesses.

The absolute percentages of businesses illustrated in Figure 24 are small. However, innovating firms tend to be economically significant even if they represent a minority of the business population. The UKRI State of Innovation report found that innovating firms consistently report average sales growth far greater than non-innovating firms, while frontier firms (those at the forefront of introducing new products and services) saw an even higher average growth in sales.⁴⁴ This reinforces why universities' role as an input to innovation matters: even marginal improvements in the innovation performance of this group can have disproportionate impacts on productivity and growth.

Figure 24 Proportion of firms across the UK reporting information from universities as “highly important” to innovation activities (2020-2022)

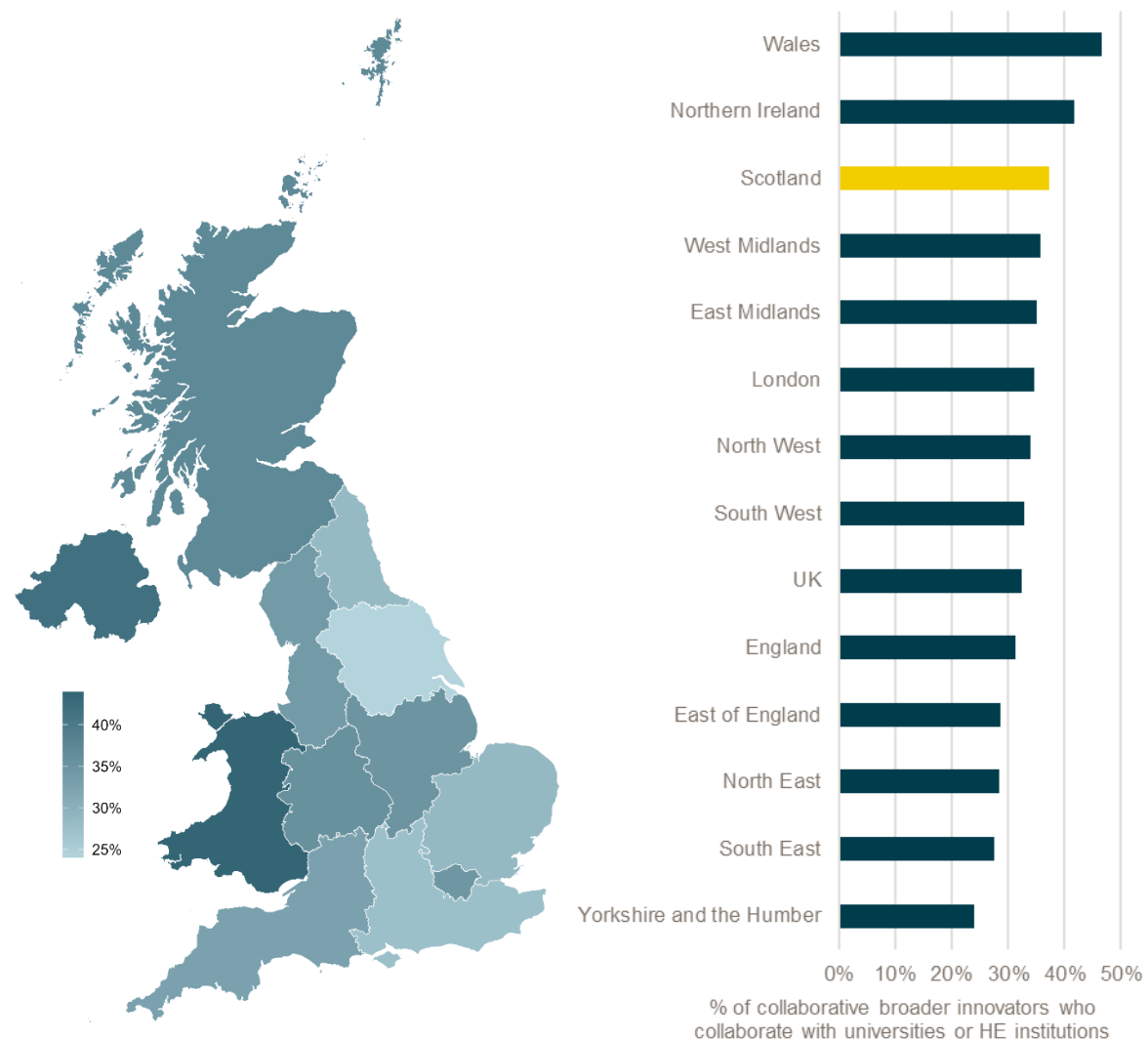


Source: Frontier Economics; UK Innovation Survey 2023
 Notes: Includes all businesses; North East data unavailable

⁴⁴ UKRI (2025) [State of Innovation 2025](#)

The UKIS survey also asks businesses whether they cooperated with other organisations on any innovation activities and, if so, which partners were involved. Universities are particularly prominent collaboration partners for Scottish firms that cooperate on innovation. Between 2020 and 2022, 37.2% of collaborative innovators in Scotland reported collaborating with universities or higher education institutions, compared with 32.5% across the UK and 31.4% in England. Figure 25 shows Scotland above every English region on this measure. This suggests universities serve as key innovation partners in Scotland. While these universities could be located anywhere, it is likely that firms have a greater tendency to collaborate with nearby universities and that Scottish universities will be important to innovating Scottish firms.

Figure 25 Proportion of collaborative broader innovators who collaborate with universities or higher education institutions (2020-2022)

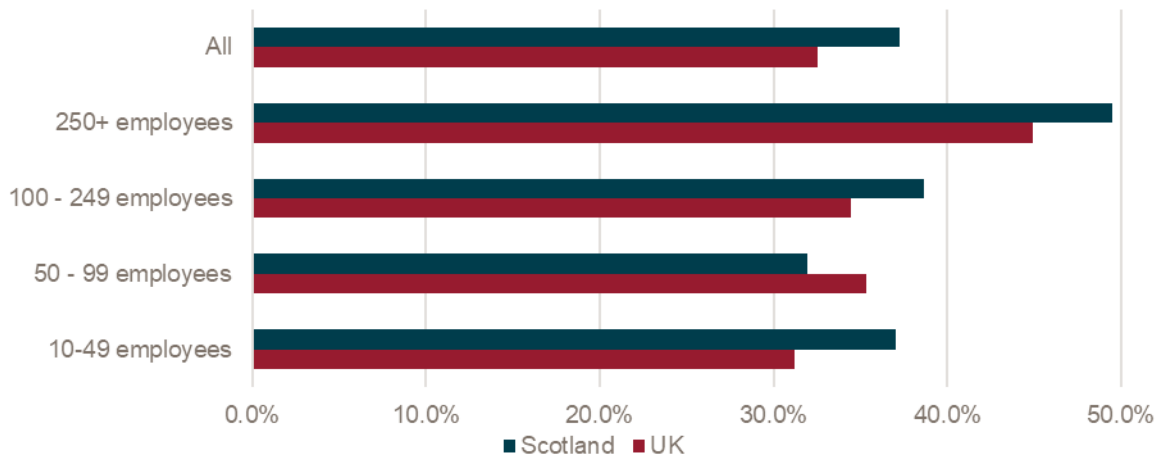


Source: Frontier Economics; UKIS

Scottish Government analysis, shown in Figure 26, indicates that universities are important partners for all sizes of business that are co-operating on innovation, though slightly more so

for the largest businesses than small businesses. The higher propensity to collaborate with universities among Scottish businesses appears across almost all firm sizes (it is only businesses with 50-99 employees where innovating businesses in the UK who co-operate on research are more likely to collaborate with universities than those in Scotland).

Figure 26 % of cooperating innovators that collaborate with universities or HE institutions, by business size (2020-2022)



Source: Frontier Economics; Scottish Government analysis of UKIS data.

5.3 Summary of business R&D and innovation

Scotland has lower business R&D and a lower prevalence of innovation-active firms than the UK average, and all English regions. This could indicate a lower likelihood that new knowledge from university research is built on by innovating firms in Scotland. However, Scottish businesses that do innovate appear to rely more heavily on universities than firms elsewhere in the UK, suggesting the university research base is a key input to the innovation that happens in Scotland. The importance of university research for business innovation appears to be almost as strong in the North West. Future work that examines the sources of information for innovating firms in more detail would be valuable, as would exploring links between firm-level innovation outcomes and university engagement. This could help indicate where such collaboration could have the greatest impact on Scottish productivity returns.

