Assessing the business growth and productivity effects of Invest NI and UKRI grant support for R&D and innovation

Enrico Vanino, Stephen Roper and Nola Hewitt-Dundas

e.vanino@sheffield.ac.uk; Stephen.roper@wbs.ac.uk; nm.hewitt@qub.ac.uk

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Executive Summary

Background
Firms in Northern Ireland have access both to regional grants for R&D and innovation provided by Invest NI and national, UK-wide, project opportunities offered by UKRI. Here for the first time, we are able to compare the comparable impacts of these local and national supports for R&D and innovation on business growth and examine synergies between the two types of support measures. The results provide evidence of the effectiveness of regional support measures and positive synergies between local and national support policies for R&D and innovation.

We examine support provided by Invest NI (INI) and UKRI over the period 2006-16 and draw on administrative data provided by Invest NI, data on UK grant support taken from Gateway to Research and longitudinal information on business performance derived from the Business Structures Database. We adopt a modelling strategy combining propensity score matching and difference in difference estimation and consider five research questions:

- Do Invest NI R&D and innovation grants support faster growth in terms of employment and turnover in the short (3 years) and medium term (6 years)?
- Does the growth effect of INI R&D and innovation grants differ?
- Do UKRI grants support NI firms to achieve faster growth in the short (3 years) and medium term (6 years)?
- Does UKRI support, or INI support have the strongest effect on growth?
- Does receiving INI support increase the probability of receiving UKRI support?

R&D and innovation in NI and the UK
Levels of business R&D activity in Northern Ireland – measured as a percentage of GDP – have broadly reflected those in the UK as a whole over the last decade. This represents a significant shift from the earlier 2001 to 2007 period during which the level of business R&D activity in Northern Ireland was consistent with the lower trend level in Scotland and Wales. Much of the sharp rise in R&D spend in Northern Ireland was attributable to an increase in R&D spend by SMEs, with spend increasing by 91 per cent between 2010 and 2015.

Data on innovative activity in Northern Ireland and other parts of the UK comes from the UK Innovation Survey. A key indicator in this survey is the proportion of innovation active firms, i.e. those firms which are engaged in either R&D, product or process innovation or have either on-going or abandoned innovation in the three-year period covered by the survey. The proportion of innovation active firms in Northern Ireland has remained slightly, but consistently, below that in the UK as a whole and Scotland and Wales since 2008.

Supporting R&D and innovation – different approaches
Approaches to providing grant support for R&D and innovation differ significantly between Northern Ireland and the UK with support packages often negotiated in Northern Ireland and subject to competitive allocation at UK level. This distinction may be important in shaping the quality of projects supported and, potentially, their downstream performance benefits.

The relatively small size of the region allows Invest NI to maintain close relationships to many businesses in the region through a network of Client Executives or Client Managers. ‘The client executive works with the business and agrees the priorities, and then we provide a solution’.

The negotiated approach to supporting business R&D and innovation in Northern Ireland contrasts sharply with the competitive and hands off approach adopted by Innovate UK and the other UK research councils. Typically, UKRI support for R&D and innovation is delivered through open and competitive calls for proposals from firms.

Levels of grant funding
A key source of R&D and innovation funding across the UK is Innovate UK. Perhaps due to the availability of local funding, grant support from Innovate UK to Northern Ireland firms is lower than that in almost any other UK region both when calculated on a per business basis and a per R&D active business basis. Indeed, total Innovate UK spend in Northern Ireland in 2018-19 was only £11m, around a fifth of the total value of Invest NI support for R&D and innovation in Northern Ireland companies in 2018-19.

Invest NI spend per R&D active company in NI in 2018-19 was around £33,650. This is a significantly higher level of public grant support than that available in any other UK region and added to the level of Innovate UK support (£7,023 per R&D active company) suggests total support per R&D active business of £40,670 in 2018/19. This is more than twice the level of support for R&D and innovation available to most firms in England.

