INNOVATION & RESEARCH CAUCUS

ECONOMIC BENEFITS OF PUBLICLY FUNDED INTERNATIONAL RDI COLLABORATIONS

Phase 2 Report

IRC Report No. 066

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The Innovation and Research Caucus supports the use of robust evidence and insights in UKRI's strategies and investments, as well as undertaking a co-produced programme of research. Our members are leading academics from across the social sciences, other disciplines and sectors, who are engaged in different aspects of innovation and research systems. We connect academic experts, UKRI, IUK and the ESRC, by providing research insights to inform policy and practice. Professor Tim Vorley and Professor Stephen Roper are Co-Directors. The IRC is funded by UKRI via the ESRC and Innovate UK, grant number ES/X010759/1. The support of the funders is acknowledged. The views expressed in this piece are those of the authors and do not necessarily represent those of the funders.

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EXECUTIVE SUMMARY

This report presents an econometric analysis of the economic benefits of publicly funded international collaboration in Research, Development, and Innovation (RDI) for UK businesses, with a focus on both innovation outputs and broader measures of business performance. The study builds on a comprehensive literature review conducted in Phase 1 of this project (Ozusaglam et al., 2024), and initial Phase 2 analysis which examined the additionality of international collaboration for process and product innovations (Ozusaglam et. al., 2026). This report provides the most comprehensive firm-level assessment of the additionality of publicly funded international RDI collaboration in the UK to date, integrating innovation and business performance outcomes within a single analytical framework and examining the conditions under which international collaboration generates additional benefits over domestic collaboration.

Data and Approach

The analysis draws on a novel linked dataset combining three sources, i) the Gateway to Research (GtR) database, which records UKRI supported collaborative projects since 2006; ii) the UK Intellectual Property Office (IPO) data, which provides information on all intellectual property rights registered by UK businesses; and iii) the Office for National Statistics Business Structure Database (BSD), which covers the population of UK businesses and provides information on turnover, employment, age, ownership, and industrial classification. The matched dataset covers UK businesses engaged in UKRI supported collaborative projects between 2006 and 2023.

The study examines six outcome measures; employment growth, turnover growth, and labour productivity growth as measures of business performance, and patents, trademarks, and registered design application growth as measures of innovation outputs. It considers the benefits to UK businesses engaged in international collaborations with foreign businesses (B2B) and foreign universities (B2U), and distinguishes between projects funded by Innovate UK (IUK) and those funded by the Research Councils (RCs). The analysis employs a Propensity Score Matching (PSM) procedure combined with the Callaway and Sant'Anna (2021) staggered Difference-in-Differences (CSDiD) estimator to estimate the causal impact of international collaboration relative to domestic collaboration over time.

Key Findings

Before outlining our key findings, it is useful to reiterate that this report measures the additional benefits of international collaboration *relative to domestic collaboration*, not relative to no collaboration. Specifically, within the population of firms supported by UKRI to undertake collaborative innovation projects, we compare those whose collaborations included international partners against those whose collaborations were purely domestic.

This distinction is important because our findings should not be read as the impact of international collaboration, or of collaboration generally, compared to a no-collaboration baseline. Two IRC projects address that issue separately. Using a representative sample of UK firms, Ozusaglam et al., (2026) show that collaborating for innovation, whether domestically or internationally, is better for innovation than not collaborating at all, and that international collaboration is better than domestic collaboration particularly for process and new-to-the-market innovations. Jibril et al., (2026, forthcoming) compare all UKRI-supported collaborations, international and domestic combined, against non-supported firms and show consistent positive impacts on growth in employment, turnover, patents and registered designs. These findings reflect the fact that domestic collaboration itself delivers benefits over not collaborating at all.

The aim of the present report is to strip out that baseline domestic benefit in order to isolate whether international collaboration adds any further benefits. Consequently, a null result here does not mean international collaboration is not beneficial, only that it performs no better than domestic collaboration alone.

Our main findings are as follows:

- The results show that publicly supported international RDI collaboration confers additional benefits over domestic collaboration, but the nature and extent of these benefits are highly selective as they depend on the funding mechanism, the scale of funded projects, the type of firm, and the evolution of the firm's collaboration practices. Table 1 specifies the level of additionality for different types of firms.

- The funding mechanism, i.e., the type of funding organisation, is the primary differentiator of the nature of impact. Compared to domestic-only collaborations, Innovate UK (IUK)-supported international collaborations generate the clearest benefits for innovation outputs, leading to increases in patent application growth and registered design application growth. Research Council (RC)-supported collaborations yield more pronounced business performance gains, improving employment, turnover, and labour productivity relative to domestic-only collaboration.

- Within each funding mechanism, the type of collaboration – i.e., whether UK businesses collaborate with international businesses (B2B) or with international universities (B2U) does not significantly influence the extent of impact.

- International collaborations from RC-supported projects improve turnover growth and productivity growth among small firms, employment growth among young firms, and registered design and patent application growth among mature and established firms, respectively. IUK-supported international collaborations increase employment growth and patent application growth among micro firms and patent application growth among small firms with additional and

comparatively larger gains in patents observed among large firms, who also see registered design application growth. IUK-supported international collaborations further increase turnover growth among mature firms and both patent and registered design application growth among established firms, while RC-supported collaborations also increase patent application growth among established firms, albeit to a more modest degree.

- Likewise, firms in different industries see different impacts. Additionality from international collaboration occurs only among firms in highly innovative sectors. IUK supported firms in high-technology manufacturing sectors see increases in patents and registered design application growth. Firms in these sectors that engage in RC-supported projects also improve turnover, labour productivity and patent application growth. In services, firms in high knowledge-intensive sectors benefit across innovation and business growth outcomes. By contrast, firms in both low-technology manufacturing and low knowledge-intensive services experience little additional benefit from their international collaboration.

- The scale of collaborative projects and the pattern of engagement condition the extent of impact. Firms involved in larger-value projects see meaningful additionality across both innovation and business growth outcomes, while those involved in lower-value projects see little additional benefits. One-off engagement in RC-supported projects tends to improve business growth outcomes whereas accumulating multiple IUK grants leads to greater innovation outputs.

- International collaboration complements domestic collaboration in two ways. First, firms initiating international collaborations tend to retain existing domestic partners while forming new domestic and international relationships. Second, this ability to preserve and expand domestic networks while internationalising R&D generates the greatest economic benefits from international collaboration.

Table 1. Additionality of International Collaboration Relative to Domestic Collaboration by Firm Characteristics

Firm characteristic	RC-supported projects	IUK-supported projects
Micro firms	–	Employment growth (+7%); Patent application growth (+3.3%)
Small firms	Turnover growth (+8%); Labour productivity growth (+5%)	Patent application growth (+6.4%)
Large firms	–	Patent application growth (+11%); Registered design application growth (6.3%)
Young firms	Employment growth (+6.3%)	–
Mature firms	Registered design application growth (+1.6%)	Turnover growth (+12.8%)
Established firms	Patent application growth (+2%)	Patent application growth (+4%); Registered design application growth (+3%)
High-technology manufacturing	Turnover growth (+8.5%); Labour productivity growth (+5.2%); Patent application growth (+5%)	Patent application growth (+13.4%); Registered design application growth (+8.1%)
High knowledge-intensive services	Employment growth (+3.6%); Turnover growth (+8.4%); Productivity growth (+4.6%); Patent application growth (+1.7%); Registered design application growth (+1.2%); Trademark application growth (+1.6%)	Patent application growth (+6.6%); Registered design application growth (+1.6%); Trademark application growth (+3%)
Low-technology manufacturing	Little or no additional benefit observed	Little or no additional benefit observed
Low knowledge-intensive services	Little or no additional benefit observed	Little or no additional benefit observed
Note: Values represent estimated additional effects of international collaboration relative to comparable firms participating only in domestic collaborations.		

Actionable Insights

The findings provide targeted insights for RDI funding and support strategies aimed at maximising the additionality of international collaboration:

- International RDI collaboration is an activity best suited to innovative firms operating at the technological frontier within sectors with high absorptive capacity. It is not currently an activity that shows clear value added for all UKRI

supported firms. To expand its impact more widely, policy would need to additionally support resource and capacity building for firms that are not yet able to translate international collaboration into strong innovation or growth outcomes.

- Different funding mechanisms help to deliver additionality across a range of innovation and growth outcomes, underscoring their complementarity. Maintaining this diversity of support appears important for enabling the widest range of business outcomes through international collaboration. The complementarity between IUK and Research Council funding mechanisms is a critical feature of the current system that policy should explicitly seek to preserve. Each stream supports a distinct but equally valuable pathway to firm-level impact, and strategies that substitute one for the other risk narrowing the overall range of outcomes that UKRI supported international collaboration can deliver.

- To maximise *employment growth*, the results broadly suggest that UKRI support for international collaboration should seek to target micro and younger firms.

- To maximise turnover and associated *labour productivity growth*, the results broadly suggest that UKRI support for international collaboration should seek to target small and mature firms.

- To maximise both technological and non-technological *innovation*, the results broadly suggest that UKRI support for international collaboration should seek to include more large and established firms. Table 2, below, summarises the potential policy targets and outcomes in each case.

- Across all outcomes, additionality tends to be higher for larger grant awards or longer project durations. Policy support for international collaboration should therefore consider whether funding thresholds and durations are sufficient to offset the additional costs of international collaboration and allow sufficient learning, particularly for smaller firms, for whom domestic collaboration may represent better value for short projects or for projects below a certain resource threshold

- There is an opportunity for policy to leverage internationally collaborative firms as conduits or network anchors that can help expose domestic firms to international partners, potentially linking more UK firms into global value chains, enabling more firms to benefit from international collaboration and potentially leading to wider spillover effects for domestic firms.

Table 2: Potential Policy Targets

Target outcomes	Most promising target firms
Employment Growth	Micro & Young
Turnover & Productivity growth	Small & Mature
Innovation	Large & Established

Limitations

To our knowledge, this analysis represents the most comprehensive study to date of the additionality of UKRI funded international RDI collaboration for UK businesses. Nevertheless, it has some limitations:

Data limitations:

- Gateway to Research (GtR) provides a public portal of research and innovation awards funded by UK Research and Innovation (UKRI). It includes data on the majority of awards funded through UKRI's systems, but non-award investments such as infrastructure investments, including in international infrastructures, are not included.

- The GtR data also does not include Innovate UK support provided through other delivery partners, for example growth-orientated international programmes delivered by Innovate UK Business Growth are not included. This may help explain the weaker growth effects observed for IUK supported projects.

- The BSD data allows us to measure only labour productivity, defined as the ratio of turnover to employment, rather than total factor productivity. As a result, productivity findings reflect relative changes in turnover and employment and should be interpreted with caution. For example, a null effect may simply indicate that turnover and employment changed by a similar magnitude.

- ONS disclosure rules relating to "bodies corporate," in place at the time of analysis, limited our ability to disaggregate findings by individual Research Council funding body beyond the broad IUK versus non-IUK distinction.

Scope limitations:

- The findings relate specifically to the population of UKRI-supported firms engaged in RDI. Two boundaries follow from this. First, the findings exclude firms without public funding and those supported through other funding routes. Second, the findings do not cover the substantial share of UK businesses that do not engage in any formal RDI activity. Therefore, our findings are only representative of the population of UKRI-supported firms, not UK businesses more generally. The findings in Ozusaglam et al., (2026) address this limitation

by using a representative sample of UK firms, although that analysis relies on self-reported innovation outcomes.

- The study focuses on firm-level outcomes and does not examine the returns to universities or other public research organisations, nor does it illuminate the mechanisms through which international collaboration influences firm performance. A parallel qualitative study by the IRC explores the mechanisms for deriving benefits from university-led collaborations, but not for business-led collaborations (De Silva et al., 2026, forthcoming).

- Our definition of international collaboration relies on overseas organisations being reported by award holders as project partners or collaborators on a given award. This measure may therefore not capture all forms of collaboration, and it provides no indication of the nature or extent of the collaborative activity involved.

Methodological limitations:

- While the PSM and CSDiD approach mitigates concerns of self-selection into international collaboration, and matching within the population of publicly funded firms substantially reduces the threat of unobservable characteristics associated with receiving innovation support, some residual selection bias cannot be ruled out.

1. Introduction and Objectives

This report presents an econometric analysis of the economic benefits of publicly funded international collaboration in Research, Development, and Innovation (RDI) for UK businesses. It builds on Phase 1 of this project (Ozusaglam et al., 2024), which reviewed the evidence on the economic benefits of international RDI collaboration. The Phase 1 review identified clear evidence of the research and innovation benefits of international RDI collaboration. These include direct benefits to participating organisations, such as better bibliometric research outputs, talent development, improved business innovation and sales outcomes, and higher individual and organisational productivity. The review also identified wider benefits such as knowledge spillovers, societal and reputational benefits, national competitiveness and economic growth.

However, the Phase 1 review also identified three key gaps in both the academic literature and in evaluation studies of the effectiveness of international RDI collaboration. First, there is very little empirical evidence directly comparing the benefits of international collaborations with those of domestic collaborations across U2U, U2B, and B2B modes of collaboration. There is thus little evidence of *additionality* of international collaboration over domestic collaboration. Second, the review found insufficient evidence on the *mechanisms* through which international RDI collaboration produces additional benefits over domestic collaboration. Third, few attempts have been made to *monetise* the potential economic benefits of international RDI collaboration.

Initial analysis as part of Phase 2 of the project began to address these gaps. Drawing on UK Innovation Survey (UKIS) data, Ozusaglam et al., (2026) examined the additionality of international B2B and B2U collaborations for a broader population of innovative UK businesses, including those without UKRI funding. The UKIS analysis found that, compared to domestic-only collaboration, businesses engaged in international B2B collaboration are 13 percentage points more likely to introduce process innovations and 7.3 percentage points more likely to introduce new-to-market product innovation. For B2U collaborations, international partnerships raise the likelihood of process innovation by 11 percentage points, though no significant additional impact was found for product innovation. This analysis provides evidence that international RDI collaborations offer additional benefits over domestic collaborations for innovation outcomes, while also highlighting important differences by collaboration type.

The present report integrates and extends these findings by incorporating broader business performance outcomes; employment, turnover, and labour productivity growth, by linking the Gateway to Research (GtR) database with both the UK Intellectual Property Office (IPO) data and the Office for National Statistics Business Structure Database (BSD). This richer, integrated dataset allows for a more comprehensive assessment of the impact of UKRI funded international RDI collaboration, encompassing not only IP outcomes but also broader measures of business

performance, including employment, turnover, and labour productivity growth. The report also examines the extent to which international collaborations substitute for or complement domestic partnerships and the implications this has for business outcomes.

1.1 Research Objectives

The primary objective of this report is to strengthen the evidence base on the additional economic benefits that UKRI funded international RDI collaboration offers to UK businesses over and above domestic RDI collaboration. To achieve this, the analysis addresses the following research questions:

- Relative to UKRI supported domestic RDI collaboration, does UKRI supported international RDI collaboration lead to additional benefits in terms of innovation outputs (IP generation) and business performance outcomes for UK businesses?
- How do the effects of international RDI collaboration differ across types of collaboration (B2B versus B2U) and types of public funding mechanisms (Innovate UK versus Research Councils)?
- How do the effects of international RDI collaboration vary across firm characteristics, including firm size, age, and sector?
- How do the effects of international RDI collaboration vary across project characteristics, including project size, project duration and the pattern of project engagement?
- Does engagement in international RDI collaboration substitute for or complement domestic collaboration, and does this pattern influence business performance?

The analysis focuses on six outcome measures: three capturing business growth (turnover growth, employment growth, and labour productivity growth) and three capturing innovation outputs (patents, trademarks, and registered design application growth). To estimate the causal impact of international collaboration relative to domestic collaboration, the analysis employs a Propensity Score Matching (PSM) procedure combined with the Callaway and Sant'Anna (2021) staggered Difference-in-Differences (CSDiD) estimator which mitigates concerns of self-selection, endogeneity, and omitted variable bias.

The rest of this report is organised as follows. Section 2 describes the data and the characteristics of firms engaging in UKRI funded domestic and international RDI collaborations. Section 3 outlines the empirical methodology. Section 4 presents the results, including heterogeneity analyses by funding organisation, collaboration type, firm characteristics, and project characteristics, as well as an assessment of the complementarity between domestic and international collaborations. Section 5 concludes with a summary of findings, implications for policy and funding strategy and limitations of the study.

2. Data

This analysis relies on the integration of three different datasets. First, our primary data source is the Gateway to Research (GtR) database. This dataset provides information on all UKRI supported RDI projects since 2006. It includes information on around 150,000 funded projects, including start-end dates, funders, awards, project descriptions and partners. DSIT has enhanced this database by providing detailed information for around 60,000 lead and partnering organisations, in terms of their organisation type (university, firms, etc.) and geographical location. This dataset is frequently used to assess public funding for RDI activities (Vanino et al., 2019), and it allows us to identify UK companies involved in UKRI funded RDI collaborations, knowing the funding body, the awarded funding, and the types and locations of partners.

In order to analyse the business and innovation performance of companies before and after their engagement in RDI collaborations, we complement this with two other data sources. First, we measure firms' innovation outputs by using data from the UK Intellectual Property Office (IPO), providing detailed information on all intellectual property rights (IPRs) registered by businesses in the UK yearly. We do not consider only registered patents, but also consider other types of intellectual property which are increasingly used in the literature to better reflect innovation outcomes in industries non intensive in patents, such as domestic and international registered designs (Corradini and D'Ippolito, 2022), and trademarks (Flikkema et al., 2019). Secondly, we complement the previous data sources with the Office for National Statistics (ONS) Business Structure Database (BSD), covering the whole population of businesses in the UK since 1997 (ONS, 2025). The BSD provides balance-sheet information on firms' age, ownership, turnover, employment, and industrial classification at the Standard Industrial Classification (SIC) four-digit level and postcode.