The conceptual framework set out in Section 1.3 highlighted that a potential benefit of university research is that it may stimulate additional private R&D. It has been demonstrated internationally that public R&D leverages additional private R&D. Oxford Economics estimated, based on international data, that a 1% increase in public R&D increased private R&D over the long run by 1.02-1.32%.⁴⁵ A similar impact is estimated for publicly-funded R&D conducted in universities and research institutes as is estimated for public funded R&D conducted by businesses. The additional leveraged private R&D would then be expected to

⁴⁵ Oxford Economics (2020) [The relationship between public and private R&D funding](#)

have productivity benefits, since there is an extensive literature that demonstrates productivity from private R&D.⁴⁶

There is no existing evidence on the amount of additional private R&D leveraged by university research in Scotland, or whether the rate of leverage differs in Scotland as compared to the UK. This would be an interesting avenue for future work, if suitable data and a credible econometric strategy could be devised. Given the backdrop of business R&D in Scotland being lower than elsewhere, the effect of university research stimulating private R&D is particularly pertinent. The environment of lower business R&D in Scotland, described in this Section, may raise the concern that public R&D is less likely to spur additional activity than if there were greater business R&D being conducted. However, this is not necessarily the case, and there may be other conduits for Scottish businesses to innovate, such as the purchase of consultancy services. The explicit link between public R&D and stimulated business investment would be interesting to explore further in future.

⁴⁶ For a review see Frontier (2023) [Rate of return to investment in R&D](#)

6 Spinouts and startups

Key findings

Scottish universities are active in directly commercialising research findings through spinout companies. Relative to research funding, however, Scottish institutions produce spinouts at a lower rate than the rest of the UK.

- There were 14 new spinouts from Scottish universities established in 2023-24, and 237 Scottish university spinouts active in that year. A further 410 startups were established, with 2,311 active startups [see *Figure 27 and Figure 31*].
- Over the past seven years for which data is available Scottish universities have produced fewer new spinouts per £ billion of research funding, than the UK average (13 compared to 19). The same is true of startups (218 in Scotland compared to 492 across the UK) [see *Figure 28 and Figure 32*].
- The number of new spinouts and startups relative to research funding was lower in Scotland than in any other country or region of the UK.

Scottish spinout and startup performance lags the UK average but outperforms English regions outside of the 'golden triangle'.

- Average employment and average turnover of spinouts from Scottish universities was similar to the average across all UK university spinouts for the period 2016/17 to 2019/20. However, a gap has emerged in recent years, with the average employment and turnover of Scottish university spinouts being slightly lower than the UK average [see *Figure 30 and Figure 33*].
 - The UK average is skewed by high performing companies in the 'golden triangle'. Scottish spinouts and startups tend to outperform UK regions outside the 'golden triangle' in average employment, turnover and investment received.
-

The creation of spinout and startup companies is a direct route through which university research can result in private sector activity and a return to the Scottish economy. They provide a tangible measure of direct commercialisation. Spinouts and startups represent cases where knowledge created by universities is embodied in a new firm rather than diffusing to existing firms via publications, consultancy, or collaborative research.

We use HESA data to benchmark both the volume of spinouts and startups, and the average performance of the active firms associated with universities, from Scottish institutions:

- **University spinouts:** Companies set up to exploit intellectual property that has originated from within a university, which may continue to have an ownership stake in the company. As spinouts are directly based on university IP, they provide a clear indicator that research-generated knowledge is being used in a commercial setting.

- **University startups:** Companies created by current or recent staff, or by current or recent students, who have received formal enterprise support from a university. These firms are not necessarily based on university IP, so the link to research spillovers is less direct. However, these companies may still be influenced by knowledge generated at the university or expertise gained through university research.

This data captures one specific segment of university commercialisation, and it should be noted that approaches to commercialisation do differ across institutions which may influence some of the comparisons made.

Furthermore, the number of spinouts and startups is small relative to the number of other businesses in the economy, and relative to the number of businesses who interact with universities. Therefore, while spinouts may be an important route to productivity benefits, their role in generating returns from university generated knowledge should not be overstated.

6.1 Spinouts

Spinouts turn university-owned intellectual property into standalone firms with the potential to scale. They are particularly prominent in certain sectors. For instance, 42% of all startups in pharmaceuticals and biotechnology founded during 2019 to 2024 that raised some venture capital funding were university spinouts, and the share is higher among the best performing startups (measured by equity raised).⁴⁷ Across the wider economy, spinouts have been found to account for 2.5% of the UK's high-growth companies, and to have attracted 9.1% of equity finance raised by private UK firms.⁴⁸

Successful spinouts can be an important route to generating direct returns from research funding. To encourage this, universities and funding bodies may provide early-stage support to help spinouts develop. In Scotland, one source of such support is the SFC-funded Converge programme. Through prizes and awards, it helps university spinouts to develop and grow without taking equity or imposing similar conditions.⁴⁹

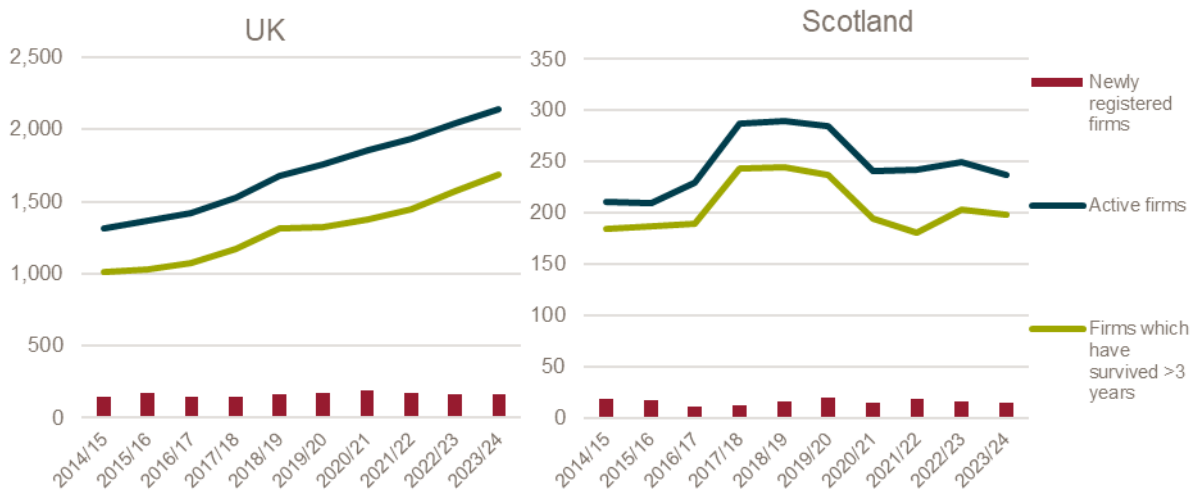
Scottish universities are active in generating spinouts and there is a sizeable existing base of active firms that have spun out from Scottish institutions. HESA data demonstrates that, in 2023/24, 14 new spinouts were established and 237 spinouts were active, of which 84% had survived at least three years. Figure 27 illustrates the number of newly registered and active spinouts over time for Scotland and the UK overall.

⁴⁷ Ulrichsen, T. C. and Miller, J. 2025. Powering Ideas to Innovation: The significance, structure and dynamics of the UK university spinout ecosystem. Policy Evidence Unit for University Commercialisation and Innovation (UCI), University of Cambridge.