Do Invest NI R&D and innovation grants support faster growth?
Invest NI R&D and innovation grants have strong and statistically significant impacts on both turnover and employment growth. Grant-aided companies grow employment 14.3% faster after 3 years and 27.2% faster over 6 years than comparable firms and grow turnover faster by 28.2% and 49.3% respectively. These effects are consistent across both manufacturing and services firms and for those both with and without UKRI support. Growth effects are larger for micro and smaller firms, high-tech firms and those in receipt of multiple grants.

Based on the best practice econometric modelling approach we adopt, this provides strong evidence of the importance of Invest NI R&D and innovation grants to support local enterprises in their innovative activities, in particular smaller firms, on top of the already available national public R&D funding.

Does the growth effect of INI R&D and innovation grants differ?
We observe no significant difference between the impact of R&D and innovation grants on turnover growth. R&D grants do trigger more sustained employment growth of 14% over 6 years relative to innovation grants but this effect is limited to medium-large companies and those in high-tech sectors.

Do UKRI grants support faster growth in NI firms?
Despite identifying only a limited number of UKRI supported firms in Northern Ireland, we find that national UKRI R&D funding plays an important role in fostering employment and turnover growth in participating firms in Northern Ireland. This effect is strongest for firms operating in high-tech services.

Results here need to be regarded as somewhat tentative due to the small number of companies involved. However, the estimated magnitude of these growth effects are notably larger than for the rest of the UK identified in previous studies. This suggests that the support of national public R&D funding could be particularly beneficial to foster business growth in peripheral regions of the country like Northern Ireland.

Does UKRI or INI support have the strongest effect on growth?
Here, the answer depends strongly on the type of firm being considered with each type of support proving important for different groups of firms. Overall, medium-term turnover growth is more strongly supported by national UKRI support. Regional support is significantly more beneficial for low-tech firms, however, and for employment growth in micro and small firms. Single grant awards are more beneficial for turnover growth if they are from UKRI.

This is important evidence corroborating the complementarity between regional and national R&D support schemes. In fact, on the one hand regional supporting schemes seem to mainly benefit smaller firms in low-tech industries through smaller scale innovation grants, by helping them to adopt new technologies and commercialise new innovations. On the other hand, national R&D funding seems more appropriate to support medium-large firms in high-tech sectors, supporting larger scale collaborations with universities and other private partners for the development of more advanced and risky research projects.

Does receiving Invest NI support increase the probability of receiving UKRI support?
Our findings corroborate this hypothesis, identifying higher probabilities of securing national UKRI funding for firms previously supported by regional Invest NI schemes operating in high-tech sectors (+3.3%), for medium-large companies (+6.6%), and those which managed to secure multiple R&D grants from Invest NI (+2.6%).

This is additional evidence in favour of the complementarity of national and regional support measures showing how regional R&D support schemes could be used to better prepare future applications and leverage additional funding from national UKRI R&D public support.

1. Introduction

Public support for private R&D and innovation activity is common across almost all economies, although the profile of public support and its delivery varies widely. Drawing on arguments about market failures and the potential for positive knowledge spillovers, governments provide tax incentives for firms' innovation as well as more direct grant support. In the UK, tax supports – most notably the R&D tax credit – are particularly important providing over £5.1bn in 2017-18[1]. Other key elements of the support for R&D and innovation are direct grants to companies to fund R&D or innovation projects. In the UK this support is provided primarily through UKRI, and the evidence suggests that UKRI support has a strong, significant and positive effect on firms' R&D investments and business growth (Scandura 2016; Vanino et al. 2019). Vanino et al. (2019) find that UKRI support contributes to strong growth in turnover and employment in participating firms both 3 and 6 years after their participation in publicly funded R&D and innovation projects. This positive growth effect is very similar regardless of whether firms are involved in Innovate UK projects (in which they receive direct funding) or other Research Council projects (e.g. EPSRC) where firms are typically unfunded partners in university-based R&D projects.