In our analysis, we only focus on UK-based firms participating in UKRI funded RDI collaborative projects. We distinguish between firms collaborating only with other UK-based organisations ("Domestic Collaboration") and firms collaborating also with organisations based overseas ("International Collaboration"). In terms of funding bodies, we make a clear distinction between RDI collaborative projects funded by Innovate UK (IUK) and by other Research Councils (RCs). Research Councils primarily fund university-led research projects, in which private businesses may participate as partners, whereas Innovate UK is the UK government's principal agency for supporting RDI projects led by private firms. As a consequence, there is a difference in terms of funding received by companies, and in terms of the goals of projects funded by Innovate UK and other Research Councils. Since we have detailed information on project partners, we can also make the distinction between business-to-business (B2B) collaborations, and business-to-university (B2U) collaborations, where at least one of the international partners is a university.

Figure 1 provides an initial overview of the data covering an overall sample of 29,343 funded collaborative projects. Collaborations involving at least one international partner account for around 20% of all funded projects. About 96% of international collaborations are undertaken in RC supported projects, and only about 4% of projects involving an international partner are funded by IUK. Within both domestic and international collaborations, there are more B2U than B2B collaborations.

Figure 1: Distribution of domestic and international collaborations by collaboration type

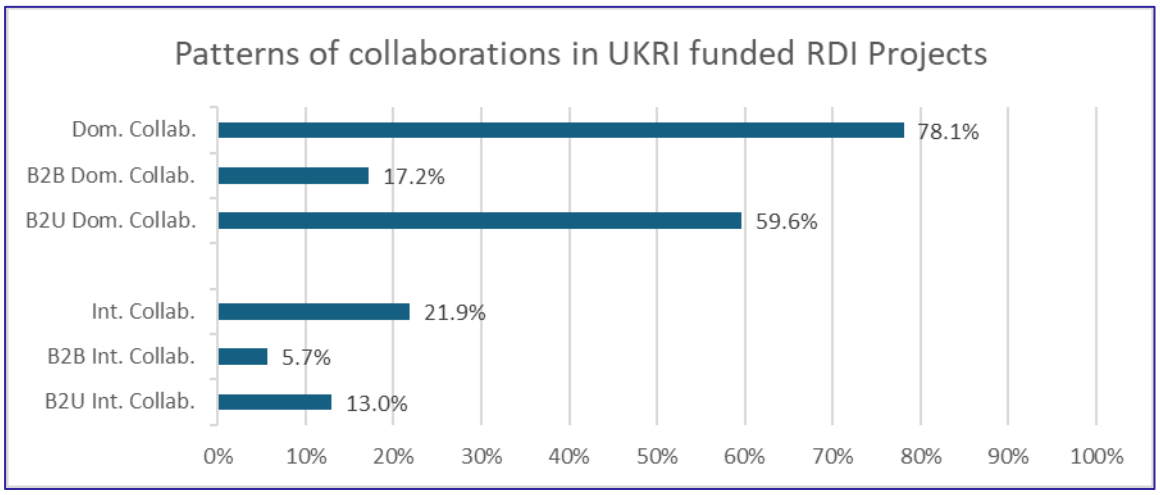


Figure 2 shows the composition of collaborations by funder. Approximately 65% of all collaborations are supported by Research Councils. As would be expected by the focus of support, most B2B domestic collaborations are undertaken in IUK supported projects whereas the majority of B2U collaborations are undertaken in RC supported projects.

Figure 2: Distribution of domestic and international collaborations by funding body

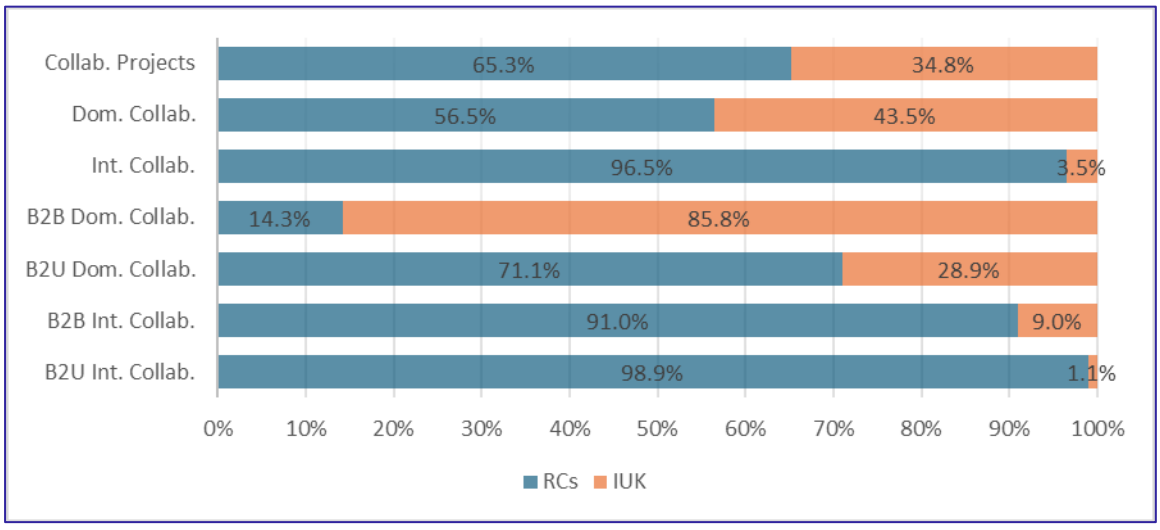


Figure 3: Trend of UKRI funded domestic and international collaborations.

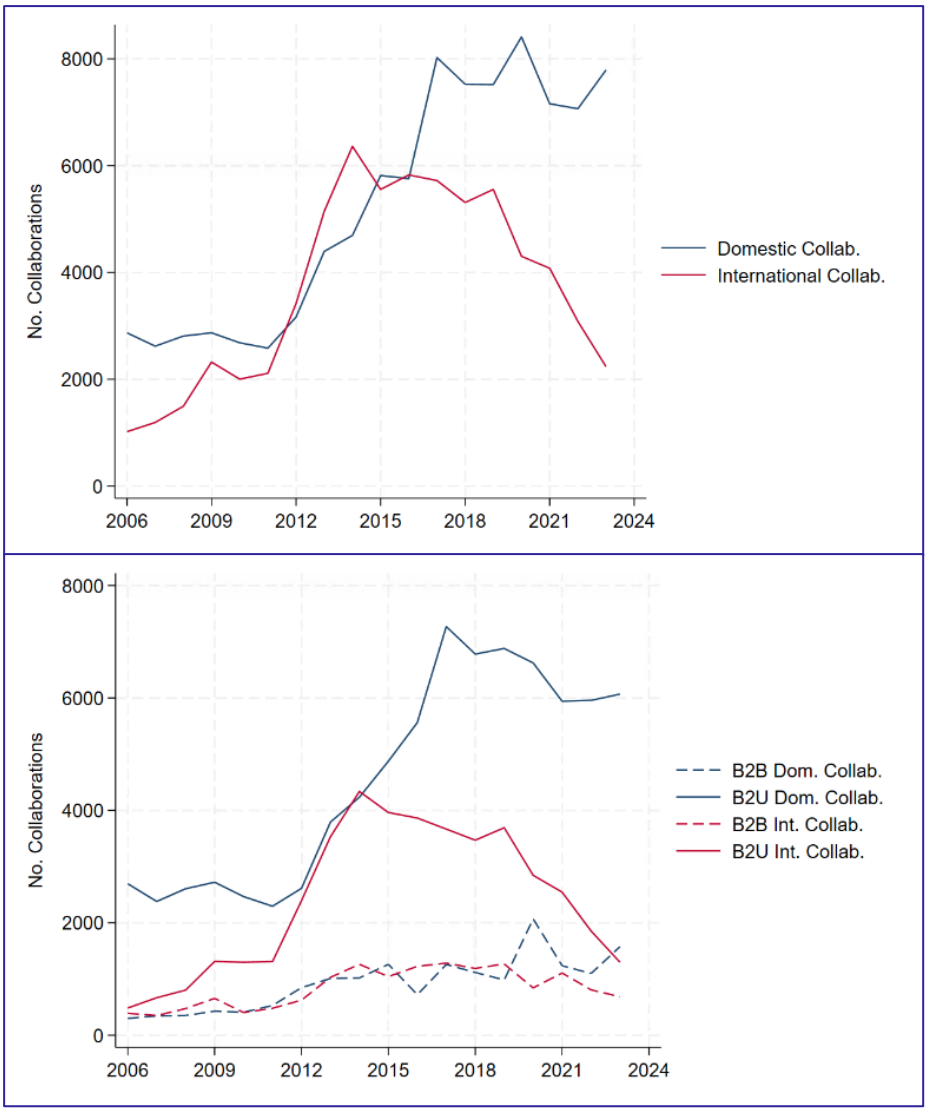


Figure 3 illustrates the evolution of these collaborations over time. However, it is important to note that the observed temporal trend does not, in itself, provide evidence of a global pattern, as it may be influenced by changes in UKRI and His Majesty's Government (HMG) policies. The left-hand panel shows that both domestic and international collaborations increased rapidly after 2011. However, while domestic collaborations continued to grow steadily until 2017 before stabilising, international collaborations plateaued around 2014 and began to decline sharply after 2019. This apparent decline in international RDI collaboration is in line with recent studies which find that collaborations between UK firms and international partners in the development of patents declined sharply after 2014, driven by a decline in collaborations with European partners (Du and Ribaudo, 2026). The right-hand panel further decomposes these trends into B2B and B2U collaborations. The decline in international collaborations appears to be driven primarily by a marked reduction in international B2U

projects, most of which were funded by the Research Councils, whereas other forms of collaboration continued to increase steadily over the period.

Table 3 presents the main characteristics of collaborative projects funded by UKRI. Domestic collaborations constitute by far the largest category. However, international collaborations are substantially larger on average, both in terms of grant value and the number and diversity of participating partners. The table also highlights that, within domestic or international collaborations, there are no marked differences in the size and composition of B2B and B2U collaborations.

Table 3: Characteristics of UKRI funded domestic and international collaborations.

	Dom. Collab.	Int. Collab.	B2B Dom. Collab.	B2U Dom. Collab.	B2B Int. Collab.	B2U Int. Collab.
No. Collabs.	22,816	6,228	5,049	17,382	1,610	3,680
Av. Grant Value	£583,173	£1,361,167	£494,142	£654,524	£1,414,147	£1,410,435
Av. No. Partners	4.2	10.6	3.3	4.8	9.4	11.6
Av. No. Dom. Bus.	1	1.7	1.7	0.9	2.5	1.5
Av. No. Dom. Uni.	1	2	0	1.4	1.5	2.3
Av. No. Int. Bus.	0	0.6	0	0	1.3	0.4
Av. No. Int. Uni.	0	1.3	0	0	0	2.2

We now turn to the characteristics of UK firms participating in UKRI funded collaborative projects. Table 4 shows that the majority of firms are involved exclusively in domestic collaborations. Moreover, firms engaged in international collaborations differ substantially from those collaborating only with domestic partners and differences are confirmed as statistically significant by the t-statistic reported in the final column of the table, which indicates that the observed gaps between the two groups are unlikely to be the result of chance. Firms partnering with foreign organisations tend to be larger and older, and are more likely to belong to a corporate group and to be foreign-owned. Despite these differences, they do not appear to be more productive than firms involved solely in domestic collaborations.

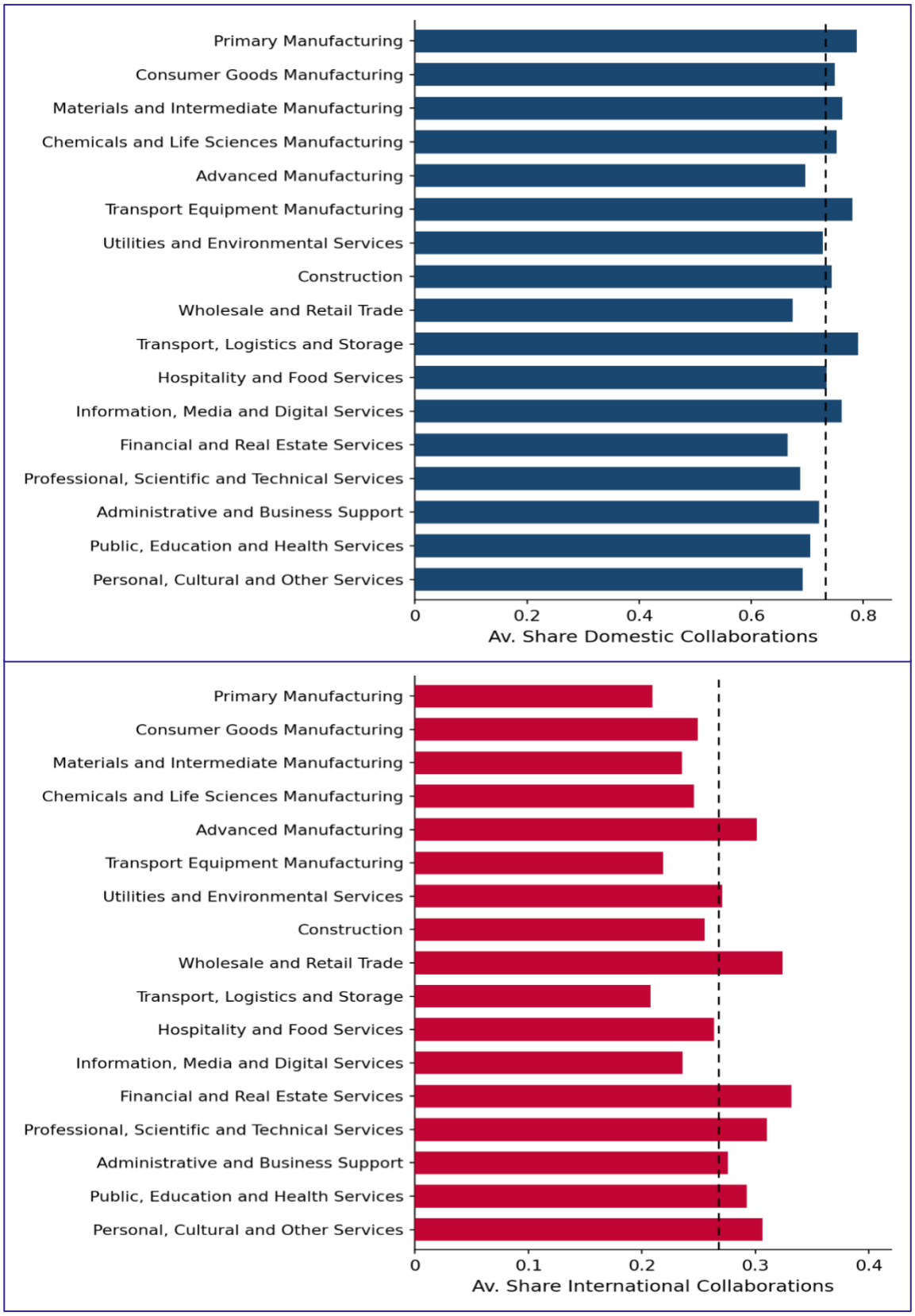
Table 4: Characteristics of firms engaging in UKRI funded domestic and international collaborations.

	Domestic Collaboration	International Collaboration	T-difference
Number of firms	8,167	3,205	
Employment	256	539	3.122
Age	14.6	16.5	7.028
Labour productivity	271.65	332.85	0.837
Manufacturing	23.2%	21.1%	2.472
High-tech manufacturing	58.5%	61.0%	2.490
Part of a group	42.4%	50.8%	8.109
Foreign owned	12.4%	22.1%	13.103

Figure 4 further shows that firms participating in international collaborations are less likely to operate in manufacturing, but are more likely to belong to high-technology industries. Indeed, apart from the advanced manufacturing sector, international collaborations are particularly concentrated in services industries, especially wholesale and retail, finance and professional services, as well as education, health, and personal services[1].

[1] Note that this sectoral classification is based on SIC codes which reflect the sector of the firm but do not necessarily reflect the technology area of the RDI project in which firms are involved.

Figure 4: Share of firms engaging in UKRI funded collaborations by industry.



3. Methodology

To estimate the causal impact of UKRI funded international collaborations on firms' innovation and economic performance, we compare firms participating in international collaborative projects (treatment group) with firms involved only in domestic collaborations (control group). The analysis focuses on outcomes related to intellectual property rights (IPRs) and firm-level economic performance.

3.1 Propensity Score Matching

Given the non-random selection of firms into international collaborations, as shown in Table 2 above, we first implement a Propensity Score Matching (PSM) to construct a balanced sample of treated and control firms that are as similar as possible prior to treatment. This approach helps mitigate potential self-selection and omitted variable bias by matching firms on a range of observable pre-treatment characteristics. To do so, we first estimate the likelihood of a firm to engage in an international collaboration:

$$T_{it} = \beta_0 + \beta_1 X_{it-1} + \beta_2 \Delta Z_{it-3} + \beta_3 K_{irst-1} + \gamma_t + \gamma_s + \varepsilon_{it}$$

Where T_{it} is an indicator variable equal to 1 if a firm engages in an international collaboration for the first time, and 0 if the firm engages for the first time in a domestic collaboration. X_{it-1} denotes a vector of firm characteristics measured in the year prior to treatment, including firm size (measured by total employment), labour productivity, firm age, and patent stock. To account not only for differences in levels between firms participating in domestic and international collaborations, but also for differences in their pre-treatment trajectories, we include ΔZ_{it-3}, which captures firms' employment and productivity growth over the three years preceding treatment. In addition, we control for firms' position within the wider economic ecosystem through K_{irst-1}, which includes measures of market share within the relevant industry to account for market power, as well as the degree of regional-industry agglomeration. The latter is measured by the number of employees in other firms operating in the same industry and region, capturing potential positive externalities arising from agglomeration economies. Finally, the specification includes year (γ_t) and industry (γ_s) fixed effects to control for common time-specific and sector-specific shocks.