⁴⁸ [Spotlight on Spinouts 2025 - Beauhurst - Royal Academy of Engineering](#)

⁴⁹ [Converge - Scottish Funding Council](#)

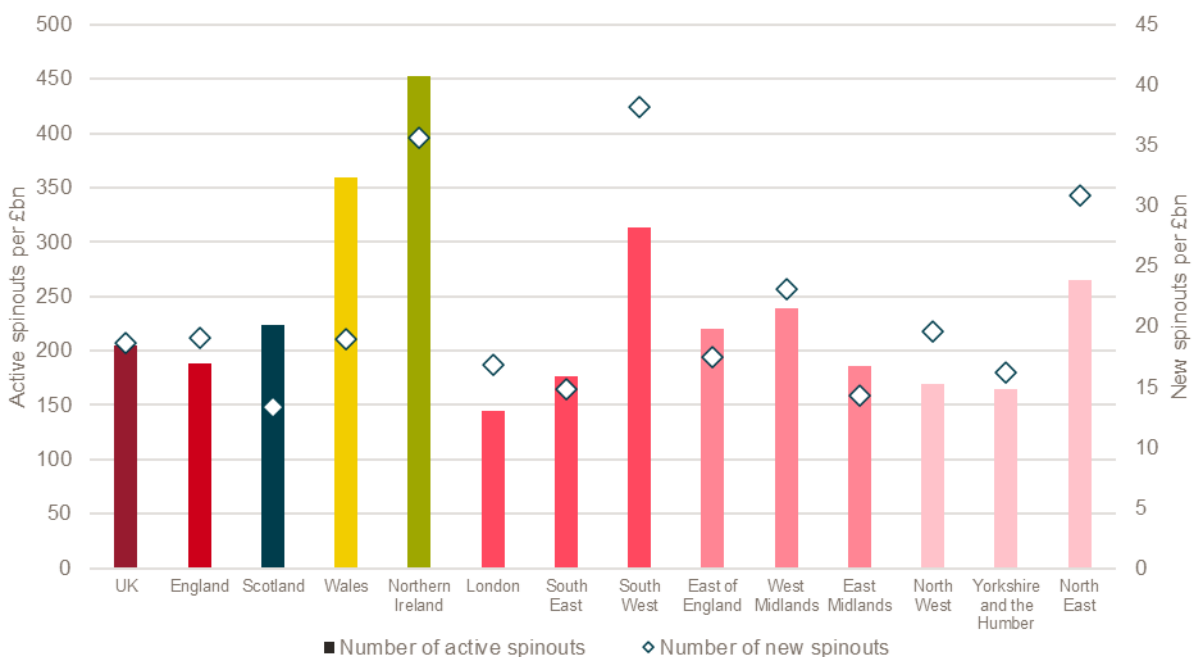
Figure 27 Number of newly registered and active spinouts in Scotland and the UK overall (2014/15 - 2023/24)



Source: Frontier Economics; HESA spinouts data

Relative to their total research funding, Scottish universities have produced fewer spinouts than any other country or English region over the past six years for which data is available (illustrated in Figure 28). This implies that, controlling for the scale of research inputs, the rate at which research is converted into new IP-based firms is lower in Scotland than elsewhere.

Figure 28 Average annual number of active and new spinouts by UK region per £bn of university research funding (2017/18 - 2023/24)



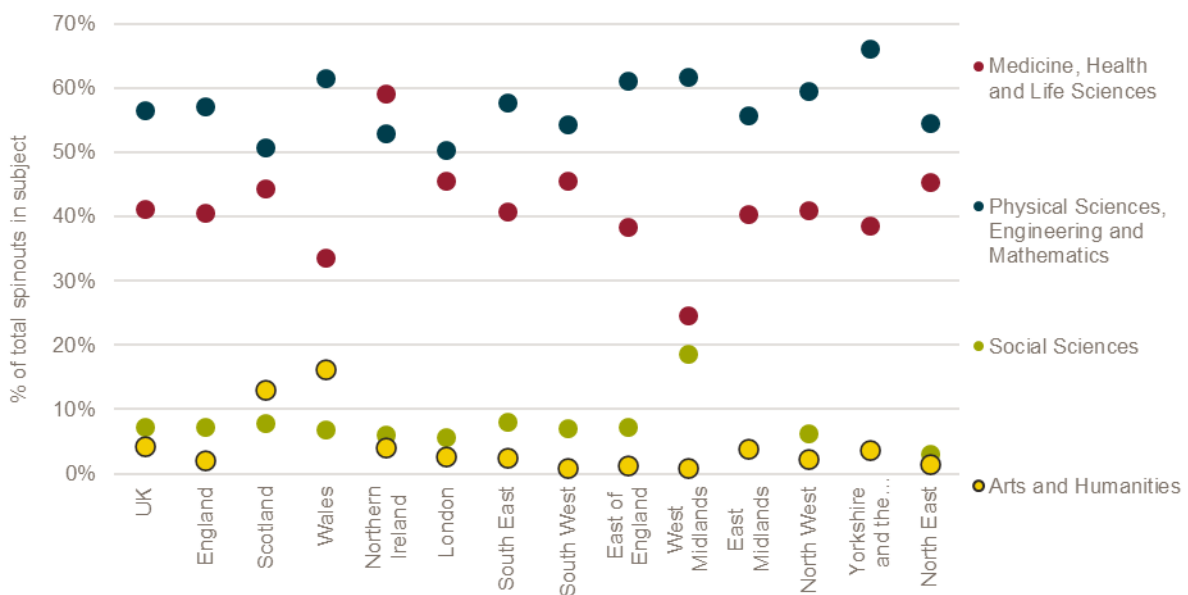
Source: Frontier Economics; HESA spinouts data

Notes: NI spinouts data allocates a disproportionate number of the total number of spinouts and startups as spinouts, suggesting this is an overestimate for NI

However, Scotland performs somewhat better when looking at the stock of active spinouts relative to research funding. Scottish universities have more active spinouts relative to their total research funding than the average for the UK or English universities, including the North West. An assessment of spinout exit rate over the period suggests that this is due to historically greater formation rates, rather than greater survival rates of Scottish spinouts.

The subject composition of Scottish spinouts broadly reflects Scotland's research strengths. Figure 29 illustrates that subject area of Scottish university spinouts is broadly similar to that of the UK as a whole, but with a slightly smaller proportion of spinouts in physical sciences, engineering and mathematics, and a slightly higher proportion of spinouts in medicine, health, and life sciences, and in arts and humanities. This aligns with Scotland's research profile and with areas such as life sciences, where university-based IP plays a prominent role in commercialisation.

Figure 29 Average percentage of new university spinouts classified into each subject area (2015-2024)



Source: Frontier Economics; HESA spinout register data

The performance of Scottish spinouts, in terms of average employment and average turnover, has diverged from the UK average in recent years. Figure 30 demonstrates that the average employment and turnover of spinouts from Scottish universities was similar to the average across all UK university spinouts for the period 2016/17 to 2019/20 (the data in this chart excludes particular outliers as detailed in the notes to aid comparability). However, a gap has emerged in recent years, with the average employment and turnover of Scottish university spinouts being slightly lower than the UK average. This suggests Scottish university spinouts are smaller than the average UK spinout.

Spinouts associated with the University of Cambridge have been removed from the turnover panel in Figure 30, as otherwise outlier performance drives a significant uplift in UK average

turnover from 2020/21 to 2023/24. Regardless, strong performance from spinouts located within the 'golden triangle' continues to drive much of the performance gap shown in the chart. Over the last 10 years, Scottish spinouts have had greater average employment levels than spinouts from outside the 'golden triangle'.

Figure 30 Average employment (FTE), turnover and external investment received, per active spinout (2014/15 - 2023/24)



Source: Frontier Economics; HESA spinouts data

Note: 2018/19 outlier from Ulster University has been removed from employment chart; All Cambridge university data removed from turnover chart due to high values skewing UK figures; 2022/23 Cambridge university value removed from UK data in external investment received chart, as this HESA data value was over 10 times the value of total external investment received by all spinouts in the rest of the UK.

The ability to secure equity investment is important to the development of many companies. The final panel of Figure 30 illustrates average external investment received by spinouts from Scotland compared with spinouts across the UK as a whole. Annual investment is more volatile than employment or turnover, but shows a similar trend in Scotland as in the UK. A recent UCI report used Pitchbook data to look in detail at the investment performance of UK spinouts. In 2024 UK Spinouts raised £2.8 billion in venture capital investment – around 17% of all venture capital invested in UK companies in that year.⁴⁷ For pre-seed/seed investment, the spinouts from Scotland raised less than in the East and South East (median £1,000 compared to £1,400) but more than other regions including London (median £900).