UKRI support is available to all firms across the UK. Other innovation funding mechanisms differ across the home nations, however, with funding regimes in Scotland, Northern Ireland and Wales all providing additional support to local firms. In Scotland, Scottish Enterprise have traditionally provided R&D grants, although this has recently shifted towards an emphasis on supporting the green transition[2]. In Wales innovation and R&D are supported through Business Wales' SMARTCymru service which provides advisory support and limited funding support through Innovation Vouchers[3]. In Northern Ireland, our focus here, both innovation and R&D grant support is provided by Invest NI over and above any UKRI support. Although schemes have changed through time this support currently includes Innovation Vouchers and larger Follow-on R&D grants for firms with prior R&D experience[4]. In England, while the primary source of R&D and innovation grant funding is UKRI, local initiatives also exist, often supported by Growth Hubs or Local Enterprise Partnerships. Interestingly, however, devolution has led to calls for more localised innovation funding with 'Innovation Greater Manchester' developing a bid in early 2021 for a £250m pa devolved fund to support innovation in the city[5].

In this report we examine the impacts on business performance of the R&D and innovation grants provided by Invest NI (INI). We adopt a comparable approach to that used in Vanino et al (2019) allowing a direct comparison between the impact of NI support for business

[1] Table RD2 R&D tax credits combined tables. Available at: https://www.gov.uk/government/statistics/corporate-tax-research-and-development-tax-credit.

[2] See https://www.scottish-enterprise.com/support-for-businesses/funding-and-grants/business-grants/research-and-development-grant.

[3] See https://businesswales.gov.wales/expertisewales/support-and-funding-businesses/smartcymru.

[4] See https://www.investni.com/support-for-business/funding-for-innovation-and-research-and-development.

[5] See https://www.greatermanchester-ca.gov.uk/news/innovation-greater-manchester-provides-blueprint-for-boosting-rd-investment-and-levelling-up-north/.

innovation and that provided nationally. Our findings have implications both in terms of regional support for innovation but also the potential value of devolved R&D and innovation support measures. We consider five research questions:

(1) Do Invest NI R&D and innovation grants support faster growth in terms of employment and turnover in the short (3 years) and medium term (6 years)?
(2) Does the growth effect of INI R&D and innovation grants differ?
(3) Do UKRI grants support NI firms faster growth in the short (3 years) and medium term (6 years)?
(4) Does UKRI or INI support have the strongest effect on growth?
(5) Does receiving INI support increase the probability of receiving UKRI support?

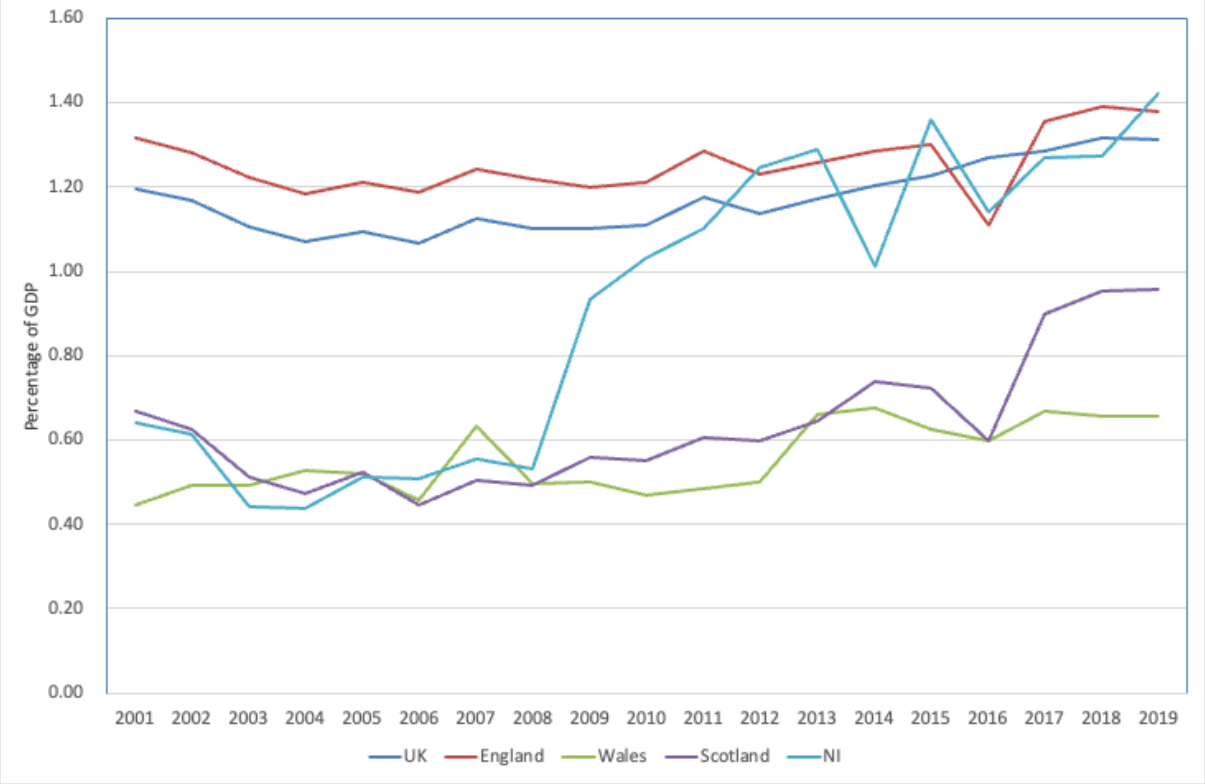
Section 2 sets the context for our more detailed econometric analysis and provides an overview of R&D and innovation support mechanisms and outcomes in Northern Ireland compared to that in the UK. Section 3 focuses on data and methodology and provides some descriptive data on Invest NI (INI) support for R&D and innovation. Section 4 outlines the main empirical results, addressing our five research questions. Section 5 summarises the main findings and draws out the key conclusions.