Once the probability of engaging in an international collaboration, the so-called propensity score, has been estimated, we use it to construct an appropriate control group composed of firms participating only in domestic collaborations but exhibiting a similar likelihood of engaging internationally. To do so, we implement a nearest-neighbour matching procedure, selecting for each treated firm the most comparable untreated firm from the pool of domestic collaborators. The matching process aims to ensure that treated and control firms are as similar as possible in terms of observable pre-treatment characteristics before the start of the collaboration.

3.2 Callaway and Sant'Anna (2021) staggered Difference-in-Differences (CSDiD) estimation

After we have built a suitable group of untreated control firms for each treatment, we estimate the causal treatment effects using the Callaway and Sant'Anna (2021) staggered Difference-in-Differences (CSDiD) estimator. This method identifies the impact of international collaborations by comparing changes in outcomes over time between treated and untreated firms, while explicitly accounting for variation in the timing of treatment adoption across firms. The CSDiD framework is particularly suitable in settings with multiple time periods and staggered treatment implementation, providing robust and unbiased estimates under heterogeneous treatment effects.

$$y_{it} = \alpha_0 + \sum_{t=-q}^{-1} \alpha_1 T_{it} + \sum_{t=0}^{m} \alpha_2 T_{it} + X_{it-1} + \gamma_i + \gamma_t + \varepsilon_{it}$$

Where y_{it} represents the main outcome variables capturing firm performance, including employment and turnover growth, and the number of registered IPRs. We estimate the event-study specification using a linear model in which treatment for firm *i* occurs at event time 0. The model includes *q* leads (anticipatory effects) to test for potential pre-treatment differences in performance between treated and control firms, and *m* lags (post-treatment effects) of the treatment indicator T_{it} to trace the dynamic evolution of treatment effects over time. The specification also includes additional covariates X_{it-1}, such as the estimated propensity score, together with year fixed effects (γ_t) and firm fixed effects (γ_i) to control, respectively, for common macroeconomic shocks and time-invariant firm-specific characteristics. By centring the analysis around the event time, irrespective of the calendar year in which treatment occurs, the model allows the estimated lead and lag coefficients to identify the relevant event window and to characterise the temporal dynamics of the treatment effect. This framework makes it possible to assess whether the impact of international collaborations is transitory or persistent over time. Importantly, the coefficients on the lead indicators also provide a direct test of the parallel trends assumption, by showing whether treated and control firms followed similar performance trajectories prior to treatment.

The model is estimated using fully balanced panel data from the Business Structure Database (BSD), considering alternative observation windows requiring firms to be observed at least (i) two years, (ii) four years, and (iii) six years before and after their first international collaboration. In addition, we conduct heterogeneity analyses for the four-year sample to explore differences in treatment effects across funding schemes (Innovate UK versus other Research Councils), collaboration types (B2B versus B2U), and firm characteristics.

4. Results

Here, we report average treatment effects (ATTs) for the full sample and, in later sections, ATTs for different types of firms and for firms involved in different types of projects. In each case, we report the impact of international collaboration relative to domestic collaboration across all six outcomes. Three of these capture measures of economic performance through aspects of business growth;

- turnover (revenue) growth,
- employment growth
- labour productivity growth

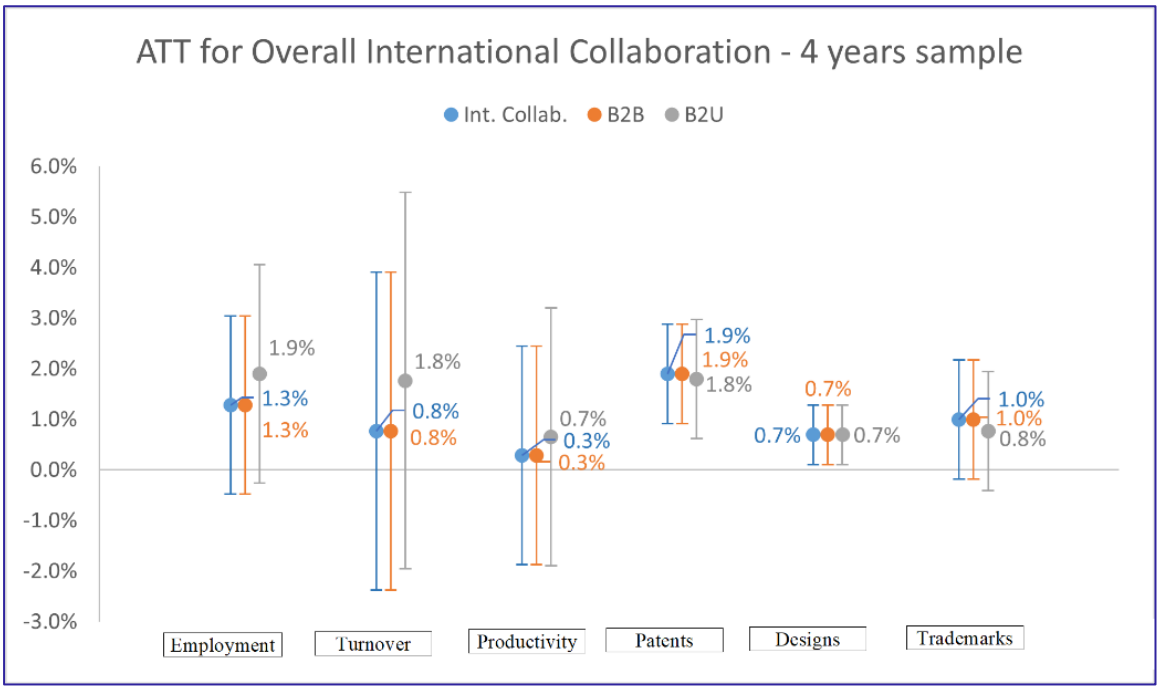
The remaining three outcome measures capture growth in firm innovation activities through intellectual property;

- patent application growth
- trademark application growth
- registered design application growth

For each outcome measure, we report the average impact across all internationally collaborating firms, as well as separate impacts for firms involved in international collaborations only with other firms (B2B) and those involved in collaborations involving at least one foreign university (B2U).

Figure 5 shows the average treatment effects across outcomes for the full sample of firms, along with associated standard error bars with 95% confidence intervals. Error bars that cross the zero line indicate a statistically insignificant effect, whereas those above the zero line indicate a statistically significant effect. ATTs with overlapping error bars are not statistically different from each other.

Figure 5: Effect of International Collaborations on firms' performance.



Note: 95% confidence intervals reported.

When looking at the overall average, international collaboration does not appear to improve employment, turnover, or productivity growth on average. However, there is a significant impact on firms' innovation outputs. For example, international collaboration leads to a 1.9% increase in the patent application growth, a 0.7% increase in registered design application growth, and a 1% increase in the trademark application growth, with the latter only marginally significant at the 10% level. These impacts are of remarkably similar magnitudes whether the international collaboration is B2B or B2U.

It is important to note that the absence of an average business growth effect in the present study differs from the medium-term turnover growth advantage (31.5% vs 21%) that Vanino et al. (2019) attribute to international over domestic collaboration. Three methodological differences are relevant here. First, Vanino et al. (2019) measure growth relative to a baseline of no public support, whereas the present analysis compares international to domestic collaborators which is a more demanding counterfactual that controls for the general effect of UKRI funding. Second, Vanino et al. (2019) examine a narrower sample of Research Council-funded projects, whereas the present study finds that business growth additionality is concentrated among RC-funded collaborations and is absent for IUK-funded ones on average. Third, the present study uses a more disaggregated identification strategy, the Callaway and Sant'Anna (2021) staggered DiD estimator, which accounts for treatment effect heterogeneity that pooled estimates may not be able to reveal.

The positive impact on patent application growth is in line with the literature identified as part of the Phase 1 literature review (Ozusaglam et al., 2024) which finds broadly positive effects of international collaboration on patent applications (Kang and Park,

2012), the likelihood of successful patent applications (Moaniba et al., 2019), patent quality (Lino et al., 2021), and innovation novelty more broadly (Miotti and Sachwald, 2003). The literature does not yet examine the impacts of international collaboration on intellectual property protection for non-technological innovations through trademarks and registered designs; this is an important contribution of our study.

The insignificant effects of international collaboration on business growth outcomes are not in line with existing evidence identified in the Phase 1 review. The existing evidence tends to find positive additionality for turnover growth (Vanino et al., 2019), revenues from innovative products (Cincera et al., 2003; Fu and Li, 2016), and labour productivity (Aguiar and Gagnepain, 2017).

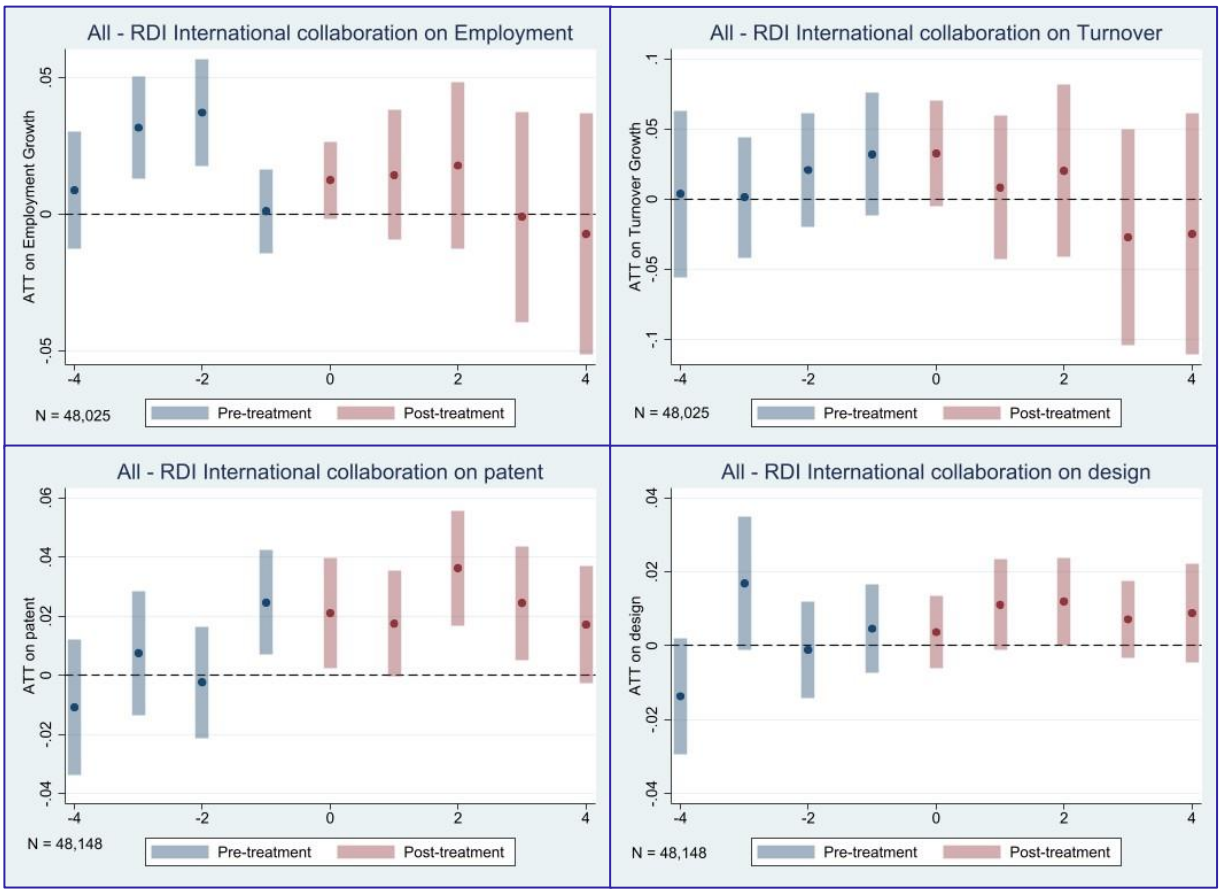
It is important to note that the absence of average business growth additionality from international over domestic collaboration does not imply that collaboration itself is without value for these outcomes. The Phase 1 evidence review found that domestic collaboration generates its own positive returns relative to no collaboration at all. For instance, Vanino et al. (2019) find that UK firms involved in domestically collaborative Research Council-funded projects see approximately 5% turnover growth and around 5% employment growth in the short term relative to non-collaborating firms. Similarly, Harris et al. (2011) find that UK firms collaborating with higher education institutions, regardless of whether those partners are domestic or foreign, exhibit on average 12% higher total factor productivity relative to non-collaborating firms. Aguiar and Gagnepain (2017) also find that participation in EU Framework Programme R&D collaborations increases labour productivity by at least 44% four years after project initiation relative to firms that would not have participated in R&D activities without the subsidies. In addition to these, a parallel IRC project examines impacts across all UKRI-supported collaborations, international and domestic combined, against non-collaborating firms, and finds substantial effects: employment growth increases by 4% on average, turnover growth increases by 6%, patents growth increases by 6.5%, trademarks growth increases by 6%, and designs growth increases by 2.7% (Jibril et al., 2026, forthcoming). Again, these gains reflect the fact that domestic collaboration itself delivers benefits over not collaborating at all.

The present findings should therefore be read as evidence about the additional benefit of international collaboration, rather than as evidence that collaboration, domestic or otherwise, does not produce firm-level returns. In addition, as we show in later sections, the insignificant average effects found in this study conceal a high degree of heterogeneity, with international collaboration selectively improving business growth for some types of firms but not for others.

Figure 6 shows the dynamic impacts over time for the full sample, with dots representing ATTs and bars representing standard errors. Blue bars represent differences between domestic and internationally collaborating firms before the first incidence of international collaboration, whereas red bars represent differences between the two groups from the period of treatment, year zero, onwards. As discussed, we primarily rely on analysis with

a fully balanced sample of firms observed for at least four years before and after their first incidence of international collaboration. As implied by the ATTs, there are no significant dynamic impacts for turnover and employment growth. The impact on patent application growth appears gradual and transient, peaking in the second year after treatment before beginning to dissipate. The impact on registered design application growth is also transient and disappears by the third year after treatment.

Figure 6: Dynamic effect of International Collaborations on firms' performance: employment and patents.



4.1. The role of funding organisation and collaboration composition

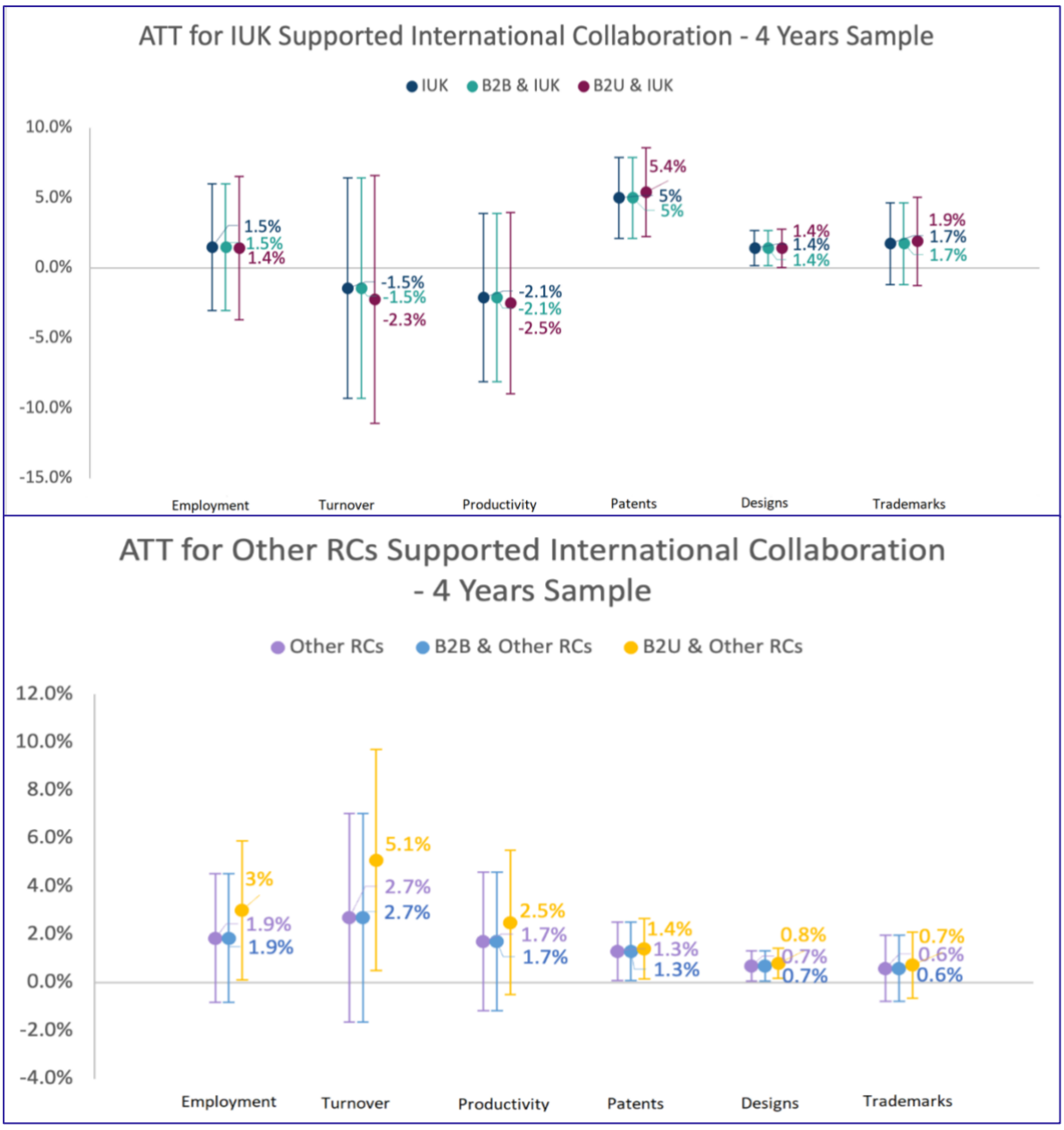
Figure 7 shows the average impacts of international collaboration where, for each type of funding organisation, we disaggregate whether projects are B2U or B2B. We distinguish between firms involved in projects funded by IUK and those involved in projects funded by other Research Councils (RCs). It is worth noting that B2U collaborations supported by RCs represent primarily university-led international collaborations, since RCs provide funding to universities, which may then involve businesses as project partners. By contrast, both B2U and B2B collaborations funded by IUK typically represent direct grants to businesses; these are thus business led collaborations.