The 2023 Scottish Universities Spinout Review examined the spinout ecosystem in detail to understand drivers of difference in Scottish generation and performance of spinouts compared to the rest of the UK, and particularly why Scotland lags behind the 'golden triangle'.⁵⁰ The underlying explanation identified is not weakness in the science base, but differences in the depth and risk appetite of local capital markets. The 'golden triangle' benefits from dense venture capital ecosystems and large funds capable of supporting later-stage rounds, whereas Scotland's investment landscape contains a higher share of angel and early-stage investors and fewer large venture capital funds focused on the domestic market. The Spinout Review also points to potential constraints relating to translational funding and access to commercial expertise, which may be less prevalent in Scotland than in London and the South East.

Taken together with the evidence discussed in Section 2 on university innovation and knowledge production, this evidence on spinouts is consistent with Scotland's challenge being less about generating ideas and more about scaling them. However, Scotland appears to have a spinout growth environment which is at least as effective as English regions outside the 'golden triangle'.

6.2 Startups

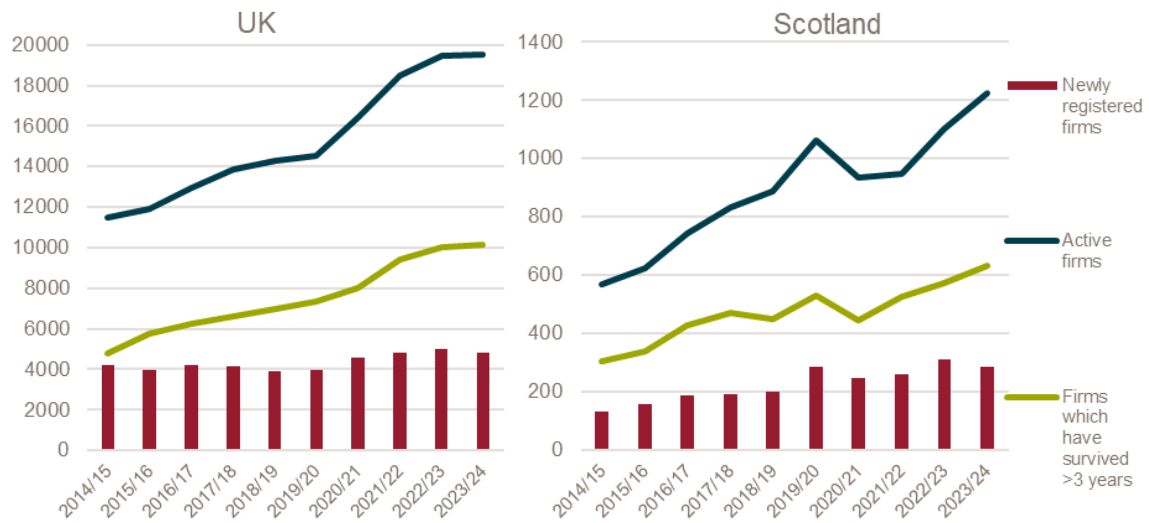
Startups represent a broader form of entrepreneurial activity linked to universities: firms that are not necessarily based on university-owned IP, but may still embody tacit knowledge, networks and skills developed through research activity.

According to HESA data, in 2023-24 there were 410 startups established from Scottish universities. In the same year, there were a total of 2,311 active Scottish university startups, of whom 58% had survived for at least three years.

Figure 31 illustrates the number of newly registered and active startups over time for Scotland and the UK overall since 2014/15. The number of newly registered startups had been relatively flat over this period in the UK with signs of a step increase in 2020/21. In Scotland there has been more steady growth in the number of newly registered startups each year.

⁵⁰ Scottish Enterprise (2023) [Scottish Universities Spinout Review](#)

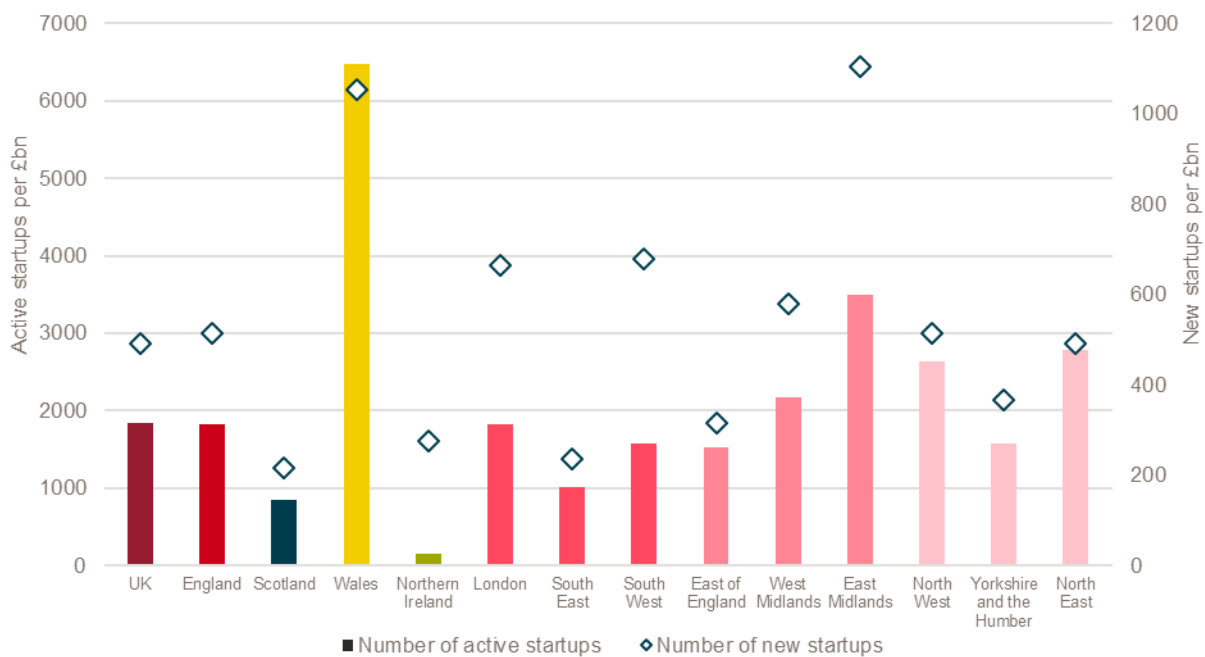
Figure 31 Number of newly registered and active startups in Scotland and the UK overall (2014/15 - 2023/24)



Source: Frontier Economics; HESA spinouts data

Despite this recent growth, relative to total research funding, Scotland produced fewer university startups than any other country or English region over the past six years for which data is available. This is demonstrated on Figure 32, which shows that Scotland also has fewer active startups relative to research funding than any country or region except Northern Ireland.

Figure 32 Average number of new startups by UK region per £bn of university research funding (2017/18 - 2023/24)



Source: Frontier Economics; HESA spinouts data

Note: NI spinouts data allocates a disproportionate number of the total number of spinouts and startups as spinouts, suggesting this is an underestimate for NI.

Figure 33 Average employment (FTE), turnover and external investment received, per active startup (2014/15 - 2023/24)



Source: Frontier Economics; HESA spinouts data

Notes: 2014/15 data removed from external investment received chart as absolute value for Scotland was an order of magnitude greater than other years of data, whilst 2023/24 data removed due to Cambridge University entry being 18 times greater than the preceding year.

Mirroring the picture seen for spinouts, whilst the recent performance of startups has been less strong in Scotland than in the UK overall, Scotland outperforms regions of the UK outside the 'golden triangle'. As shown in Figure 33, the average employment of active Scottish university startups has declined over time. It is lower in 2023/24 than the average employment of active university startups from across the UK (with Scottish startups employing an average of 2.4 full-time employees, compared with the UK average of 3.3). However, it remains higher when comparing to the UK outside of the golden triangle (with an average of 2.3 employees).

Showing a similar trend, the average turnover of active Scottish university startups has declined over time, while the UK average has been stable since 2015/16. Average external investment received has risen in Scotland over the period, outstripping UK regions outside the 'golden triangle', although it still lags behind the overall UK average in recent years.

6.3 Summary of spinouts and startups

Spinouts and startups provide a direct and tangible mechanism through which university research can translate into private sector activity and provide an economic return.

Scottish universities are active in producing both spinouts and startups. However, in recent years, relative to the scale of its research funding, Scotland produces fewer spinouts and startups than any other country or region in the UK. Active companies have performed less well in terms of turnover and employment than the UK average, but this is skewed by the high performance of the golden triangle regions. Scotland appears to have a more effective spinout and startup growth environment than English regions outside of the golden triangle.