2. Study context: R&D and innovation – support and outcomes in Northern Ireland

2.1 Innovation and business R&D trends

Levels of business R&D activity in Northern Ireland – measured as a percentage of GDP – have broadly reflected those in the UK as a whole, over the last decade (Figure 1). This represents a significant shift from the earlier 2001 to 2007 period during which the level of business R&D activity in Northern Ireland was consistent with the lower trend level in Scotland and Wales. The sharp increase in business R&D activity over the 2009-13 period was not reflected in other elements of R&D spending in Northern Ireland or in other UK regions, with growth in Northern Ireland more marked than that elsewhere as Figure 1 suggests. Commentary at the time suggested that: 'The change in R&D expenditure in NI is the result of several factors, including companies beginning new projects, resulting staff increases and spending on new equipment and materials. This can have a large impact on annual NI R&D estimates, particularly where larger companies have commenced a significant R&D project' (NISRA, 2016, p.11). Much of the sharp rise in R&D spend is attributable to an increase in R&D spend by SMEs in Northern Ireland, with their spend increasing by 91 per cent between 2010 and 2015 (Figure 2).

Figure 1: Business R&D as a percentage of GDP: 2001-2019



Source: ONS Regional Breakdown of R&D and regional GDP

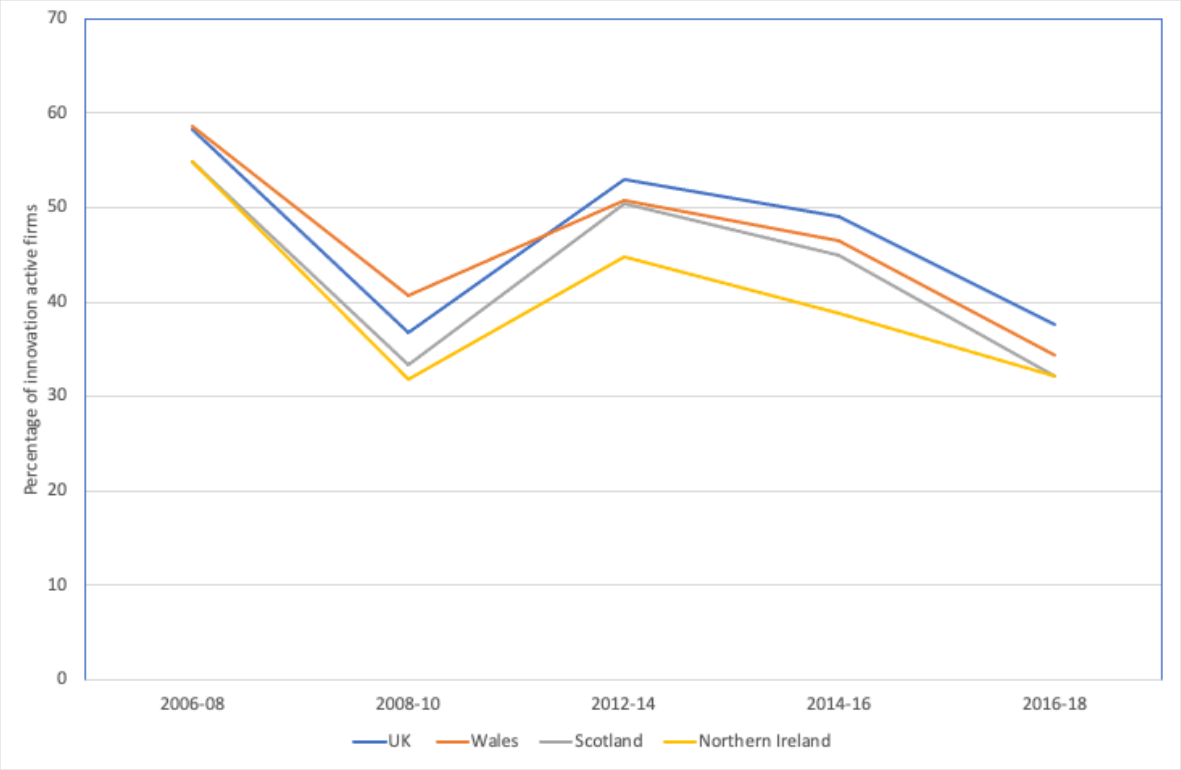
Figure 2: Total Business R&D spend by SMEs and larger companies in NI: 2010, 2014 and 2015 (£m)

Source: NISRA, 2016, Figure 4, p. 13.

Data on innovative activity in Northern Ireland and other parts of the UK comes from the UK Innovation Survey[6]. A key indicator in this survey is the proportion of innovation active firms, i.e., those firms which are engaged in either R&D, product or process innovation or have either on-going or abandoned innovation in the