The results show that, on average, the clearest benefits of IUK support are for innovation outputs: patent application growth increase by about 5% and registered design application growth by about 1.4%. There is no statistically significant difference between B2U and B2B collaborations, suggesting that while international collaboration yields additional benefits relative to domestic collaboration, the composition of collaborating partners is, on average, unimportant for determining innovation impacts from IUK-supported international collaborations.

Relative to firms involved only in domestic collaboration, firms participating in RC-supported projects experience significant but smaller increases in patent application growth (1.3%) and registered design application growth (0.7%). As with IUK support, there is no statistically significant difference between B2U and B2B collaborations supported by RCs. The primary impacts for firms involved in projects supported by RCs, therefore, are on employment (3%) and turnover growth (5.1%), which are driven solely by B2U collaboration.

These findings point to the type of funding organisation as the primary differentiator of both the extent and nature of impact, with RC support usually signifying university involvement. As such, this is an important finding which may reflect the distinct goals and mechanisms of IUK and RC support, and underscores their complementarity in supporting different but equally valuable ranges of firm outcomes.

Figure 7: Effect of International Collaborations on firms' performance: Innovate UK and Research Councils funded projects.



4.2. Firm Heterogeneity

Here we report differences in the impact of international collaborations based on firm characteristics. Since B2B and B2U international collaborations, on average, exhibit broadly similar patterns of impact, in what follows we report the average impact across both types of international collaboration. Where impacts differ significantly, particularly for B2U collaborations supported by research councils, we highlight these results with associated tables provided in the Appendix. Subsequent sections examine the impact for firms involved in projects supported by IUK and those supported by Research Councils.

4.2.1. Heterogeneity based on firm size

Figure 8 shows heterogeneous impacts by firm size. The top left panel shows the ATTs for micro firms, that is, those with fewer than 10 employees. Any type of international collaboration leads to a 1.5% increase in employment growth within this group of firms. Micro firms involved in IUK-supported projects improve their employment growth by 7% and patent growth by about 3.3% compared to those in domestic collaborations. Those involved in RC-supported projects see no increase in employment growth or patent application growth, but experience a small, marginally significant increase in registered design application growth (0.5%). There is no statistically significant impact on other outcome measures. Thus, the primary benefits from international collaboration for micro firms relate to employment growth and patent application growth where these firms are supported by IUK.

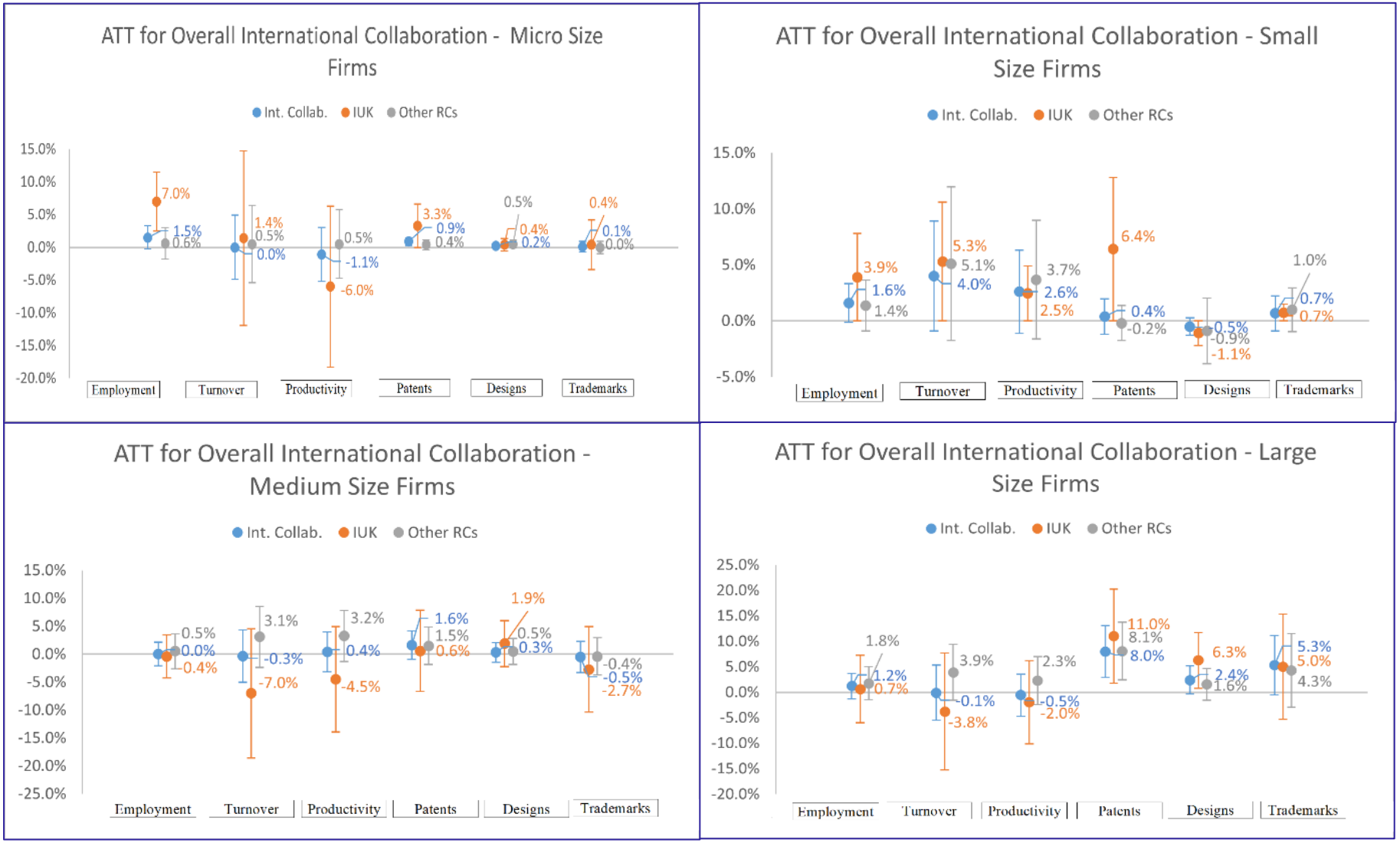
The top right panel of Figure 8 shows the effects for small firms with between 10 and 49 employees. Here, any type of international collaboration improves employment growth by 1.6% on average, but the effects of IUK or RC support are not individually statistically significant. Firms involved in IUK-supported projects see a 6.4% increase in patent application growth and a small, marginally significant decline in registered design application growth (1.1%). In addition, we find that small firms benefit most from B2U collaborations supported by RCs, i.e., university-led collaborations (see Table A1 of the appendix). Here, firms see a 2.3% increase in employment, a 7.7% increase in turnover, and a corresponding 5% increase in labour productivity. Thus, for small firms, the relative benefits of international collaboration are stronger for business growth outcomes where firms are involved in RC-supported, university-led projects, whereas IUK support increases patent application growth to a more modest degree.

The bottom left panel shows the impact for medium-sized firms, that is, those with between 50 and 249 employees. Here, international collaboration does not appear to yield additional benefits relative to domestic collaboration, except that medium-sized firms involved in B2U collaborations supported by RCs (university-led) improve their turnover and productivity growth by about 5% on average (see Table A2 in appendix for more detailed results).

The bottom right panel shows impacts for large firms, that is, those with more than 250 employees. Here, we see consistent positive impacts on patent application growth: 8% on average and for RC-supported collaborations and 11% for IUK-supported collaborations. Firms supported by IUK additionally increase registered design application growth by around 6.3%. There are no significant impacts on trademark application growth, except for B2U collaborations supported by RCs (university-led), where firms increase their trademark application growth by 6.1%.

Therefore, the results indicate that across all size categories, the benefits of international collaboration are rather selective. For example, IUK support proves particularly important for patent application growth among smaller firms and employment growth among micro firms, while RC support plays a greater role in driving business growth outcomes for small and medium-sized firms.

Figure 8: Effect of International Collaborations on firms' performance: firm size.

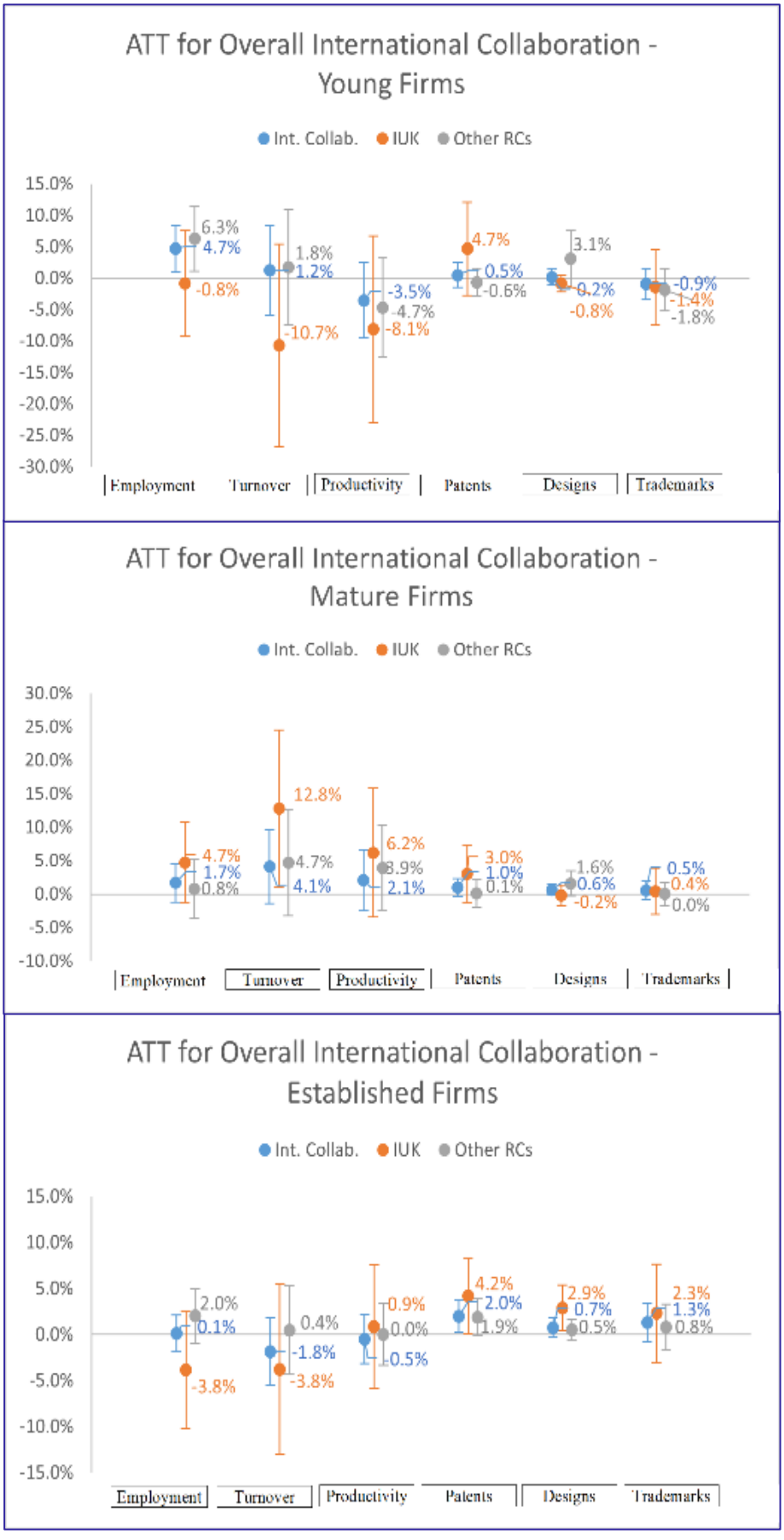


4.2.2. Heterogeneity based on firm age

Figure 9 shows the impact of international collaboration by firm age. For young firms (those less than 5 years old), international collaboration leads to a 4.7% increase in employment relative to domestic collaboration. This is driven primarily by firms involved in collaborations supported by RCs (6.3%), with IUK support having no significant impact. For mature firms (those 5 to 15 years old), IUK support improves turnover growth by 12.8% on average, and RC support increases registered design application growth by about 1.6%. Results presented in Table A3 in appendix show that B2U collaborations supported by RCs (university-led) improve turnover and productivity growth for mature firms by about 1% and 6.6%, respectively. For established firms (those more than 15 years old), international collaboration leads to a 2% increase in patent application growth, driven by both IUK (4.2%) and RC (1.9%) support, and a 2.9% increase in registered design application growth, driven by IUK support. Results presented in Table A4 in appendix show, established firms involved in B2U collaborations supported by RCs (university-led) also improve their employment growth by 2.7%.

These results indicate that the age of the firm shapes the nature of benefits derived from international collaboration. In particular, younger firms gain primarily through business growth, driven by RC support, while older and more established firms benefit mainly through improved innovation outputs, with employment gains arising selectively for those involved in RC-supported B2U collaborations. This suggests that supported firms which are already operationally established with relatively consolidated organisational capabilities may prioritise innovation over business growth, whereas younger firms may additionally direct resources towards employment growth in order to develop operational capacity needed to deliver projects.

Figure 9: Effect of International Collaborations on firms' performance: firm age.



4.2.3. Industry heterogeneity

Here, we report results for broad groups of manufacturing and services sectors, categorised as high-technology and low-technology manufacturing sectors, and high-knowledge-intensive and low-knowledge-intensive services sectors, (Figure 10). Table A5 of the Appendix shows the detailed sector classifications in each category.

For high-tech manufacturing sectors, international collaboration leads to increases in patent application growth (5.2%), registered design application growth (3.2%) and trademark application growth (2.8%). Patent and registered design application growth are driven mainly by IUK support (13.4% and 8.1%, respectively), although RC support also yields a 5% increase in patent application growth. Notably, internationally collaborating firms involved in projects supported by RCs see an 8.5% increase in turnover growth and a corresponding 5.2% increase in labour productivity growth relative to domestic collaborators.

For low-tech manufacturing firms, we find that domestic collaboration sometimes appears better than international collaboration, especially when these firms are engaged in projects supported by RCs. Here, we see, on average, a 12% reduction in turnover growth and a corresponding 8.3% reduction in productivity growth. This may reflect a high penalty for international collaboration for firms with low initial levels of innovativeness and lower absorptive capacity than those in high-tech sectors. Importantly, the evidence that domestic collaboration outperforms international collaboration for these firms does not imply that collaboration itself is detrimental. Rather, it indicates that firms engaged in international collaboration experience slower growth relative to their domestically collaborating counterparts, regardless of whether their turnover or productivity increases in absolute terms. Phase 1 evidence from Fitjar et al. (2016) indicates that collaboration with domestic or regional partners still raises the likelihood of process innovation by around 13% relative to non-collaborating firms, while collaboration with foreign partners raises it by 65%. This suggests that for firms in low-technology sectors, domestic collaboration may represent a more proportionate and cost-effective form of publicly supported engagement with the innovation system which delivers meaningful returns without the additional coordination costs and knowledge distance challenges associated with international partnerships (Ozusaglam et al., 2024).