For the purposes of understanding returns to university research, the implication is that this commercialisation pathway exists and is active in Scotland. The aggregate productivity gains mediated through high-growth firms may be lower than in the golden triangle but compares more favourably to elsewhere. This has been suggested in the Scottish Universities Spinout Review to primarily reflect differences in capital depth and commercial ecosystem rather than research quality.

However, it is worth bearing in mind that the number of spinouts and startups is small relative to the number of other interactions between universities and businesses through which knowledge may flow. Therefore, while spinouts may include high growth firms, their role in generating returns from university generated knowledge should not be overstated.

The economic implications of spinouts and startups will also depend critically on where firms' activity is located. If spinouts and startups from Scottish institutions locate elsewhere, the productivity benefits may accrue outside Scotland. Future work could usefully examine firm-level trajectories of Scottish spinouts, including geography of employment growth, follow-on funding, and acquisition patterns, to better quantify how much of the value created by these firms is retained within Scotland. This would require new detailed time-series data on the location and performance of individual spinouts.

7 Implications for the return on Scottish university research spending for Scotland's economy

This study has sought to increase understanding of the economic returns to university research in Scotland. Rather than quantifying returns directly, which is inhibited by data availability, the approach taken has been to set out the pathways through which economic returns are expected to be realised. We have then examined evidence relating to these pathways in Scotland and compared the relevant metrics with other nations and regions of the UK. The metrics are descriptive and do not estimate causal productivity impacts or financial returns on research spending. However, they provide indicative evidence on where and how economic benefits may arise, and how these pathways may compare between Scotland and the rest of the UK.

University research plays a vital role in the Scottish innovation ecosystem

The evidence suggests Scotland's university research base compares well with the UK average on many of the dimensions considered.

Scottish universities are strong at producing high quality knowledge and innovation. Scottish universities produce more publications per £ of research income than most UK regions, including the 'golden triangle' and the North West.

There are also active pathways through which university-generated knowledge can reach industry and generate productivity benefits and economic growth. Scottish universities directly collaborate on research with industry, with broadly similar levels to the UK average. This suggests the co-production of strategically important knowledge. Scottish universities also have high levels of wider business and community interactions relative to their research funding. Of the UK nations and English regions, only the North West shows similarly high volumes. This suggests that relatively more businesses in Scotland are likely to have exposure to university-generated knowledge, which might impact on their own innovation.

Scottish universities have performed less well than the UK average in recent years at producing high-growth startup and spinouts. However, UK performance is skewed by stronger scale-up dynamics within the 'golden triangle', and Scotland tends to outperform other English regions in terms of the average turnover, employment, and investment of its spinouts.

Scottish firms spend less on R&D relative to GDP than all English regions, and (partly as a result) are less likely to develop product or process innovations. However, Scottish businesses that are innovating are more likely to be collaborating with universities, and more likely to consider information from universities as highly important for their innovation, than innovating businesses elsewhere in the UK. This difference is so pronounced that even taking into account the lower prevalence of innovating businesses, businesses in Scotland are nearly twice as likely than UK businesses to consider information from universities as highly

important. University research therefore clearly plays an important role in supporting business innovation in Scotland.

These findings are summarised in Table 2, which indicates for a selection of key metrics how Scotland compares to both the UK average, and each region and nation of the UK. The levels of each metric and each region's rank within the UK are provided in tables in Annex B.

Table 2 Summary of Scottish performance in key metrics assessed

	Knowledge production		Collaboration		Interactions		Business R&D & innovation		Spinouts and startups	
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
UK	■	▲	■	▼	▲	■	▼	▲	▼	■
London	▲	▼	▲	▼	▲	▲	▼	▲	■	■
South East	▲	▼	■	▲	▲	▼	▼	▲	■	▼
East of England	▲	▼	■	▲	▲	■	▼	▲	▼	▼
North West	▲	■	▲	■	■	■	▼	▲	▼	▲
South West	▲	■	■	▲	▲	■	▼	▲	▼	■
North East	▼	■	▲	▲	▲	■	▼	▲	▼	▲
West Midlands	▲	■	▼	▲	▲	▼	▼	▲	▼	▲
East Midlands	▼	■	▼	▲	▲	▼	▼	▲	■	■
Yorkshire and the Humber	▲	▲	▼	■	▲	▼	▼	▲	■	■
Wales	▼	■	■	▲	▲	▲	▲	▲	▼	▲
Northern Ireland	▼	■	▲	▲	▲	▼	■	▲	▼	▼

Source: Frontier Economics; Clarivate

Notes: Columns indicate Scotland's relative performance for a metric, when compared to each region. ▲ indicates Scotland performing at least half a standard deviation above region; ■ indicates performance within one standard deviation; ▼ indicates Scotland performing at least half a standard deviation below region. Metrics in each column correspond to the following numbers: [1] Average number of publications produced annually, per £m of research funding (2020-2024) [2] Average CNCI (2020-2024); [3] Average % of total research funding from industry-funded external research grants and contracts, per £m of research funding (2017/18 – 2023/24); [4] Average proportion of publications produced which involved industry collaboration (2020-2024); [5] Average number of business and community services interactions, per £m of research funding (2017/18 – 2023/24); [6] Average income from business and community services interactions, per £m of research funding (2017/18 – 2023/24); [7] Proportion of firms identifying as innovation active (2020-2022); [8] Proportion of firms across the UK rating information from universities as "highly important" to innovation activities (2020-2022); [9] Average number of new spinouts produced, per £bn of research funding (2017/18 – 2023/24); [10] Average employment (FTE), per active spinout (2014/15 – 2023/24)

Comparing Scotland to the North West of England

The North West of England was identified in Section 1.3 as being an interesting point of comparison, as the North West is similar in some ways, economically and geographically, to Scotland. Compared with the North West, Scottish universities are relatively strong at producing high-quality knowledge, collaborating on research, and engaging with industry. As with the UK-wide comparison, Scotland has lower levels of business R&D and innovation than the North West of England, but information from universities is still relatively more important for innovation. Scotland has produced fewer spinouts than the North West in recent years, but Scottish spinout companies have tended to perform better.

There is no strong reason to believe the return from Scottish university research in terms of UK productivity benefits differs from that of UK university research

There are currently no direct estimates of the impact of Scottish university R&D on private sector productivity. There are existing estimates of the returns to UK productivity from publicly conducted R&D in the UK. As discussed in Section 1.2, these estimates have sometimes been used to infer returns to Scottish university research, while others have suggested the returns to university research in Scotland may be higher than the UK average.

This report provides descriptive evidence on how Scotland compares to the UK in terms of indicators of knowledge production and pathways to private sector productivity growth. For the metrics considered Scotland on balance performs broadly comparably to the UK. On the basis of this evidence there therefore seems no strong reason to believe that the return to Scottish university research, in terms of increased UK productivity, differs from that of UK university research in general. This conclusion should be still treated as indicative, as the UK and Scotland may differ on dimensions not assessed, and this report does not estimate realised productivity benefits in Scotland or the UK. However, the evidence in this report is helpful to those considering what can be inferred from UK-wide estimates about the return to Scottish university research.

What remains an important question is how much of those UK productivity benefits are captured by the Scottish economy. This will depend on the geographical spread of firms who increase their productivity or growth as a result of knowledge generated by university research. It will also depend on the extent to which university research affects firms' location decisions within the UK. There is limited existing evidence specific to Scotland on these issues.

There is an international literature that seeks to understand the geographical nature of knowledge spillovers from R&D, with varying conclusions. Recent UK evidence (Aitken et al, 2023), found that only firms within a 15-mile radius of UK universities are able to enjoy the benefits of university research spillovers for private innovation.⁵¹ However, this analysis is relatively short-term in nature. It is likely that in the longer-term the benefits of university research, which is often focused on basic foundational questions, would spread widely. Furthermore, much of the analysis presented in this report suggests that knowledge spillovers from Scottish university research would be expected to accrue to UK firms as well as Scottish firms. Almost a quarter of Scottish publications are co-authored with authors from elsewhere in the UK, while one in six industry-funded external research grants and contracts held by Scottish universities were with organisations located in the rest of the UK. Overall, it seems certain that Scotland would not capture all the productivity benefits arising from Scottish university research. However, it is also the case that Scotland will benefit from productivity spillovers from university research in the rest of the UK and beyond.