three-year period covered by the survey. The proportion of innovation active firms in Northern Ireland has remained slightly but consistently below that in the UK as a whole and Scotland and Wales since 2008 (Figure 3). This is despite the significantly higher level of R&D spend in Northern Ireland relative to Scotland and Wales shown in Figure 1.

[6] https://data.gov.uk/dataset/29e719be-534d-4a83-8919-1014b26e89f9/uk-innovation-survey.

Figure 3: Percentage of innovation active firms



Source: UK Innovation Survey Data Annex – various years.

2.2 UK and NI support for R&D and Innovation

Approaches to providing grant support for R&D and innovation differ significantly between Northern Ireland and the UK with support packages often negotiated in Northern Ireland and subject to competitive allocation at UK level. This distinction may be important in shaping the quality of projects supported and, potentially, their downstream performance benefits.

Northern Ireland is the smallest region of the UK with a population of around 1.9m[7]. Invest NI – the regional economic development agency – was established in 2002 and is the body responsible for providing support for established local businesses, start-ups and inward investment. The relatively small size of the region allows Invest NI to maintain close relationships to many businesses in the region through a network of Client Executives or Client Managers. These client executives provide the first point of contact between firms and Invest NI and enable Invest NI to tailor support packages to individual firm's needs. Giving evidence to the NI Assembly Economy Committee, 29th June 2016 (p. 10), Jeremy Fitch, MD of Business International, Invest NI described the operation of the Client Executive system as follows[8]:

[7] https://www.nisra.gov.uk/sites/nisra.gov.uk/files/publications/MYE20-Bulletin.pdf.
[8] http://data.niassembly.gov.uk/HansardXml/committee-18356.pdf.