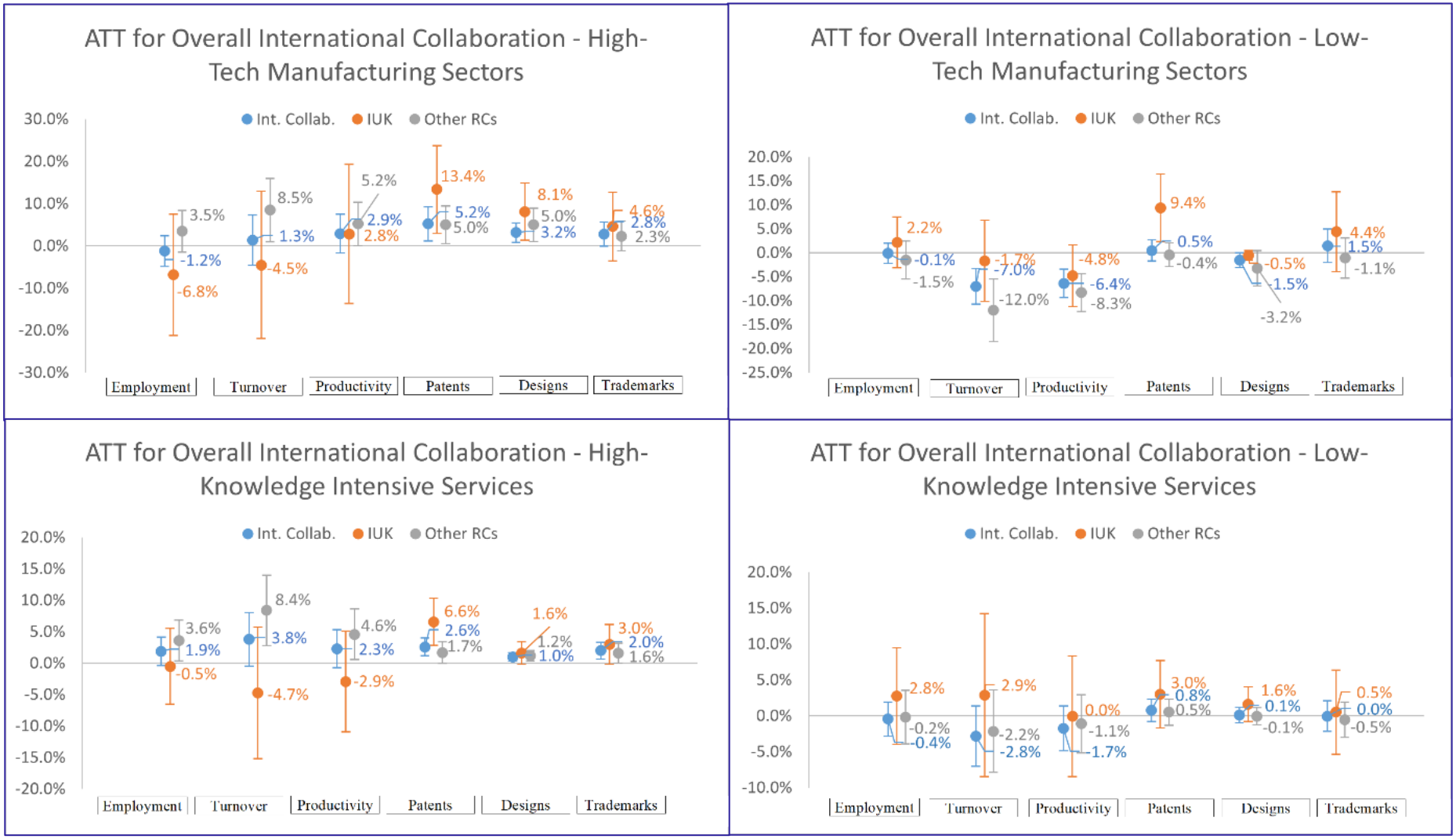
For high knowledge intensive services sectors, international collaboration leads to significant increases in turnover growth (3.8%), patent application growth (2.6%), registered design application growth (1%) and trademark application growth (2%). These impacts on innovation outputs are driven primarily by IUK support, with increases of 6.6% in patent application growth, 1.6% in registered design application growth, and 3% in trademark application growth. By contrast, firms in high knowledge intensive sectors involved in international projects supported by RCs see significant business growth impacts relative to domestic collaborators, with a 3.6% increase in employment, an 8.4% increase in turnover, and a corresponding 4.6% increase in productivity growth. These findings contradict those in Rodríguez et al., (2018), who find that for Spanish

firms in Knowledge Intensive Services sectors, international collaboration improved the likelihood of service innovation to a lesser extent than domestic collaboration. Our findings show that these firms engage in a wider range of innovations than those captured through subjective survey-based measures of service innovations, and that using intellectual property measures of innovation reveals significant additionality over domestic collaboration. For firms in low knowledge intensive service sectors, we find no significant impacts of international collaboration on any outcome measure, suggesting that domestic collaboration is as good as international collaboration for these firms.

Results from our heterogeneity analysis across sectors reveal that the additionality of international collaboration is concentrated among the most innovative industries, where IUK support predominantly drives innovation outcomes and RC support predominantly drives business growth outcomes; this reinforces complementarity between these funding sources.

Taken together, the results from our firm-level heterogeneity analysis show highly selective areas of additionality for international collaboration, with implications for the types of firms likely to benefit from it. For example, the results suggest that a medium-sized, older firm operating in a low-tech manufacturing sector is unlikely to benefit from international collaboration, whereas a start-up firm that is both micro and young, and that operates in a high knowledge intensive sector, is very likely to benefit across a range of outcomes. We find many instances of statistically insignificant effects for different types of firms and outcomes. In each case, this represents cases where domestic collaboration appears at least as good as international collaboration. Overall, therefore, the results suggest the importance of highly targeted support for international collaboration.

Figure 10: Effect of International Collaborations on firms' performance: Industry heterogeneity.



4.3. Project Heterogeneity

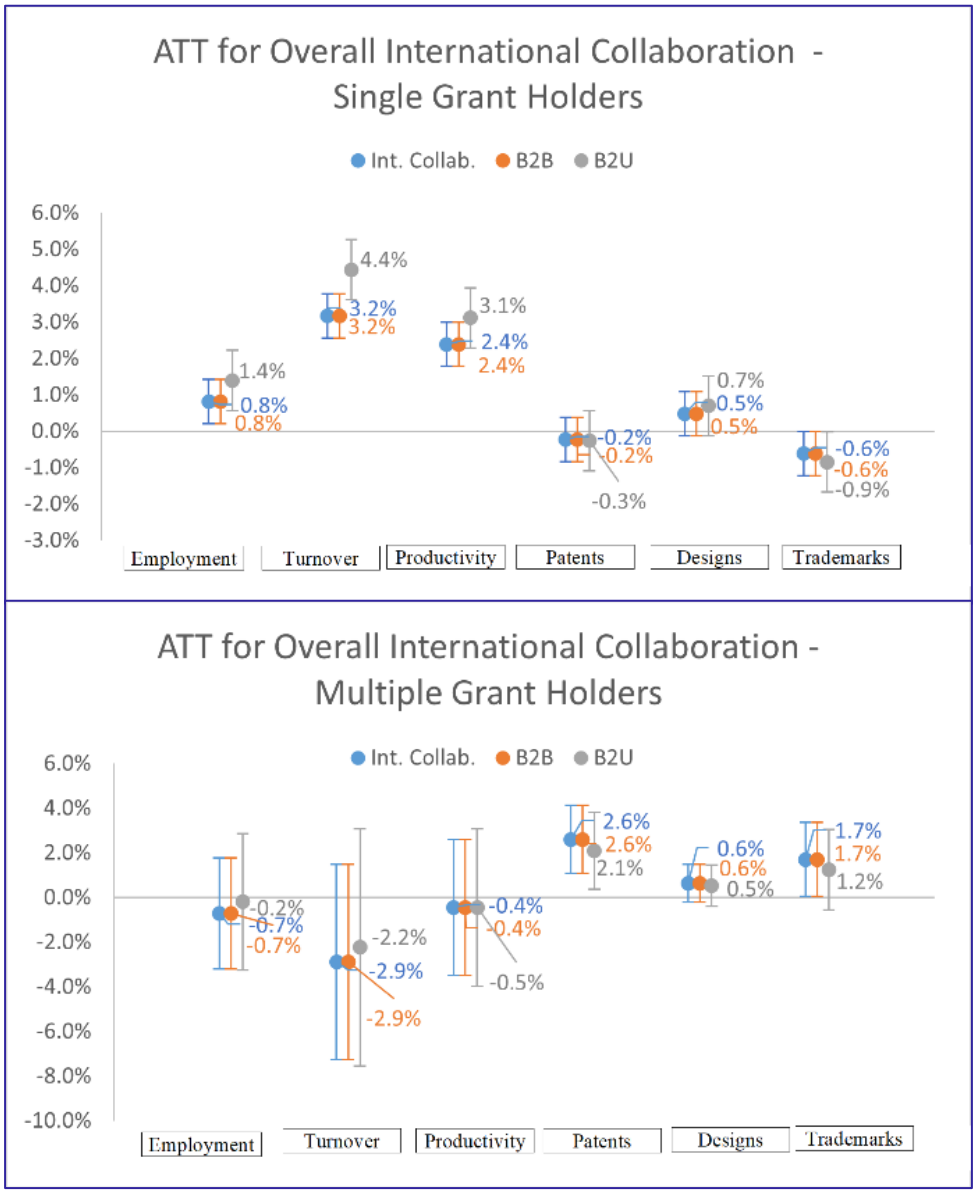
Here we consider the impact of international collaboration based on patterns of engagement in UKRI projects and the characteristics of projects.

4.3.1. Heterogeneity by engagement frequency

Figure 11 shows the impact of international collaboration for firms engaged in only one project (single grant holders) and those engaged in multiple projects (multiple grant holders). For single grant holders, international collaboration leads, on average, to increases in employment growth (0.8%), turnover growth (3.2%), and productivity growth (2.4%). These impacts are slightly larger for B2U collaborations (see Table A6 in appendix) and, we find that they are driven primarily by RC support. There is no significant impact on innovation outputs.

By contrast, the impact for multiple grant holders is concentrated in innovation outputs rather than business growth performance. Compared to domestic collaborators, these firms increase patent growth (2.6%) and trademark application growth (1.7%), with no difference between B2U and B2B collaborations. Table A7 in appendix shows that these innovation effects are driven by IUK support. Multiple grant holders do not appear to see additional benefits in terms of business growth impacts. These contrasting patterns suggest that the nature of the returns from international collaboration is shaped by the frequency and type of public funding received. For example, firms engaging once in RC-supported projects tend to realise business growth benefits, while those accumulating multiple IUK grants derive their primary gains through improved innovation outputs.

Figure 11: Effect of International Collaborations on firms' performance: Single versus multi-grant holders.



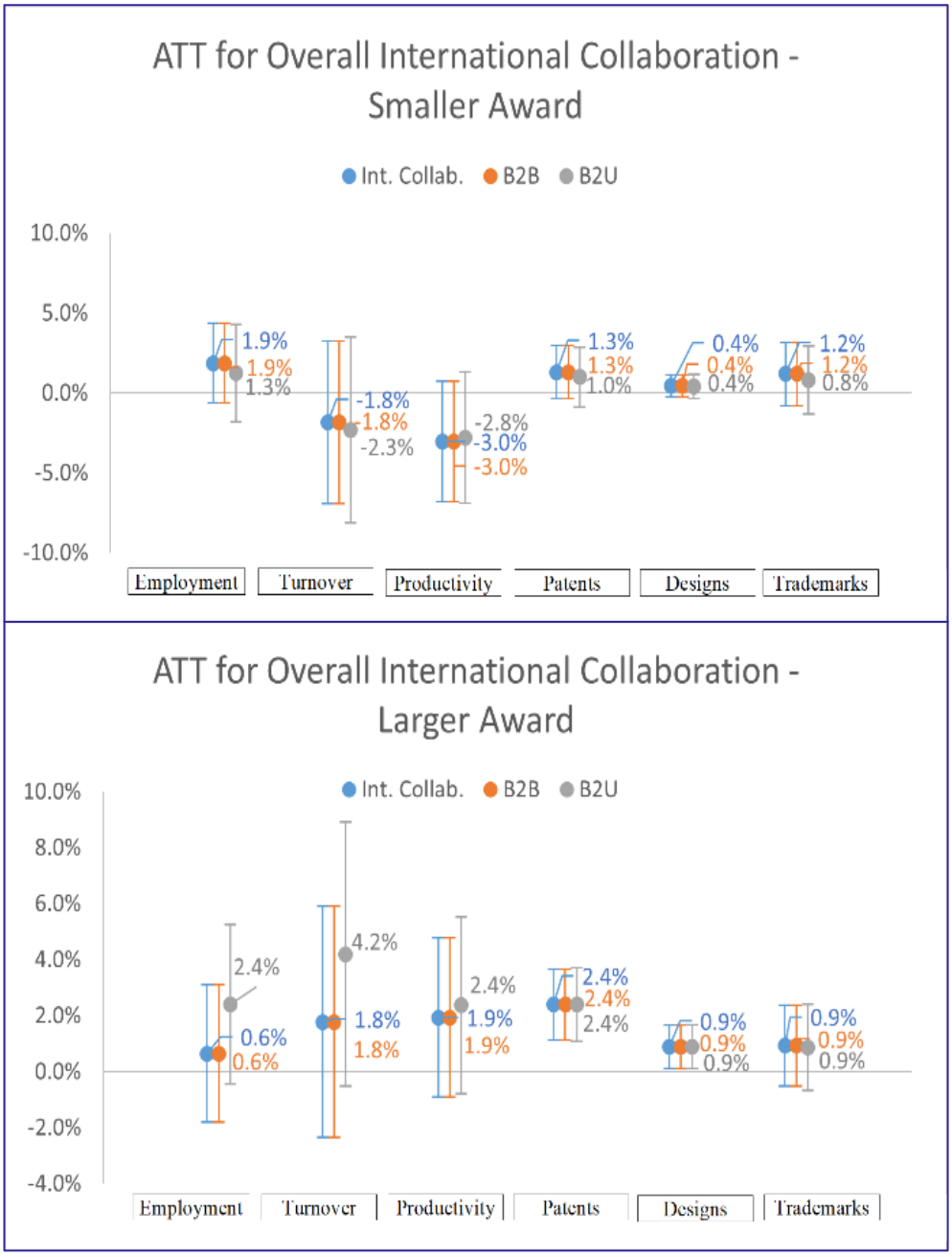
4.3.2. Heterogeneity by grant size

Figure 12 shows how the impacts of international collaboration differ based on the monetary value of the grant award for the project in which a firm is involved. We categorise smaller awards as firms involved in projects whose total award value is less than the median total award (roughly £316K) across all firms, and larger awards as firms involved in projects whose total award value is higher than the median.

We find no statistically significant impacts on any outcomes for firms with smaller awards. For these firms, domestic collaboration appears as good as international collaboration. Accordingly, the results show that (see Table A8 of the appendix) IUK-supported firms with smaller awards see a reduction in labour productivity relative to domestic collaborators, which may be driven either by a reduction in turnover or by an increase in employment without a corresponding increase in turnover. In any case, the low monetary value of the grant for IUK recipients suggests that they may be better off focusing on domestic collaborations, which is generally more cost-effective than international collaboration given lower logistical, legal, and coordination costs (Van Beers et al., 2008; Chen et al., 2019; Ozusaglam et al., 2024).

For firms involved in larger grants, there is, on average, an increase in patent application growth (2.4%) and registered design application growth (0.9%). There are also increases in employment growth (2.4%) and turnover growth (4.2%) for firms involved in B2U collaborations with a larger grant award, although these impacts are only marginally significant. The results presented in Table A9 of the appendix shows that impacts on patent and registered design application growth are driven mainly by IUK support, and those on business growth are driven by RC support. These results highlight that grant size is an important condition for realising the additional benefits of international collaboration, with meaningful additionality emerging only for firms involved in larger-value projects. This likely reflects the greater resources required to manage and sustain successful cross-border partnerships, and suggests that public support below a certain threshold may be insufficient to offset the additional costs of collaborating internationally.

Figure 12: Effect of International Collaborations on firms' performance: Grant size.



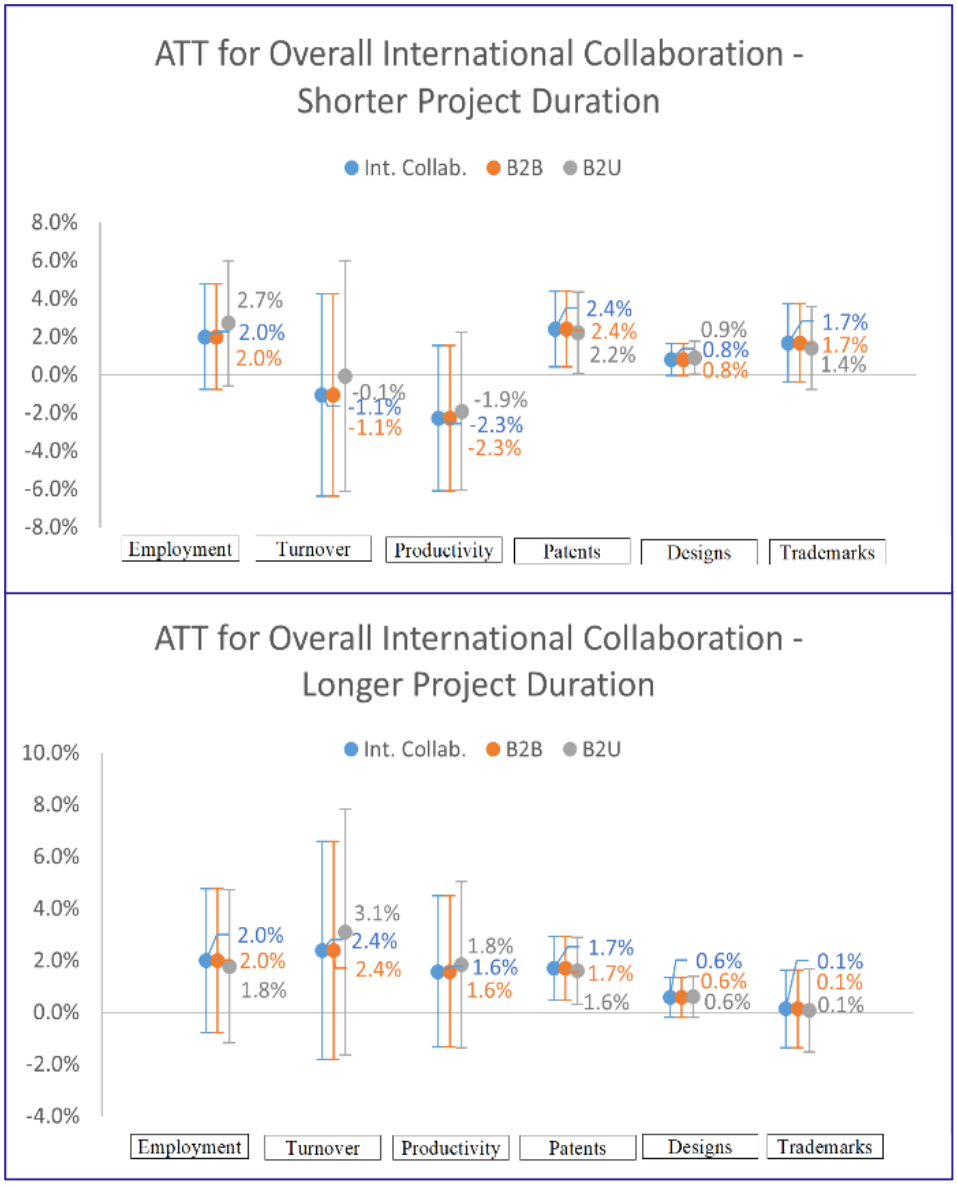
4.3.3. Heterogeneity by project duration

Figure 13 shows the impact of international collaboration for firms involved in projects with shorter and longer durations. These are similarly defined based on the median duration of projects, which is 2 years.