The reputation of Scottish universities may help attract business activity to Scotland, which would benefit the Scottish economy. Scotland has been identified as doing relatively well at

⁵¹ [Aitken et al \(2023\)](#)

securing Foreign Direct Investment. In 2024 Scotland secured 16% of all UK FDI projects (while accounting for 8% of UK GDP), a proportion that has grown for the past six years.⁵² There is, however, more limited evidence on the role of Scottish universities in this. EY research explored investment criteria for firms considering investing in regional locations outside of London in the UK. Universities were not explicitly identified, but 'availability and skills of workforce', 'availability of business partners and suppliers' and 'strength of business networks locally' were three of the four most important factors (behind 'access to regional grants and incentives'), and universities may have a positive impact on the perception of a local area on these dimensions. This is consistent with Scottish Government evidence on inward investment support which identifies wider spillover benefits as a key outcome of FDI support in Scotland, including through knowledge exchange.⁵³

More research is needed to understand the extent to which the productivity benefits from Scottish university research accrue to the Scottish economy. What is clear from this study though is that university research in Scotland stands well placed to deliver productivity benefits. These increase the return to spending on research over and above the measured direct supply chain benefits, and in addition to the many important social benefits that arise (for example improvements in health outcomes, environmental quality, and public policy design) which also justify public investment.

Further research on the returns to Scottish university research would be valuable.

Further research would be valuable to strengthen the evidence on how Scottish university research benefits the Scottish economy.

Directly estimating the productivity benefits of Scottish university research remains challenging. Standard econometric approaches would require data on firm productivity, firms' own investment in R&D, and proxies for the relative strength of knowledge transfer from Scottish university research and, separately, from other university research. These data would need to be available for a large, representative sample of firms, either at firm level or at a sufficiently granular industry level. While the Office for National Statistics collects UK-level data that can be used for this type of analysis, equivalent data are not available for Scotland. Collecting them is also unlikely to be feasible given the resources that would be required.

However, this report has identified several areas where further evidence would be valuable and may be more tractable to explore. These include:

- Exploring the geography of university-business collaborations in more detail to understand the extent to which Scottish universities, in particular, act as important collaborators and sources of information for Scottish businesses.

⁵² [2025 UK Attractiveness Survey | EY](#)

⁵³ [Team Scotland's inward investment support: evaluation – GOV.Scot](#)

- Examining whether and how interactions between Scottish universities and Scottish businesses are associated with firm-level productivity and growth outcomes.
- Analysing the fields of Scottish university research and the extent to which they align with local economic growth, including both the growth of local businesses and the growth in the local business population. This could help shed light on the role Scottish universities play in local industrial clusters and the contribution of those clusters to local economies.
- Examining the extent to which university research stimulates additional private R&D among Scottish businesses, including direct co-funding, subsequent follow-on investment or investment inspired by university research.
- Exploring the movement of research staff into local private sector labour markets. This is important both as a mechanism for disseminating knowledge produced from university research and as potential driver of increased labour productivity which would further benefit the Scottish economy.

In most cases, this research would still require novel data sources. This could include new, detailed data on firm interactions with universities that can be analysed geographically and linked, at a firm level, to data on business outcomes.

This further research would not provide quantitative estimates of the return to Scottish university research. However, as with this report, it should provide insights that help Scottish policy makers as they seek to understand, demonstrate and maximise the economic returns to Scottish research.

Annex A Data sources and methodology

In this report we provide quantitative evidence for the main pathways through which university research could result in productivity benefits. The evidence is drawn from bibliometrics and descriptive analysis of secondary data sources. These data and the methodology used are described in more detail here.

A.1 Bibliometric data

The bibliometric analysis uses publication data sourced from Clarivate's Web of Science (WoS) Core Collection. This includes the Science Citation Index Expanded (SCIE), Social Sciences Citation Index (SSCI) and Arts & Humanities Citation Index (A&HCI).

The data used covers the ten-year period from 1 January 2015 to 31 December 2024.

A research publication is attributed to Scotland where at least one author is affiliated to a Scottish academic institution. The same approach is used for other UK countries and regions, with institutions allocated to regions using the same allocation as used by the Higher Education Statistics Agency (HESA) in its data releases. Because publications may have authors from more than one institution or geography, the same publication may be associated with more than one place. For this reason, regional publication counts should not be summed to derive a UK total as this would involve double counting. UK and England totals are omitted from some comparative charts where this would risk misleading interpretation driven by double-counting.

Subject-level analysis is used to test whether headline regional comparisons are driven by a different subject mix across geographies. The bibliometric data are disaggregated using a custom mapping from the 254 Web of Science subject categories to HESA cost centres. This allows publication activity and citation indicators to be examined by broad subject area and compared with subject-level funding data where available. As noted in the main report, publications can be assigned to more than one subject category or cost centre, so subject totals are not additive.

In interpreting the bibliometric evidence, it is helpful to distinguish between two types of indicators. Some indicators are 'scale-dependent', because they are directly influenced by the volume of research activity. In the report, this is the **number of publications**, defined as the number of publications with at least one author affiliated to an institution in the relevant country or region. Larger regions would be expected to record higher values on these measures. We therefore normalise the number of publications by comparing to the amount of research funding in the country or region (see section A.4 below).

Other indicators, namely indicators of impact, are 'relative' rather than scale-dependent. On these indicators smaller institutions or regions can outperform larger ones if their research outputs are more influential on average. The indicators we use are:

- **Category Normalised Citation Impact (CNCI).** Papers refer to or 'cite' earlier work relevant to the material being reported. Papers that accumulate more citations are thought of as having greater 'impact,' which is interpreted as significance or influence on their field. Citation counts are therefore recognised as a measure of impact, which can be used to index the excellence of the research from a particular group, institution, or country. Citation rates vary substantially across research fields, publication years and document types. CNCI adjusts for these differences by normalising citations per paper for subject, year, and document type. A CNCI above 1 indicates that publications are cited more frequently than the relevant global benchmark, while a score below 1 indicates below-average citation performance.
- **Share of papers in the world's top 10% most cited publications.** The top 10% most cited publications are papers that rank in the top 10% by citation count for their specific field and publication year. When expressed as a share of all papers produced in a geography this metric is scale independent.
- **Share of papers involving industry collaboration.** These are defined as publications with two or more organisations in the affiliation metadata, where at least one organisation is classified by Clarivate as corporate or global corporate.

A.2 Patent data

Patent data is sourced from the Derwent World Patents Index and related global patent collections available through Derwent Innovation.

The report focuses on the number of patent families published. A patent family represents a distinct invention that may be protected through multiple filings across jurisdictions and is therefore a more meaningful unit of analysis than the number of individual patent documents.

The data used covers the ten-year period from 1 January 2015 to 31 December 2024. The year assigned to a patent family is the earliest priority date, which is the earliest filing date associated with the invention and provides the best available proxy for when the underlying invention was created. Patent applications generally remain confidential for around 18 months after the earliest filing date. Therefore, we do not present patent family counts for 2023 or 2024, as relevant patent counts are not complete for those years.

Patent family counts, as with publication counts, are influenced by the scale of research activity. We therefore also present normalised comparisons, normalising patent counts relative to research funding (see section A.4 below).

To provide additional evidence on the significance of patented inventions, the report uses the Derwent Strength Index (DSI). This is a composite indicator derived from Derwent data that reflects the technological strength of a patent family, or set of families, based on a combination of patent family size, citation impact, and technological relevance. DSI should not be interpreted as a direct measure of commercial value, but it provides a useful comparative indicator of the relative strength and influence of patent portfolios across geographies.

A.3 Secondary data sources

The report uses HESA's Higher Education Business and Community Interaction (HE-BCI) data to benchmark the number of interactions between universities and external organisations across the UK, and the income from such interactions. The main HE-BCI measures used in the report relate to business and community services, (contract research, consultancy, and facilities and equipment related services), as well as Continuing Professional Development (CPD) and Continuing Education (CE) activity. This data is reported on an academic year basis and is available from 2014/15 to 2023/24 and comes from Table 2a⁵⁴ and Table 2b⁵⁵ from the HE-BCI data, respectively. A time series of the annual number of interactions is presented for 2014/15 to 2023/24. The total number of, and income from, such interactions is then normalised in the context of total research funding over the seven years 2017/18 and 2023/24.