> 'The way it works, is that we have, as I said, a client executive or client manager who manages the account. Their job is to understand the business. We will use models like a business health check. We will go into the business, have a look at it and say, "What issues do you face? What opportunities are there? What impediments are there?". From that, the client manager or client executive agrees with the company a range of solutions that we can provide to those issues. It may be something to do with skills — can we offer skills? It may be something to do with research and development to develop a new product, or it may be some marketing support to help it to get into new export or trade areas. The client executive works with the business and agrees the priorities, and then we provide a solution'.

The negotiated approach to supporting business R&D and innovation in Northern Ireland contrasts sharply with the competitive and hands off approach adopted by Innovate UK and the other UK research councils[9]. Typically, UKRI support for R&D and innovation is delivered through open and competitive calls for proposals from firms. This competitive process and the need to complete detailed grant applications may discourage firms – particularly smaller firms from seeking UKRI grant support – a factor reinforced by success rates which are often low. Although the focus and nature of the competitions run by Innovate UK change depending on the Council's research priorities, the contrast between Invest NI and UKRI/Research Council approaches to funding have remained consistent throughout our study period (2006-2016).

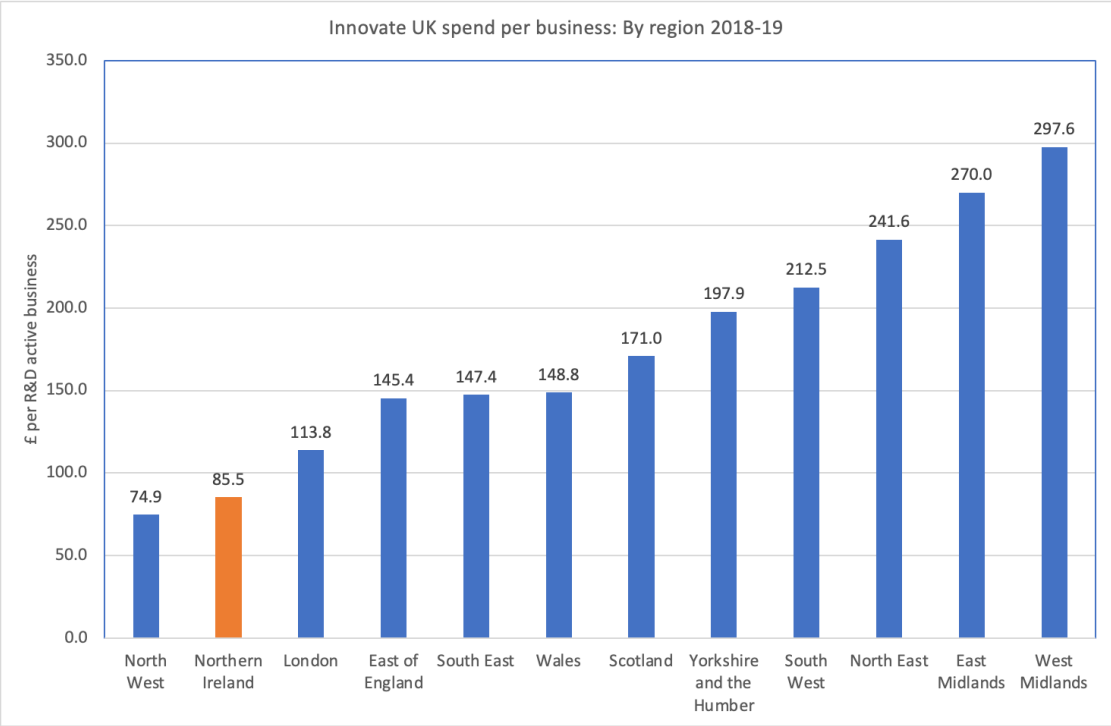
This dual structure means that the funding opportunities for R&D and innovation for firms in NI and the rest of the UK differ significantly. For firms in England support for R&D and innovation is typically only available from UKRI, and predominantly from Innovate UK. For firms in Northern Ireland and the other devolved regions, R&D and innovation support is available both from UK sources such as Innovate UK as well as local sources such as Invest NI. The availability of both regional and national support measures creates the potential for trade-offs and complementarities between support mechanisms and provides firms with multiple funding opportunities for any specific project.