Firms involved in projects with shorter durations see an average increase in patent application growth of about 2.4% and in registered design application growth of about 0.8%. The results also show that (see Table A10 of the appendix), for firms supported by IUK and involved in projects with relatively shorter durations, employment growth improves by around 6.5%.

For firms involved in projects with longer duration, patent application growth increases by about 1.7% on average, with larger effects for those supported by IUK (6.5%) than for those supported by RCs (1.3%). The results also show marginally significant increases in employment (3.8%) and turnover growth (5.4%) for firms involved in projects of relatively longer duration supported by RCs (see Table A11 of the appendix). Unlike grant size, therefore, project duration does not appear to be a strong differentiator of whether firms benefit from international collaboration, as improvements in innovation outputs are observed across both shorter and longer projects. Where duration does matter is in shaping the additional business growth benefits, and here the pattern aligns with the broader findings on funding type, shorter projects supported by IUK appear sufficient to generate employment gains alongside innovation benefits. This is possibly due to the more applied and commercially focused nature of IUK-funded collaborations where tangible business impacts can materialise relatively quickly. By contrast, the business growth benefits associated with RC support, particularly improvements in employment and turnover, tend to emerge in longer projects, which may reflect the more exploratory nature of RC-funded research and the longer time horizons typically required before such collaborations translate into measurable firm-level gains.

Figure 13: Effect of International Collaborations on firms' performance: Project duration.



4.4. Complementarity Between Domestic and International Collaborations

Given the rapid increase in UKRI funded collaborations documented in Figure 3, it is increasingly important to understand whether international collaborations substitute for or complement domestic collaborations, and what the implications of these patterns are for domestic partners and the overall performance of participating firms.

To investigate this question, we adopt the same econometric framework described above, but focus on firms that initially engage exclusively in domestic collaborations. We compare firms that subsequently begin collaborating internationally (treated group) with firms that continue to collaborate only domestically (control group). We first examine how the initiation of international collaborations affects the overall number and value of collaborations in which firms participate, as well as the composition of their research partnerships.

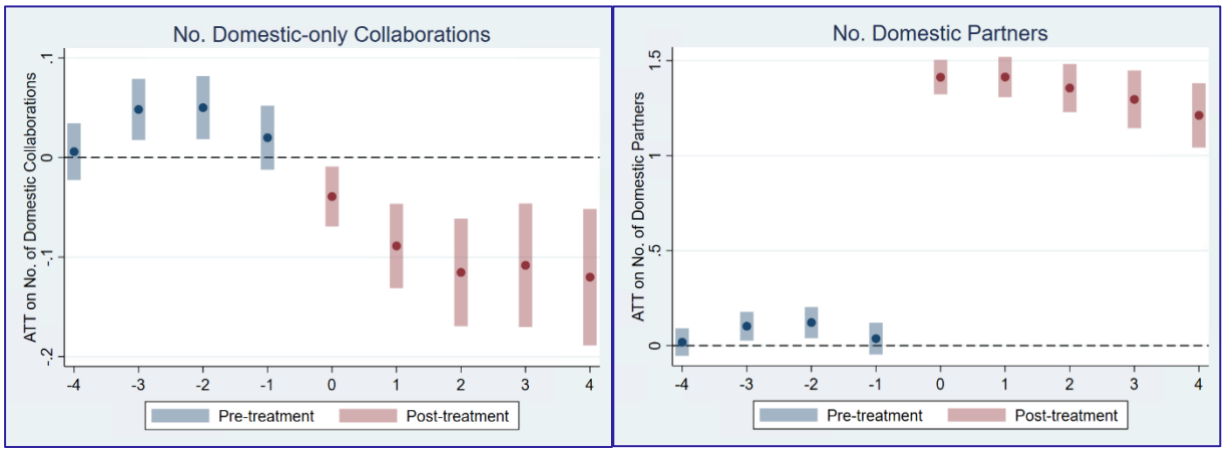
The results, reported in Table 5, show the effects of starting international collaborations on the number and value of projects involving only domestic collaborations, and on the composition of research partnerships. Overall, firms that begin international collaborations tend to reduce both the number and value of their domestic-only collaboration projects, suggesting a substitution effect. This pattern is driven primarily by projects funded through the Research Councils. In contrast, firms involved in internationally collaborative projects funded by Innovate UK appear to expand their domestic collaboration projects alongside their international ones, indicating a complementary effect.

We then examine how international collaboration affects the composition of firms' research teams, distinguishing between existing and new partners. The findings suggest that, regardless of the funding source, firms initiating international collaborations do not replace domestic collaborators with foreign ones. Instead, the inclusion of international collaborators appears to complement domestic networks, with internationally collaborating firms increasing the number of domestic collaborators relative to firms engaged only in domestic collaborations. This pattern reflects both a greater likelihood of *maintaining* relationships with existing domestic partners and a higher probability of *forming* collaborations with new domestic partners. This pattern is also illustrated in Figure 14, which suggests that these effects take the form of discrete step changes rather than gradual dynamic adjustments. Specifically, the figure shows a sharp decline in the number of domestic-only projects alongside a marked increase in the number of domestic collaborators.

Table 5: Effect of starting international collaborations on number and value of domestic collaborations and their team composition.

No. Collab.	Val. Collab.	Dom. Bus.	Dom. Uni.	New Dom. Bus.	New Dom. Uni.	Old Dom. Bus.	Old Dom. Uni.
GENERAL (N=17,007))							
-0.038***	-0.744***	0.593***	0.331***	0.211***	0.102***	0.527***	0.303***
(0.013)	(0.138)	(0.024)	(0.015)	(0.014)	(0.010)	(0.021)	(0.014)
IUK (N=7,553)							
0.0798***	0.280	0.531***	0.326***	0.205***	0.123***	0.475***	0.302***
(0.025)	(0.237)	(0.044)	(0.033)	(0.036)	(0.025)	(0.038)	(0.029)
RCs (N=9,454)							
-0.072***	-0.928***	0.622***	0.342***	0.211***	0.100***	0.556***	0.309***
(0.018)	(0.205)	(0.033)	(0.022)	(0.016)	(0.012)	(0.030)	(0.020)

Figure 14: Dynamic effect of starting international collaborations on the number of domestic projects and partners.



The next step is to assess whether this pattern has implications for firm performance. Specifically, for firms engaged in international collaboration, does complementarity between foreign and domestic collaborators lead to better firm performance relative to substitution?

To address this question, we adopt a modified empirical strategy focusing exclusively on firms that initiate international collaborations. We first estimate the expected level of domestic partner displacement associated with the introduction of foreign collaborators, distinguishing between cases in which foreign collaborations substitute for domestic partnerships and those in which they complement them. Specifically, we predict the number of domestic collaborators a firm is expected to have on the basis of firm characteristics, as well as the characteristics of both past and current funded collaborations. We then compare this predicted number with the observed number of

domestic collaborators. Firms with more domestic collaborators than predicted are classified as “complementing firms,” while those with fewer domestic collaborators than predicted are classified as “substituting firms.”

Using the same econometric framework described earlier, we then compare the performance of “complementing firms”, those that maintain or expand domestic partnerships while adding foreign collaborators (treated group), with that of “substituting firms”, which replace domestic partners with foreign ones (control group).

The results, reported in Table 6, indicate that complementarity between domestic and foreign collaborators is associated with significantly stronger employment growth among firms participating in international collaborations. This effect is particularly pronounced for Research Councils-funded projects, which, as shown previously, are also the projects most likely to be associated with a decline in firms’ domestic-only collaborations once foreign partnerships are established. Complementarity is also beneficial for innovation outcomes such as patents. This effect instead is driven by collaborations funded by Innovate UK, following the dualism in employment and innovation effects between Research Councils and Innovate UK funded projects as previously discussed. These findings suggest that the firms able to preserve and expand domestic collaborative networks while internationalising their R&D derive the greatest economic benefits from international collaboration.

Table 6: Effect of domestic-international complementarity on firm’s performance.

Employment	Turnover	Patents	Design
	GENERAL (N=10,211)		
0.061***	0.017	0.036**	0.008
(0.018)	(0.033)	(0.017)	(0.008)
	IUK (N=2,357)		
0.035	0.092	0.097***	0.024
(0.041)	(0.061)	(0.030)	(0.015)
	RCs (N=7,853)		
0.070***	-0.005	0.021	0.005
(0.020)	(0.039)	(0.019)	(0.010)

5. Conclusions

This report contributes to a growing body of empirical literature on the economic returns from international Research, Development, and Innovation (RDI) collaboration by providing what is, to our knowledge, the most comprehensive firm-level assessment of the additionality of UKRI funded international RDI collaboration in the UK to date. Drawing on a novel linked dataset combining the Gateway to Research (GtR) database, the UK Intellectual Property Office (IPO) data, and the Office for National Statistics Business Structure Database (BSD), and employing a Propensity Score Matching procedure combined with the Callaway and Sant'Anna (2021) staggered Difference-in-Differences estimator, the analysis examines the causal impact of UKRI funded international RDI collaboration relative to domestic collaboration across six firm-level outcomes; employment growth, turnover growth, labour productivity growth, patents, trademarks, and registered design application growth.

The report sits within a broader research agenda initiated by the Phase 1 evidence review (Ozusaglam et al., 2024), which identified three critical gaps in the existing literature; i) the limited UK-specific evidence on the additionality of international over domestic collaboration; ii) the insufficient empirical testing of the mechanisms through which such benefits arise; and iii) the near-absence of attempts to monetise the economic benefits of international RDI engagement. Ozusaglam et al., (2026) began to address the first of these gaps through analyses of innovation outcomes using the UK Innovation Survey. The present report extends and integrates these earlier analyses by incorporating broader measures of business performance, using a more robust empirical methodology and enabling a more granular examination of the conditions under which international collaboration generates additionality.

5.1. Summary of findings

The results reveal a nuanced and selective picture of the additionality of UKRI funded international RDI collaboration over domestic collaboration, with the nature and magnitude of benefits varying substantially by funding mechanism, firm characteristics, project characteristics, and collaborative structure. A full statistical summary is provided in the Executive Summary. The discussion that follows focuses on the substantive interpretation of these findings and their implications for policy.

5.2. Discussion of findings

The findings reveal a complex picture associated with international RDI collaboration. At the aggregate level, the results are consistent with the emerging empirical consensus that the innovation benefits of international collaboration are more robust and more immediate than its business growth benefits. However, the analysis goes significantly further than prior work by considering different funding mechanisms, firm characteristics, project characteristics, and regional contexts. Accordingly, the results highlight that the heterogeneity of effects reflects substantive and policy-relevant variation in the

conditions under which international collaboration generates additionality. This has important implications for how UKRI supported international RDI collaboration should be designed, targeted, and evaluated.

These patterns align closely with the moderating factors identified in the Phase 1 evidence review (Ozusaglam et al., 2024), which found that organisations with stronger research capabilities and higher absorptive capacity are best positioned to leverage international knowledge flows, while those with limited prior RDI engagement are more likely to encounter net costs from international collaboration. The Phase 1 review identified absorptive capacity, breadth of international networks, IP protection mechanisms, and the duration of collaboration as key moderators of the strength and scope of benefits. The present findings give these moderators an empirical form where absorptive capacity is captured by sector classification (high-tech versus low-tech), collaborative intensity is captured by the distinction between firms with multiple versus single international engagements, and duration is captured by the results on project heterogeneity. The negative effects observed for RC-supported low-tech manufacturing firms may therefore reflect the cost penalties identified in Phase 1, specifically, the coordination and management costs of international collaboration that are unlikely to be offset where firms lack the absorptive capacity to translate new knowledge into measurable performance gains.

A central contribution of the report is the identification of the type of funding organisation and, by implication, the nature of the support for UK firms as a primary moderator of both the magnitude and the type of impact generated by international collaboration. For example, across a range of firm types and sectors, Innovate UK-supported collaborations, which are typically business-led and commercially focused, generate the most consistent gains in innovation outputs, particularly patents and registered design application growth. By contrast, collaborations supported by the Research Councils, which are predominantly university-led and oriented towards longer-term knowledge production, are more strongly associated with business performance gains in employment and turnover, particularly for firms engaged in B2U collaborations.

At first reading, this pattern may appear counterintuitive as one might expect the commercially oriented IUK funding stream to generate the strongest business growth returns and the research-oriented RC stream to drive knowledge and IP outputs. However, this distinction likely reflects differences in what each funding stream asks firms to do and how they participate. For example, IUK directly funds firms to undertake specific applied R&D projects which generates direct incentives for IP generation and innovation investment. This may help explain the more direct impacts on innovation rather than business growth. By contrast, firms in RC-funded projects typically participate as partners in university-led collaborations where they often contribute to projects through their expertise and data rather than leading intensive in-house R&D. This form of engagement may expose firms to new talent pools, international networks, and overseas markets. These channels are more directly linked to

employment and turnover growth than to patenting activity. The Phase 1 evidence review is consistent with this interpretation, noting that international collaboration can generate business growth through "exposure to and learning about new international markets" and access to international talent (Ozusaglam et al., 2024). This may help explain the stronger business growth effects. While our data does not allow us to directly test these potential mechanisms, the qualitative phase of this study which looks into the mechanisms of impact from university-led collaborations highlight access to globally distinctive and economically valuable knowledge as well as global resources, supply chains, facilities and international regulatory environments (De Silva et al., 2026, forthcoming).

The analysis in this report also makes a substantive contribution to the literature on absorptive capacity and firm-level moderators of RDI impact. The findings indicate that innovation gains from international collaboration are most pronounced among large firms, established firms, and those operating in high-technology manufacturing and high knowledge-intensive service sectors. This is consistent with the theoretical prediction that firms with greater absorptive capacity, those with the prior knowledge, skills, and organisational capabilities to identify, assimilate, and exploit externally generated knowledge, are better positioned to leverage the knowledge flows that international partnerships facilitate (Cohen and Levinthal, 1990).

Conversely, the near-absence of additionality for firms in low-technology manufacturing and low knowledge-intensive services, and the occasional negative effects observed for RC-supported firms in low-tech manufacturing, suggest that international collaboration may impose net costs that outweigh its benefits for firms with limited innovative capabilities or lower levels of prior RDI engagement. This finding has direct implications for the design of support programmes that seek to extend the reach of international collaboration beyond the most innovative firms. In addition, the Phase 1 evidence review makes clear that a null or negative effect of international relative to domestic collaboration does not mean these firms derive no benefit from collaboration at all. Rodriguez et al. (2018) find that domestic collaboration increases the likelihood of service innovation for knowledge-intensive services firms by 0.9%, even when international collaboration offers no additional advantage. Similarly, Miotti and Sachwald (2003) find that domestic-only collaboration with French partners does not generate significant innovation returns, but this appears to reflect the absence of knowledge diversity rather than any intrinsic limitation of collaboration; collaboration with more distant European or American partners generates positive returns. Taken together, Phase 1 suggests that the right policy response for firms unable to benefit from international collaboration is not withdrawal from collaborative support, but rather a recalibration of the collaborative model, which supports domestic partnerships that develop absorptive capacity and internal RDI capability as a foundation for future international engagement.

Beyond firm characteristics, the analysis demonstrates that project characteristics such as grant size, duration, and engagement frequency play an important role in shaping the returns from international collaboration. These project-level findings further corroborate the moderating factors identified in the Phase 1 evidence review (Ozusaglam et al., 2024), which highlights collaboration duration, breadth of international partners, and prior collaborative experience as key conditions shaping the returns from international RDI engagement. The present analysis gives empirical content to these moderators at the level of UKRI-funded firm behaviour. Accordingly, the results indicate that additionality is concentrated among firms involved in larger-value projects while it is largely absent for lower-value projects awards. This points to the existence of a minimum resource threshold below which the additional costs of managing cross-border partnerships are unlikely to be offset by the returns. Similarly, the result also shows that firms engaged in a single RC-supported project tend to realise business growth benefits, while those accumulating multiple IUK-supported grants tend to improve their innovation outputs. This suggests that the nature of the returns from international collaboration is shaped not only by the type of support received but also by the cumulative experience of international engagement as well as the moderator highlighted in the Phase 1 evidence review (Ozusaglam et al., 2024), which is consistent with learning-by-doing arguments in the innovation literature.