The report also uses HESA HE-BCI data on spinouts and startup companies, together with the HESA Spin-out Register. HESA's business and community interaction release includes data on spinouts and startup companies on an academic year basis from 2014/15 to 2023/24, represented in Table 4e of the release.⁵⁶ HESA's Spin-out Register captures spinout activity from 1 August 2012 to 31 July 2024, captured in Table 6 of the release.⁵⁷ In this report, HESA spinout and startup data are used for both trend analysis over 2014/15 to 2023/24, and benchmarking of averages over 2017/18 to 2023/24. The HESA Spin-out Register is also used for the subject composition analysis of spinouts over 2015 to 2024. As demonstrated in the report, some outlier data points have been removed from overall UK figures to maintain a reasonable comparison of trends across the UK and Scotland. This includes Cambridge turnover data which indicates extreme outperformance of spinouts in performance metrics compared to elsewhere.

For Scotland-specific analysis of university interactions with businesses and other organisations, the report uses Scottish Funding Council (SFC) knowledge exchange metrics.⁵⁸ These metrics are collected by SFC to support the allocation of its Knowledge Exchange and Innovation Fund (KEIF) and related knowledge exchange policy work. In the report, they are used to provide richer detail than is available in the HE-BCI data on the number, value, composition, and geography of interactions involving Scottish universities, including the location of partner organisations. These metrics are reported on an academic year basis. The report uses this data primarily as a 2023/24 snapshot, the latest year detailed Scottish data is available, although some backward comparisons are made where available. The SFC

⁵⁴ [Table 2a - Business and community services | HESA](#)

⁵⁵ [Table 2b - Continuing Professional Development \(CPD\) and Continuing Education \(CE\) courses for business and the community | HESA](#)

⁵⁶ [Table 4e - Intellectual property: Spin-out activities | HESA](#)

⁵⁷ [Table 6 - Spin-out register by HE provider | HESA](#)

⁵⁸ [SFC Knowledge Exchange and Innovation Fund metric data](#)

definitions do not map one-to-one to HESA HE-BCI definitions, so the two sources are used for different purposes rather than combined directly.

To examine private R&D from the perspective of businesses, the report uses the UK Innovation Survey (UKIS) 2023, which collects information from businesses on innovation activity and related behaviours. The questionnaire asks firms about a specific multi-year survey period, and the UKIS 2023 release covers the three-year period 2020 to 2022. In this report, UKIS data is used to examine the proportion of firms that are innovation active (UKIS Table 1), the proportion of firms that report information from universities or HE institutions as highly important for innovation (UKIS Table 9), and the proportion of collaborating or innovating firms that report collaboration with universities or higher education institutions (UKIS Table 8c).⁵⁹ For the comparisons of the UK and Scotland by firm size, this report also uses the Scottish Government's publication of UK Innovation Survey 2023 results for Scotland (Tables 3 and 14 of the Scottish Government publication).⁶⁰

This report uses ONS data to measure business expenditure on research and development (BERD)⁶¹ and to provide regional GDP figures⁶² used in normalisation and contextual benchmarking. This data is reported on a calendar year basis, with 2023 being the most recent year with a regional breakdown. In the report, we use a 2023 snapshot of BERD and compare this with 2023 regional GDP to calculate BERD as a share of GDP.

A.4 Normalisation and benchmarking

Many of the indicators used in the report are affected by the scale of university activity in each geography. For example, England would be expected to produce more publications than Scotland because it is larger. To make comparisons more meaningful, we use HESA Finance Data to normalise scale-dependent metrics by total university research funding in the country or region. This means we can compare the outcomes across geographies relative to the scale of research inputs.

For most metrics, total research funding comprises of the sum of total income from HESA Research grants and contracts data (Table 5 from the HESA finance data)⁶³ and total income from HESA Funding body contracts data (Table 7C from the HESA finance data).⁶⁴ The only exception to this is for subject-level bibliometric data, where funding body contracts cannot be allocated by subject, and so data is only normalised using research grants and contracts funding alone.

⁵⁹ [UK innovation survey 2023: report - GOV.UK](#)

⁶⁰ [Innovation Activity - UK innovation survey 2023 – results for Scotland](#)

⁶¹ [Business enterprise research and development, UK \(designated as accredited official statistics\) - ONS](#)

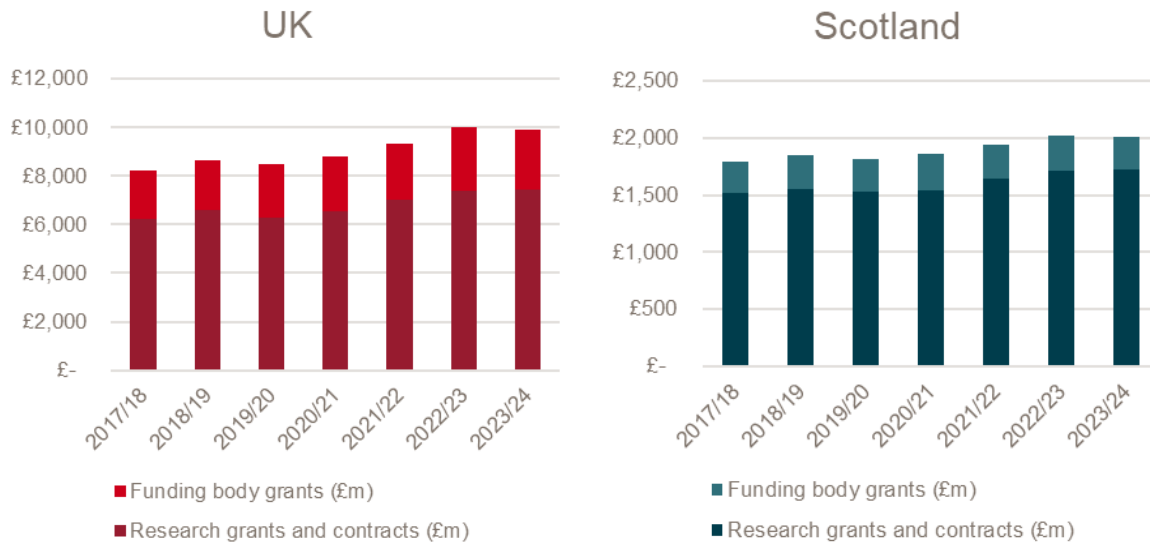
⁶² [Regional gross domestic product: all ITL regions \(Table 5\) - ONS](#)

⁶³ [Table 5 - Research grants and contracts | HESA](#)

⁶⁴ [Table 7C - Funding body grants | HESA](#)

Figure 34 gives a summary of total research funding in each academic year from 2017/18 to 2023/24.⁶⁵ This shows income from each source over time for the UK and Scotland. As demonstrated in the charts, income from Research Grants and Contracts accounts for approximately 75% of research funding in the UK, and 85% of research funding in Scotland.

Figure 34 Total research funding in the UK and Scotland (2017/18 – 2023/24)



Source: Frontier Economics; HESA Finance data

When normalising by research funding, we average over the period 2017/18 to 2023/24. That is, take the total sum over that period for the metric of interest and compare to the total research income over that same period. In doing so we provide comparisons between geographies of average performance in recent years. We look to strike a balance between smoothing volatility and providing a recent picture of performance for each normalised metric. For reference Table 3 provides the average research funding over the period 2017/18 to 2023/24 for each of the geographies that we produce normalised figures for.

⁶⁵ This excludes available data from 2015/16 and 2016/17, as research grants for English universities were awarded under the HEFCE funding regime for these years.

Table 3 Average research funding, by region (2017/18 – 2023/24)

Region		Average Research Funding (2017/18 - 2023/24)
UK	£	9,052,954,000
England	£	7,378,292,000
Scotland	£	1,167,325,000
Wales	£	330,734,143
Northern Ireland	£	176,602,857
London	£	2,140,916,714
South East	£	1,322,591,714
South West	£	508,962,857
East of England	£	906,553,429
West Midlands	£	488,670,000
East Midlands	£	369,486,857
North West	£	749,636,286
Yorkshire and the Humber	£	627,668,429
North East	£	263,805,714

Source: Frontier Economics; HESA Finance data

Annex B Metrics summary dashboard

This annex presents a set of tables representing a dashboard of the metrics explored above for each of the pathways above. It provides the values for the UK and each of the other regions and nations within it, with colours emphasising which areas of the UK perform relatively well in each metric. The tables also provide a regional ranking of these metrics for Scotland, Wales, Northern Ireland, and the English regions.