Several methodological considerations should be borne in mind when interpreting the findings. The productivity measure used throughout the analysis captures labour productivity, which is defined as turnover per employee, rather than total factor productivity that would capture the efficiency gains from international collaboration more comprehensively. Null or negative effects on labour productivity should therefore be interpreted with care. For example, in some cases they may reflect employment growth outpacing turnover growth rather than a decrease in productive efficiency. Additionally, while the PSM procedure substantially reduces observable differences between treated and control firms, and while matching within the population of UKRI funded firms significantly reduces the threat of selection on unobservable characteristics, some residual selection bias cannot be ruled out. In addition, due to ONS data access restrictions, the analysis is limited in its ability to provide disaggregated insights for specific Research Council funding bodies beyond the broad IUK versus non-IUK distinction, which constrains the granularity of the funding-type analysis. Within these constraints, however, the staggered CSDiD estimator represents the most robust and methodologically rigorous approach available given the structure of the data. Finally, we examined impacts over a maximum 6-year window, balancing a reasonably long post-collaboration impact horizon against retaining an adequate sample of supported firms, since longer horizons progressively exclude more recent cohorts. The analysis therefore cannot rule out additional positive impacts emerging beyond this period, particularly as pathways like world-class talent or knowledge access may take longer to translate into the tangible business outcomes captured here.

5.3. Implications for policy and funding strategy

The findings suggest specific implications for the design and delivery of international RDI support, which can be organised around the outcome that policy seeks to maximise.

Where the primary aim is to maximise employment growth, micro firms should be supported through IUK and young firms through university-led RC collaborations. Employment growth effect is strongest for RC-supported firms in high knowledge-intensive service sectors. Where the aim is to drive turnover and productivity growth, small firms and particularly those in high-technology manufacturing and high knowledge-intensive services should be supported by the RCs, while turnover growth among mature firms is best supported by the IUK.

In addition, where the aim is to foster technological innovation through patents, support should be directed towards larger, more established firms in high-technology manufacturing and knowledge-intensive service sectors. Within this group, Innovate UK support is the most effective delivery mechanism for generating the largest and most consistent patent gains. Where the aim is to drive softer forms of innovation, the picture is more nuanced. For example, for registered design application growth, the strongest additionality is found among large and established firms, and firms in high-technology manufacturing sectors supported through IUK. For trademark application growth, IUK-supported collaborations offer the greatest gains, particularly for firms in high knowledge-intensive services.

Across all outcome types, additionality is consistently higher for larger grant awards and longer engagement durations which highlights the importance of project sequencing and the accumulation of learning from international collaboration over time. Policymakers should consider whether existing funding thresholds are sufficient to offset the additional coordination and management costs inherent in cross-border partnerships, particularly for smaller firms. Below a certain resource threshold, directing firms towards domestic collaboration, which appears to be at least as effective for a substantial share of the firm population, may represent better value for public investment where the business outcomes considered here are the intended focus of the investment. The Phase 1 evidence review supports this finding. For example, Vanino et al. (2019) find that domestically collaborative UK firms see short-term turnover growth of around 5% and employment growth of around 5% relative to non-collaborating counterparts; Harris et al. (2011) find that HEI collaboration of any kind is associated with a 12% TFP premium; and Fitjar et al. (2016) find that even regional or domestic partnerships increase the likelihood of process innovation by around 13% relative to no collaboration. Domestic collaboration is therefore not a fallback option but a productive investment in its own right, and one that may build the absorptive capacity needed to eventually derive returns from international partnerships. It is important to note that international RDI collaboration is, by its nature,

more resource-intensive than domestic collaboration. The additional costs typically stem from logistical and travel requirements, legal and regulatory compliance across jurisdictions, intellectual property management, and the management of cultural, linguistic, and institutional differences between partners (Ozusaglam et al., 2024). This cost differential is a key part of the economic argument for targeted public support and the results of this study imply that without subsidy, international collaboration would remain accessible only to a subset of firms with the resources to absorb these costs.

The complementarity between IUK and Research Council funding mechanisms is a critical feature of the current system that policy should explicitly seek to preserve. Each stream supports a distinct but equally valuable pathway to firm-level impact, and strategies that substitute one for the other risk narrowing the overall range of outcomes that UKRI supported international collaboration can deliver.

In addition, internationally collaborative firms, by retaining and expanding their domestic networks while also forming international ones (as the complementarity analysis shows), can act as conduits through which knowledge, practices, and overseas market access flow into the wider domestic innovation ecosystem. The Phase 1 evidence review identifies knowledge spillovers, including regional specialisation, cluster formation, and technology diffusion, as important indirect benefits of international collaboration that accrue beyond the directly participating firms (Ozusaglam et al., 2024). Policy support that leverages these firms as network anchors may therefore generate returns beyond the directly measurable firm-level outcomes captured in this study.

Finally, the analysis identifies many instances of statistically insignificant effects alongside high additionality. This is an important finding in its own right. Where average treatment effects are statistically insignificant, this should not be read as evidence that international collaboration delivers no benefit to any firm within the cohort. Rather, it may reflect a high degree of dispersion in outcomes where a subset of firms may derive very substantial additionality from international engagement while others derive little or none, with these opposing effects averaging out to a statistically insignificant group-level estimate. International collaboration may therefore carry a high-risk, high-reward profile. This represents a potentially transformative opportunity for firms with the right capabilities and contextual conditions, but a negligible or even negative return for those without them. Accordingly, this interpretation reinforces the case for firm-level targeting, but also points to a distinct policy challenge. Firms that are not yet able to translate international engagement into measurable innovation or growth outcomes should not simply be excluded from international collaboration programmes. Rather, given that international support does not operate in isolation from the wider innovation support ecosystem, policy makers should consider delivering complementary capacity-building interventions in areas such as internal R&D capability, absorptive capacity, and domestic network development alongside direct international collaboration support.

5.4. Broader Limitations

Several limitations of the analysis merit attention beyond those already discussed in the context of specific findings. The dataset covers firms that received public support for RDI via UKRI and registered at least one intellectual property right or appear in the BSD over the sample period. While this provides a broad and representative coverage of publicly supported innovative firms, it excludes firms engaged in international RDI collaboration without UKRI funding, as well as the substantial share of UK businesses that do not engage in formal RDI activity at all. The findings should therefore be understood as applying to the population of publicly supported innovative firms rather than to UK businesses more generally. That is, the data largely reflects the most innovative UK businesses, as evidenced by an ability to register intellectual property and become successfully involved in UKRI supported projects. Earlier analysis using the UK Innovation Survey (UKIS) (Ozusaglam et al., 2026) provides complementary evidence for a broader population of innovative UK businesses, including those without UKRI funding. The UKIS covers approximately 22,000 UK businesses observed across seven survey waves between 2009 and 2021 and examines self-reported innovation outcomes. Taken together, the GtR-BSD and UKIS analyses offer a more comprehensive picture of the benefits of international collaboration than either study alone. As such, the UKIS analysis capture a wider spectrum of innovative firms and the GtR-BSD analysis provides more objective measures of both innovation outputs and business performance for publicly supported firms.

The analysis also does not examine the impacts of international collaboration on universities or other public research organisations, which are central participants in many of the collaborations examined here, particularly those supported by the Research Councils. A parallel IRC study qualitatively explores these questions and helps to address this gap (De Silva et al., 2026, forthcoming). The returns to the wider research and innovation system, including effects on research quality, talent development, and knowledge spillovers, remain outside the scope of the present analysis and represent an important gap in the overall evidence base.

In addition, while the report provides robust evidence on what the effects of international collaboration are, it does not explain the mechanisms through which they arise. The analysis cannot, for instance, distinguish between the knowledge transfer, network expansion, and market access channels through which international partnerships may improve firm performance. For this, a parallel qualitative study explores the mechanisms for deriving benefits from university-led collaborations.

5.5. Considerations for future research

The findings of this report, taken together with those of the initial Phase 2 analysis (Ozusaglam et al., 2026), substantially advance the evidence base on the additionality of publicly funded international RDI collaboration in the UK. However, they also sharpen the agenda for future research in three respects.

First, and most immediately, qualitative research with firms that have participated in UKRI funded international collaborations would help to open the mechanisms black box that the quantitative analyses cannot penetrate. Understanding *why* certain types of firms and projects generate stronger returns and, equally, why international collaboration appears to offer no advantage over domestic collaboration for a substantial share of firms, would allow the actionable insights from this report to be translated into more precisely designed support interventions. Qualitative research has already highlighted the value of this exercise for university-led collaborations.

Second, extending the analytical framework to universities and other public research organisations would provide a more complete account of the economic and societal returns from publicly funded international RDI collaboration across all the modes of engagement identified in the Phase 1 evidence review. The present analysis has focused almost exclusively on the firm-level returns to collaboration; the returns to the broader research and innovation base, and the spillovers from those returns to the wider economy, remain unexplored.

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Appendix

Table A1: Average Treatment Effect on Treated (ATT) by Size

	Small Size Firms Average Treatment Effect on Treated (ATT)					
RDI International collaboration	**Employment**	**Turnover**	**Productivity**	**Patent**	**Design**	**DTM**
All	0.016*	0.040	0.026	0.004	-0.005	0.007
	0.009	0.025	0.019	0.008	0.004	0.008
IUK	0.039	0.053	0.025	0.064*	-0.011*	0.007
	0.026	0.093	0.069	0.035	0.007	0.024
Other RCs	0.014	0.051	0.037	-0.002	-0.009	0.010
	0.012	0.035	0.027	0.008	0.015	0.010
B2B	0.016*	0.040	0.026	0.004	-0.005	0.007
	0.009	0.025	0.019	0.008	0.004	0.008
B2U	0.019*	0.041	0.025	0.004	-0.0087	0.008
	0.010	0.028	0.022	0.008	0.007	0.009
B2B & IUK	0.039	0.053	0.025	0.064*	-0.011*	0.007
	0.026	0.093	0.069	0.035	0.007	0.024
B2B & Other RCs	0.014	0.051	0.037	-0.002	-0.009	0.010
	0.012	0.035	0.027	0.008	0.015	0.010
B2U & IUK	0.044	0.052	0.021	0.082**	-0.028	0.021
	0.030	0.109	0.079	0.040	0.019	0.025
B2U & Other RCs	0.023**	0.077**	0.05*	-0.002	-0.009	0.011
	0.012	0.034	0.027	0.009	0.015	0.010

Notes:
-- Sample restricted to 4 years before and after the first instance of collaboration for each business in the sample
-- Standard errors are reported below each coefficient
-- Number of observations for Small businesses: All = 12,576; IUK = 4,501; Other RCs = 8,075; B2B = 12,522; B2U = 10,318; B2B & IUK = 4,501; B2B & Other RCs = 8,021; B2U & IUK = 2,532; B2U & Other RCs = 7,786.

Table A2: Average Treatment Effect on Treated (ATT) by Size

	Medium Size Firms Average Treatment Effect on Treated (ATT)					
RDI International collaboration	**Employment**	**Turnover**	**Productivity**	**Patent**	**Design**	**DTM**
All	0.000	-0.003	0.004	0.016	0.003	-0.005
	0.011	0.024	0.018	0.013	0.009	0.014
IUK	-0.004	-0.070	-0.045	0.006	0.019	-0.027
	0.020	0.059	0.048	0.037	0.021	0.039
Other RCs	0.005	0.031	0.032	0.015	0.005	-0.004
	0.016	0.028	0.023	0.017	0.012	0.017
B2B	0.000	-0.003	0.004	0.016	0.003	-0.005
	0.011	0.024	0.018	0.013	0.009	0.014
B2U	0.003	0.012	0.017	0.014	0.003	-0.006
	0.012	0.025	0.018	0.014	0.009	0.016
B2B & IUK	-0.004	-0.070	-0.045	0.006	0.019	-0.027
	0.020	0.059	0.048	0.037	0.021	0.039
B2B & Other RCs	0.005	0.031	0.032	0.015	0.005	-0.004
	0.016	0.028	0.023	0.017	0.012	0.017
B2U & IUK	0.002	-0.066	-0.047	0.005	0.027	-0.031
	0.022	0.064	0.052	0.041	0.022	0.044
B2U & Other RCs	0.004	0.048*	0.05**	0.014	0.005	-0.005
	0.018	0.029	0.024	0.019	0.012	0.019

Notes:
-- Sample restricted to 4 years before and after the first instance of collaboration for each business in the sample
-- Standard errors are reported below each coefficient
-- Number of observations for Medium businesses: All = 7,428; IUK = 2,381; Other RCs = 5,034; B2B = 7,428; B2U = 6,395; B2B & IUK = 2,381; B2B & Other RCs = 5,034; B2U & IUK = 1,584; B2U & Other RCs = 4,806.

Table A3: Average Treatment Effect on Treated (ATT) by Age

	Mature Firms Average Treatment Effect on Treated (ATT)					
RDI International collaboration	**Employment**	**Turnover**	**Productivity**	**Patent**	**Design**	**DTM**
All	0.017	0.041	0.021	0.010	0.006	0.005
	0.015	0.028	0.023	0.007	0.004	0.007
IUK	0.047	0.128**	0.062	0.030	-0.002	0.004
	0.031	0.060	0.049	0.022	0.008	0.018
Other RCs	0.008	0.047	0.039	0.001	0.016*	0.000
	0.023	0.041	0.033	0.010	0.009	0.009
B2B	0.017	0.041	0.021	0.010	0.006	0.005
	0.015	0.028	0.023	0.007	0.004	0.007
B2U	0.012	0.056*	0.043*	0.010	0.007*	0.002
	0.017	0.032	0.026	0.008	0.004	0.008
B2B & IUK	0.047	0.128**	0.062	0.030	-0.002	0.004
	0.031	0.060	0.049	0.022	0.008	0.018
B2B & Other RCs	0.008	0.047	0.039	0.001	0.016*	0.000
	0.023	0.041	0.033	0.010	0.009	0.009
B2U & IUK	0.037	0.11*	0.060	0.038	-0.003	0.005
	0.036	0.067	0.055	0.024	0.011	0.019
B2U & Other RCs	0.018	0.09**	0.066**	0.000	0.018*	0.001
	0.024	0.041	0.033	0.011	0.010	0.010

Notes:
-- Sample restricted to 4 years before and after the first instance of collaboration for each business in the sample
-- Standard errors are reported below each coefficient
-- Number of observations (except for Productivity): All = 12,717; IUK = 4,531; Other RCs = 8,075; B2B = 12,702; B2U = 10,285; B2B & IUK = 4,531; B2B & Other RCs = 8,171; B2U & IUK = 2,470; B2U & Other RCs = 7,815.
-- Number of observations (Productivity): All = 12,693; IUK = 4,519; Other RCs = 8,174; B2B = 12,678; B2U = 10,271; B2B & IUK = 4,519; B2B & Other RCs = 8,159; B2U & IUK = 2,458; B2U & Other RCs = 7,803.

Table A4: Average Treatment Effect on Treated (ATT) by Age

	Established Firm Average Treatment Effect on Treated (ATT)					
RDI International collaboration	**Employment**	**Turnover**	**Productivity**	**Patent**	**Design**	**DTM**
All	0.001	-0.018	-0.005	0.020**	0.007	0.013
	0.010	0.019	0.014	0.009	0.005	0.011
IUK	-0.038	-0.038	0.009	0.042**	0.029**	0.023
	0.033	0.047	0.034	0.021	0.013	0.027
Other RCs	0.020	0.004	0.000	0.019**	0.005	0.008
	0.015	0.024	0.017	0.010	0.006	0.013
B2B	0.001	-0.018	-0.005	0.020**	0.007	0.013
	0.010	0.019	0.014	0.009	0.005	0.011
B2U	0.010	-0.006	-0.002	0.019**	0.008	0.011
	0.012	0.022	0.016	0.009	0.006	0.011
B2B & IUK	-0.038	-0.038	0.009	0.042**	0.029**	0.023
	0.033	0.047	0.034	0.021	0.013	0.027
B2B & Other RCs	0.020	0.004	0.000	0.019**	0.005	0.008
	0.015	0.024	0.017	0.010	0.006	0.013
B2U & IUK	-0.038	-0.038	0.012	0.039*	0.03**	0.019
	0.036	0.054	0.038	0.023	0.013	0.030
B2U & Other RCs	0.027*	0.020	0.002	0.023**	0.007	0.012
	0.016	0.025	0.018	0.010	0.006	0.013

Notes:
-- Sample restricted to 4 years before and after the first instance of collaboration for each business in the sample
-- Standard errors are reported below each coefficient
-- Number of observations (except for Productivity): All = 24,530; IUK = 8,175; Other RCs = 16,355; B2B = 24,486; B2U = 20,716; B2B & IUK = 8,175; B2B & Other RCs = 16,311; B2U & IUK = 5,002; B2U & Other RCs = 15,714.
-- Number of observations (Productivity): All = 24,512; IUK = 8,174; Other RCs = 16,338; B2B = 24,468; B2U = 20,704; B2B & IUK = 8,174; B2B & Other RCs = 16,294; B2U & IUK = 5,002; B2U & Other RCs = 15,702.