Table 4 Metrics relating to innovation and knowledge production by universities

Pathway	Innovation and knowledge production by universities										University and business collaboration on research					
	Average number of publications produced in UK nations annually		Average CNCI (2020-2024)		Proportion of papers in the top 10% (2020-2024)		Average number of patent families produced Per £bn of research funding (2018-2024)		Average Derwent Strength Index by Country Non-age weighted (2015-2024)		Average annual income from external research grants and contracts by region (% of total research funding, 2017/18 - 2023/24)		Average proportion of publications produced which involved industry collaboration (2020-2024)		Proportion of collaborative broader innovators who collaborate with universities or higher education institutions (2020-2022)	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank
UK	23		1.50		15.1%		62		47		17.6%		5.0%		32.5%	
England	24		1.53		15.4%		65	1	48	2	17.6%		5.3%		31.4%	
Scotland	23	5	1.61	7	16.0%	7	53	2	46	4	17.9%	5	4.6%	2	37.2%	3
Wales	27	4	1.58	9	15.5%	9	43	3	47	3	17.9%	6	4.1%	7	46.6%	1
Northern Ireland	28	1	1.62	6	16.2%	5	36	4	54	1	16.4%	9	4.2%	6	41.8%	2
London	19	9	1.77	2	17.6%	2					15.4%	11	5.2%	1	34.7%	6
South East	17	11	1.69	3	17.1%	3					17.5%	7	4.0%	8	27.5%	11
East of England	14	12	1.82	1	18.1%	1					16.9%	8	4.3%	5	28.6%	9
North West	19	7	1.59	8	15.6%	8					16.2%	10	4.4%	3	33.9%	7
South West	19	8	1.64	4	16.4%	4					18.3%	4	3.2%	11	32.8%	8
North East	28	2	1.63	5	16.1%	6					13.7%	12	3.4%	10	28.5%	10
West Midlands	20	6	1.57	11	15.2%	11					19.4%	3	3.2%	12	35.7%	4
East Midlands	27	3	1.58	10	15.4%	10					23.2%	2	3.6%	9	35.1%	5
Yorks & Humber	19	10	1.53	12	14.8%	12					24.7%	1	4.3%	4	24.0%	12

Source: Frontier Economics; Clarivate; Web of Science; Derwent World Patents Index

Notes: Scotland and the North West have highlighted outlines for simpler comparison of Scotland and its most similar UK region.

Table 5 Metrics relating to dissemination of university-produced knowledge to business, and business R&D and innovation

Pathway	Dissemination of university-produced knowledge to businesses										Business R&D and innovation			
	Average income from business and community services interactions		Average number of business and community services interactions		Average income relating to CPD and CE interactions		Average learner days relating to CPD and CE interactions		Proportion of firms across the UK rating information from universities as “highly important” to innovation activities		Business expenditure on R&D (BERD)		Proportion of firms identifying as innovation active	
	Per £m of research funding (by region, 2017/18 - 2023/24)		Per £m of research funding (by region, 2017/18 - 2023/24)		Per £m of research funding (by region, 2017/18 - 2023/24)		Per £m of research funding (by region, 2017/18 - 2023/24)		(2020-2022)		% of GDP (by region, 2023)		By country and region (2020-2022)	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank
UK	£ 256,020		16		£ 75,557		443		1.6%		2.0%		36%	
England	£ 262,343		14		£ 77,851		465		1.6%		2.1%		37%	
Scotland	£ 237,277	9	25	2	£ 61,898	9	193	12	2.6%	1	1.4%	7	32%	10
Wales	£ 147,797	12	13	9	£ 93,651	2	950	1	1.3%	10	0.9%	12	31%	12
Northern Ireland	£ 318,377	4	15	8	£ 36,140	12	208	11	1.4%	8	1.2%	9	32%	11
London	£ 196,469	11	9	11	£ 84,207	4	411	7	1.6%	4	2.1%	5	37%	5
South East	£ 325,414	3	8	12	£ 75,673	6	375	8	1.4%	9	2.2%	3	40%	1
East of England	£ 245,728	6	15	7	£ 74,129	7	454	6	2.2%	2	4.3%	1	39%	2
North West	£ 241,082	8	27	1	£ 87,188	3	870	3	2.0%	3	2.1%	4	35%	8
South West	£ 245,186	7	20	4	£ 54,720	10	269	9	1.5%	5	1.5%	6	37%	4
North East	£ 220,575	10	12	10	£ 72,631	8	906	2			1.0%	11	39%	3
West Midlands	£ 336,563	2	19	5	£ 83,444	5	581	4	1.5%	6	2.2%	2	35%	6
East Midlands	£ 363,609	1	21	3	£ 109,469	1	511	5	1.5%	7	1.3%	8	35%	8
Yorks & Humber	£ 317,598	5	16	6	£ 52,961	11	228	10	0.9%	11	1.0%	10	35%	6

Source: Frontier Economics; Clarivate; Web of Science; HESA HE-BCI data; ONS BERD data; UKIS data

Notes: Scotland and the North West have highlighted outlines for simpler comparison of Scotland and its most similar UK region.

Table 6 Metrics relating to spinouts and startups

Pathway	Spinouts and startups															
	Average number of new spinouts by UK region		Average employment (FTE) per active spinout		Average turnover per active spinout		Average external investment received per active spinout		Average number of new startups by UK region		Average employment (FTE) per active startup		Average turnover per active startup		Average external investment received per active startup	
	Per £bn of university research funding (2017/18 - 2023/24)		(2014/15 - 2023/24)		(2014/15 - 2023/24 - excl. Cambridge)		(2014/15 - 2021/22)		Per £bn of university research funding (2017/18 - 2023/24)		(2014/15 - 2023/24)		(2014/15 - 2023/24)		(2015/16 - 2021/22)	
Metric	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank
UK	19		18		£1,537,409		£1,496,506		492		2.6		£ 148,657		£ 40,860	
England	19		18		£1,244,470		£1,695,286		516		2.7		£ 121,503		£ 47,463	
Scotland	13	12	17	5	£1,488,389	4	£1,223,167	6	218	12	3.1	3	£ 351,382	2	£ 28,191	6
Wales	19	6	7	12	£ 761,961	10	£ 86,414	12	1054	2	1.6	11	£ 45,629	8	£ 6,150	9
Northern Ireland	36	2	42	1	£4,807,146	1	£1,488,022	4	275	10						
London	17	8	17	4	£1,146,253	5	£2,381,397	2	664	4	2.6	4	£ 92,804	6	£ 42,642	4
South East	15	10	31	2	£3,116,151	2	£2,979,231	1	236	11	2.4	5	£ 509,899	1	£ 73,882	2
East of England	17	7	24	3	£ 710,906	11	£1,981,148	3	317	9	6.2	1	£ 24,929	11	£ 181,328	1
North West	20	5	8	10	£ 576,763	12	£ 424,100	10	514	6	2.3	7	£ 60,591	7	£ 13,053	8
South West	38	1	13	7	£1,502,475	3	£1,330,693	5	679	3	2.3	6	£ 231,032	4	£ 34,884	5
North East	31	3	11	9	£ 943,336	7	£ 308,787	11	492	7	3.9	2	£ 333,232	3	£ 54,464	3
West Midlands	23	4	7	11	£ 856,742	8	£ 451,820	9	581	5	1.6	10	£ 28,260	10	£ 2,314	11
East Midlands	14	11	12	8	£ 820,060	9	£ 707,744	8	1106	1	1.9	8	£ 149,425	5	£ 25,583	7
Yorks & Humber	16	9	16	6	£1,020,061	6	£ 863,796	7	366	8	1.6	9	£ 45,344	9	£ 2,436	10

Source: Frontier Economics; Clarivate; HESA Spinouts data

Notes: Scotland and the North West have highlighted outlines for simpler comparison of Scotland and its most similar UK region.



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