Table A5: Detailed sector classifications

Aggregated Industry	Relevant UK SIC 2007 2-digit Codes	SIC Description	Classification
Primary manufacturing	01–09	Agriculture, forestry and fishing; mining and quarrying	Low-technology manufacturing
Consumer goods manufacturing	10–15, 31–32	Food products, beverages, tobacco, textiles, apparel, leather, furniture and other manufacturing	Low-technology manufacturing
Materials and intermediate manufacturing	16–19, 23–25	Wood, paper, printing, coke and refined petroleum, non-metallic minerals, basic metals and fabricated metal products	Low-technology manufacturing
Chemicals and life sciences manufacturing	20–22	Chemicals, pharmaceuticals, rubber and plastics	High-technology manufacturing
Advanced manufacturing	26–28	Computer, electronic and optical products, electrical equipment, machinery and equipment	High-technology manufacturing
Transport equipment manufacturing	29–30, 33	Motor vehicles, transport equipment, repair and installation of machinery and equipment	High-technology manufacturing
Utilities and environmental services	35–40	Electricity, gas, steam, water supply, sewerage and waste management	Low knowledge-intensity services
Construction	41–44	Construction and specialised construction activities	Low knowledge-intensity services
Wholesale and retail trade	45–48	Wholesale and retail trade; repair of motor vehicles and motorcycles	Low knowledge-intensity services
Transport, logistics and storage	49–54	Transportation, warehousing, postal and courier activities	Low knowledge-intensity services
Hospitality and food services	55–57	Accommodation and food service activities	Low knowledge-intensity services
Information, media and digital services	58–63	Publishing, audiovisual, broadcasting, telecommunications, IT and information services	High knowledge-intensity services
Financial and real estate services	64–68	Financial services, insurance and real estate activities	High knowledge-intensity services
Professional, scientific and technical services	69–76	Legal, accounting, management consultancy, scientific research, advertising and veterinary activities	High knowledge-intensity services
Administrative and business support services	77–83	Administrative, office, employment, travel agency, security and business support activities	Low knowledge-intensity services
Public, education and health services	84–89	Public administration, education, health and social work activities	High knowledge-intensity services
Personal, cultural and other services	90–99	Arts, entertainment, recreation and other personal service activities	Low knowledge-intensity services

Table A6: Average Treatment Effect on Treated (ATT) for Single Grant Holders

	Single Grant Holders Average Treatment Effect on Treated (ATT)					
RDI International collaboration	**Employment**	**Turnover**	**Productivity**	**Patent**	**Design**	**DTM**
All	0.008*	0.032*	0.024*	-0.002	0.005	-0.006
	0.013	0.026	0.020	0.005	0.003	0.007
IUK	0.135	0.202	0.084	-0.055	0.000	-0.102
	0.098	0.160	0.145	0.058	0.002	0.078
Other RCs	0.011	0.048	0.040*	-0.005	0.006	-0.007
	0.018	0.032	0.022	0.006	0.004	0.007
B2B	0.008*	0.032*	0.024*	-0.002	0.005	-0.006
	0.013	0.026	0.020	0.005	0.003	0.007
B2U	0.014	0.044	0.031	-0.003	0.007*	-0.009
	0.015	0.029	0.021	0.006	0.004	0.007
B2B & IUK	0.135	0.202	0.084	-0.055	0.000	-0.102
	0.098	0.160	0.145	0.058	0.002	0.078
B2B & Other RCs	0.011	0.048	0.040*	-0.005	0.006	-0.007
	0.018	0.032	0.022	0.006	0.004	0.007
B2U & IUK	0.135	0.205	0.095	-0.061	-0.001	-0.084
	0.109	0.177	0.159	0.063	0.002	0.081
B2U & Other RCs	0.021	0.068**	0.046**	-0.004	0.008*	-0.006
	0.019	0.034	0.023	0.007	0.005	0.007

Notes:

-- Sample restricted to 4 years before and after the first instance of collaboration for each business in the sample

-- Standard errors are reported below each coefficient

-- Number of observations for Employment and Turnover: All = 21,405; IUK = 7,683; Other RCs = 13,718; B2B = 21,315; B2U = 16,744; B2B & IUK = 7,683; B2B & Other RCs = 13,628; B2U & IUK = 3,845; B2U & Other RCs = 12,898.

-- Number of observations for Productivity: All =21,361; IUK = 7,664; Other RCs = 13,693; B2B = 21,271; B2U = 16,723; B2B & IUK = 7,664; B2B & Other RCs = 13,603; B2U & IUK = 3,843; B2U & Other RCs = 12,879.

-- Number of observations for Patent, Designs and DTM: All =21,419; IUK = 7,687; Other RCs = 13,728; B2B = 21,326; B2U = 16,754; B2B & IUK = 7,687; B2B & Other RCs = 13,635; B2U & IUK = 3,847; B2U & Other RCs = 12,906.

Table A7: Average Treatment Effect on Treated (ATT) for Multiple Grant Holders

	Multiple Grant Holders Average Treatment Effect on Treated (ATT)					
RDI International collaboration	**Employment**	**Turnover**	**Productivity**	**Patent**	**Design**	**DTM**
All	-0.007	-0.029	-0.004	0.026***	0.006	0.017**
	0.013	0.022	0.016	0.008	0.004	0.008
IUK	-0.017	-0.053	-0.019	0.054***	0.014*	0.026*
	0.025	0.044	0.033	0.015	0.007	0.015
Other RCs	-0.008	-0.020	0.002	0.021**	0.006	0.008
	0.022	0.032	0.023	0.009	0.005	0.011
B2B	-0.007	-0.029	-0.004	0.026***	0.006	0.017**
	0.013	0.022	0.016	0.008	0.004	0.008
B2U	-0.002	-0.022	-0.005	0.021**	0.005	0.012
	0.016	0.027	0.018	0.009	0.005	0.009
B2B & IUK	-0.017	-0.053	-0.019	0.054***	0.014*	0.026*
	0.025	0.044	0.033	0.015	0.007	0.015
B2B & Other RCs	-0.008	-0.020	0.003	0.021**	0.006	0.008
	0.022	0.032	0.023	0.009	0.005	0.011
B2U & IUK	-0.018	-0.066	-0.030	0.051***	0.012	0.025
	0.030	0.052	0.037	0.018	0.008	0.017
B2U & Other RCs	0.006	0.015	0.020	0.022**	0.008	0.008
	0.024	0.034	0.025	0.009	0.005	0.012

Notes:

-- Sample restricted to 4 years before and after the first instance of collaboration for each business in the sample

-- Standard errors are reported below each coefficient

-- Number of observations for Employment and Turnover: All = 26,620; IUK = 7,979; Other RCs = 18,641; B2B = 26,578; B2U = 23,656; B2B & IUK = 7,979; B2B & Other RCs = 18,599; B2U & IUK = 5,500; B2U & Other RCs = 18,156.

-- Number of observations for Productivity: All =26,593; IUK = 7,979; Other RCs = 18,614; B2B = 26,551; B2U = 23,629; B2B & IUK = 7,979; B2B & Other RCs = 18,572; B2U & IUK = 5,500; B2U & Other RCs = 18,129.

-- Number of observations for Patent, Designs and DTM: All =26,729; IUK = 7,989; Other RCs = 18,740; B2B = 26,678; B2U = 23,763; B2B & IUK = 7,989; B2B & Other RCs = 18,689; B2U & IUK = 5,508; B2U & Other RCs = 18,255.

Table A8: Average Treatment Effect on Treated (ATT) for Smaller Award

	Award equal or below the median (Smaller award) Average Treatment Effect on Treated (ATT)					
RDI International collaboration	**Employment**	**Turnover**	**Productivity**	**Patent**	**Design**	**DTM**
All	0.019	-0.018	-0.030	0.013	0.004	0.012
	0.013	0.026	0.019	0.009	0.004	0.010
IUK	0.051	-0.049	-0.096*	0.041	0.001	0.001
	0.032	0.061	0.053	0.026	0.005	0.025
Other RCs	0.020	0.017	0.005	0.007	0.006	0.008
	0.019	0.035	0.024	0.010	0.004	0.012
B2B	0.018	-0.020	-0.031	0.013	0.004	0.012
	0.013	0.026	0.019	0.009	0.004	0.010
B2U	0.013	-0.023	-0.028	0.010	0.004	0.008
	0.016	0.030	0.021	0.009	0.004	0.011
B2B & IUK	0.051	-0.049	-0.096*	0.041	0.001	0.001
	0.032	0.061	0.053	0.026	0.005	0.025
B2B & Other RCs	0.018	0.013	0.004	0.007	0.006	0.008
	0.019	0.035	0.024	0.010	0.004	0.012
B2U & IUK	0.031	-0.091	-0.110*	0.044	-0.002	0.005
	0.037	0.070	0.059	0.030	0.007	0.028
B2U & Other RCs	0.028	0.040	0.014	0.007	0.009**	0.008
	0.020	0.036	0.024	0.011	0.004	0.012

Notes:

-- Sample restricted to 4 years before and after the first instance of collaboration for each business in the sample

-- Standard errors are reported below each coefficient

-- Number of observations for Employment and Turnover: All = 18,696; IUK = 7,726; Other RCs = 10,970; B2B = 18,634; B2U = 14,160; B2B & IUK = 7,726; B2B & Other RCs = 10,908; B2U & IUK = 3,720; B2U & Other RCs = 10,440.

-- Number of observations for Productivity: All = 18,667; IUK = 7,709; Other RCs = 10,958; B2B = 18,605; B2U = 14,154; B2B & IUK = 7,709; B2B & Other RCs = 10,896; B2U & IUK = 3,720; B2U & Other RCs = 10,434.

-- Number of observations for Patent, Designs and DTM: All = 18,733; IUK = 7,734; Other RCs = 10,999; B2B = 18,664; B2U = 14,192; B2B & IUK = 7,734; B2B & Other RCs = 10,930; B2U & IUK = 3,724; B2U & Other RCs = 10,468.

Table A9: Average Treatment Effect on Treated (ATT) for Larger Award

	Award above the median (Larger Award) Average Treatment Effect on Treated (ATT)					
RDI International collaboration	**Employment**	**Turnover**	**Productivity**	**Patent**	**Design**	**DTM**
All	0.006	0.018	0.019	0.024***	0.009**	0.009
	0.012	0.021	0.014	0.006	0.004	0.007
IUK	-0.007	0.006	0.022	0.058***	0.021**	0.022
	0.031	0.052	0.038	0.018	0.010	0.019
Other RCs	0.015	0.019	0.012	0.019**	0.007*	0.008
	0.019	0.028	0.019	0.007	0.004	0.009
B2B	0.006	0.018	0.020	0.024***	0.009**	0.009
	0.013	0.021	0.015	0.006	0.004	0.007
B2U	0.024*	0.042*	0.024	0.024***	0.009**	0.009
	0.015	0.024	0.016	0.007	0.004	0.008
B2B & IUK	-0.007	0.006	0.022	0.058***	0.021**	0.022
	0.031	0.052	0.038	0.018	0.010	0.019
B2B & Other RCs	0.016	0.019	0.012	0.019**	0.007*	0.008
	0.019	0.028	0.019	0.007	0.004	0.009
B2U & IUK	0.013	0.029	0.024	0.061***	0.03**	0.023
	0.034	0.058	0.041	0.019	0.013	0.020
B2U & Other RCs	0.028	0.039	0.018	0.02***	0.008*	0.012
	0.022	0.031	0.020	0.008	0.005	0.009

Notes:

-- Sample restricted to 4 years before and after the first instance of collaboration for each business in the sample

-- Standard errors are reported below each coefficient

-- Number of observations for Employment and Turnover: All = 29,329; IUK = 7,940; Other RCs = 21,389; B2B = 29,259; B2U = 26,240; B2B & IUK = 7,940; B2B & Other RCs = 21,319; B2U & IUK = 5,626; B2U & Other RCs = 20,614.

-- Number of observations for Productivity: All = 29,287; IUK = 7,938; Other RCs = 21,349; B2B = 29,217; B2U = 26,198; B2B & IUK = 7,938; B2B & Other RCs = 21,279; B2U & IUK = 5,624; B2U & Other RCs = 20,574.

-- Number of observations for Patent, Designs and DTM: All = 29,415; IUK = 7,946; Other RCs = 21,469; B2B = 29,340; B2U = 26,325; B2B & IUK = 7,946; B2B & Other RCs = 21,394; B2U & IUK = 5,632; B2U & Other RCs = 20,693.

Table A10: Average Treatment Effect on Treated (ATT) for Shorter Project Duration

	Shorter Project Duration Average Treatment Effect on Treated (ATT)					
RDI International collaboration	**Employment**	**Turnover**	**Productivity**	**Patent**	**Design**	**DTM**
All	0.020	-0.011	-0.023	0.024**	0.008**	0.017
	0.014	0.027	0.019	0.010	0.004	0.010
IUK	0.065**	0.032	-0.028	0.037**	0.003	-0.005
	0.030	0.057	0.045	0.019	0.005	0.018
Other RCs	0.006	-0.007	0.000	0.017	0.010*	0.018
	0.022	0.039	0.026	0.013	0.005	0.013
B2B	0.019	-0.013	-0.024	0.025**	0.008**	0.017
	0.014	0.027	0.019	0.010	0.004	0.011
B2U	0.027	-0.001	-0.019	0.022**	0.009**	0.014
	0.017	0.031	0.021	0.011	0.004	0.011
B2B & IUK	0.065**	0.032	-0.028	0.037**	0.003	-0.005
	0.030	0.057	0.045	0.019	0.005	0.018
B2B & Other RCs	0.003	-0.014	-0.003	0.017	0.010*	0.018
	0.022	0.039	0.026	0.013	0.005	0.013
B2U & IUK	0.072**	0.025	-0.037	0.035*	0.004	-0.005
	0.033	0.064	0.049	0.021	0.006	0.020
B2U & Other RCs	0.020	0.027	0.011	0.020	0.013**	0.020
	0.023	0.041	0.026	0.013	0.006	0.013

Notes:
-- Sample restricted to 4 years before and after the first instance of collaboration for each business in the sample
-- Standard errors are reported below each coefficient
-- Number of observations for Employment and Turnover: All = 19,753; IUK = 10,377; Other RCs = 9,376; B2B = 19,692; B2U = 14,168; B2B & IUK = 10,377; B2B & Other RCs = 9,315; B2U & IUK = 5,419; B2U & Other RCs = 8,749.
-- Number of observations for Productivity: All =19,719; IUK = 10,360; Other RCs = 11,083; B2B = 19,658; B2U = 14,157; B2B & IUK = 10,360; B2B & Other RCs = 9,298; B2U & IUK = 5,419; B2U & Other RCs = 8,738.
-- Number of observations for Patent, Designs and DTM: All = 19,784; IUK = 10,383; Other RCs = 9,401; B2B = 24,265; B2U = 14,193; B2B & IUK = 10,383; B2B & Other RCs = 9,331; B2U & IUK = 5,421; B2U & Other RCs = 8,772.

Table A11: Average Treatment Effect on Treated (ATT) for Longer Project Duration

	Longer Project Duration Average Treatment Effect on Treated (ATT)					
RDI International collaboration	**Employment**	**Turnover**	**Productivity**	**Patent**	**Design**	**DTM**
All	0.020	0.024	0.016	0.017***	0.006	0.001
	0.014	0.021	0.015	0.006	0.004	0.008
IUK	-0.042	-0.060	-0.006	0.065***	0.026**	0.038
	0.036	0.057	0.042	0.023	0.013	0.024
Other RCs	0.030	0.041	0.016	0.013*	0.006	-0.001
	0.018	0.026	0.018	0.007	0.004	0.009
B2B	0.014	0.025	0.017	0.017***	0.006	0.002
	0.013	0.021	0.015	0.006	0.004	0.008
B2U	0.018	0.031	0.018	0.016**	0.006	0.001
	0.015	0.024	0.016	0.007	0.004	0.008
B2B & IUK	-0.042	-0.060	-0.006	0.065***	0.026**	0.038
	0.036	0.057	0.042	0.023	0.013	0.024
B2B & Other RCs	0.030	0.043*	0.017	0.013*	0.006	-0.001
	0.019	0.026	0.018	0.007	0.004	0.009
B2U & IUK	-0.052	-0.071	-0.007	0.074***	0.028**	0.045*
	0.040	0.064	0.047	0.025	0.014	0.026
B2U & Other RCs	0.038*	0.054*	0.020	0.012*	0.007*	0.000
	0.020	0.028	0.019	0.007	0.004	0.009

Notes:
-- Sample restricted to 4 years before and after the first instance of collaboration for each business in the sample
-- Standard errors are reported below each coefficient
-- Number of observations for Employment and Turnover: All = 19,753; IUK = 5,289; Other RCs = 22,983; B2B = 28,201; B2U = 26,232; B2B & IUK = 5,289; B2B & Other RCs = 22,912; B2U & IUK = 3,927; B2U & Other RCs = 22,305.
-- Number of observations for Productivity: All = 28,235; IUK = 5,287; Other RCs = 22,948; B2B = 28,164; B2U = 26,195; B2B & IUK = 5,287; B2B & Other RCs = 22,877; B2U & IUK = 3,925; B2U & Other RCs = 22,270.
-- Number of observations for Patent, Designs and DTM: All = 28,364; IUK = 5,297; Other RCs = 23,067; B2B = 28,290; B2U = 26,324; B2B & IUK = 5,297; B2B & Other RCs = 22,993; B2U & IUK = 3,935; B2U & Other RCs = 22,389.

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