Perhaps as a result of this trade-off or potential substitution, grant support from Innovate UK to Northern Ireland firms is lower than that in almost any other UK region both when calculated on a per business basis and a per R&D active business basis (Figure 4). Indeed, total Innovate UK spend in Northern Ireland in 2018-19 was only £11m (UKRI 2021). This was around a fifth of the value of Invest NI support for R&D and innovation in Northern Ireland companies in 2018-19 (Table 1). Working on the same basis as the Innovate UK figures (i.e. 1,566 R&D active firms), this means that Invest NI spend per R&D active company in NI in 2018-19 was around £33,650. This is a significantly higher level of public grant support than that available in any other UK region and added to the level of Innovate UK support (£7,023 per R&D active company) suggests total support per R&D active business of £40,670 in 2018/19. This is more than twice the level of support for R&D and innovation available to most firms in England (Figure 4b).

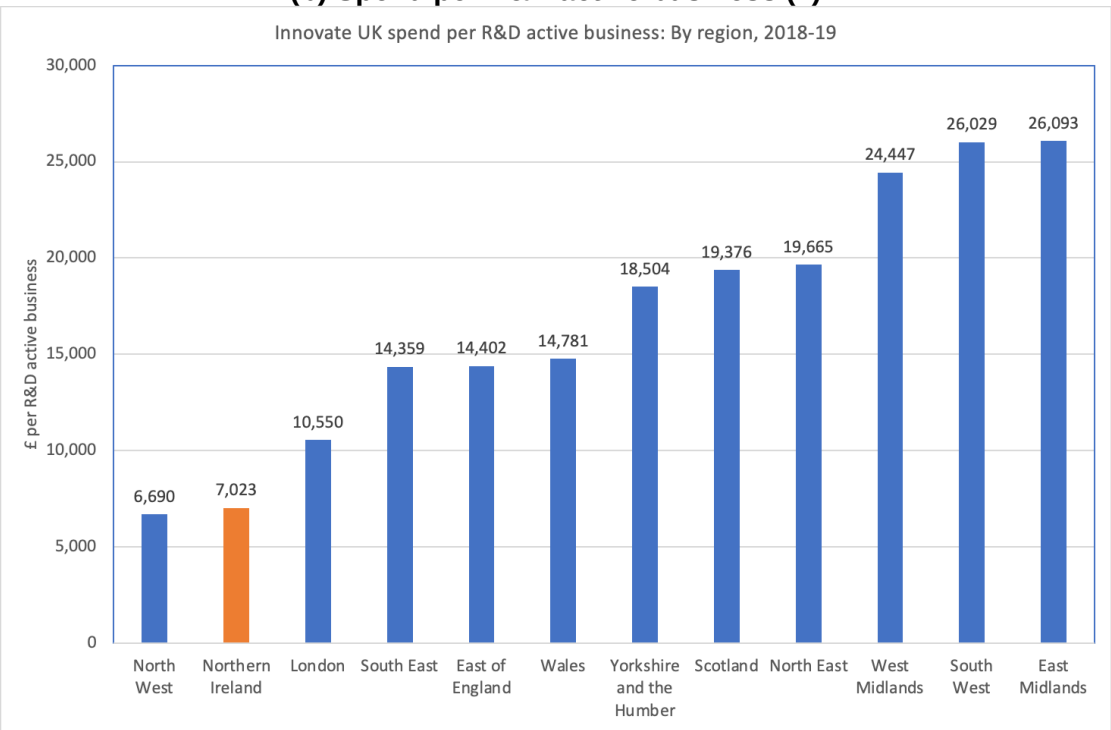
[9] This approach to business support is similar to the Account Management system operated by Scottish Enterprise. Evaluations of the Scottish Account Management system have stressed the value placed by businesses on the relationships involved and pointed to stronger additionality (although with smaller absolute effects) among smaller firms (Slims Consulting 2009).

Figure 4: Innovate UK support for R&D and innovation: 2018-19

(a) Spend per business (£)



(b) Spend per R&D active business (£)



Source: Regional Distribution of UKRI spend, UKRI 2021, Table 2, p. 12

3. Econometric analysis – data and methods

3.1 NI grants data

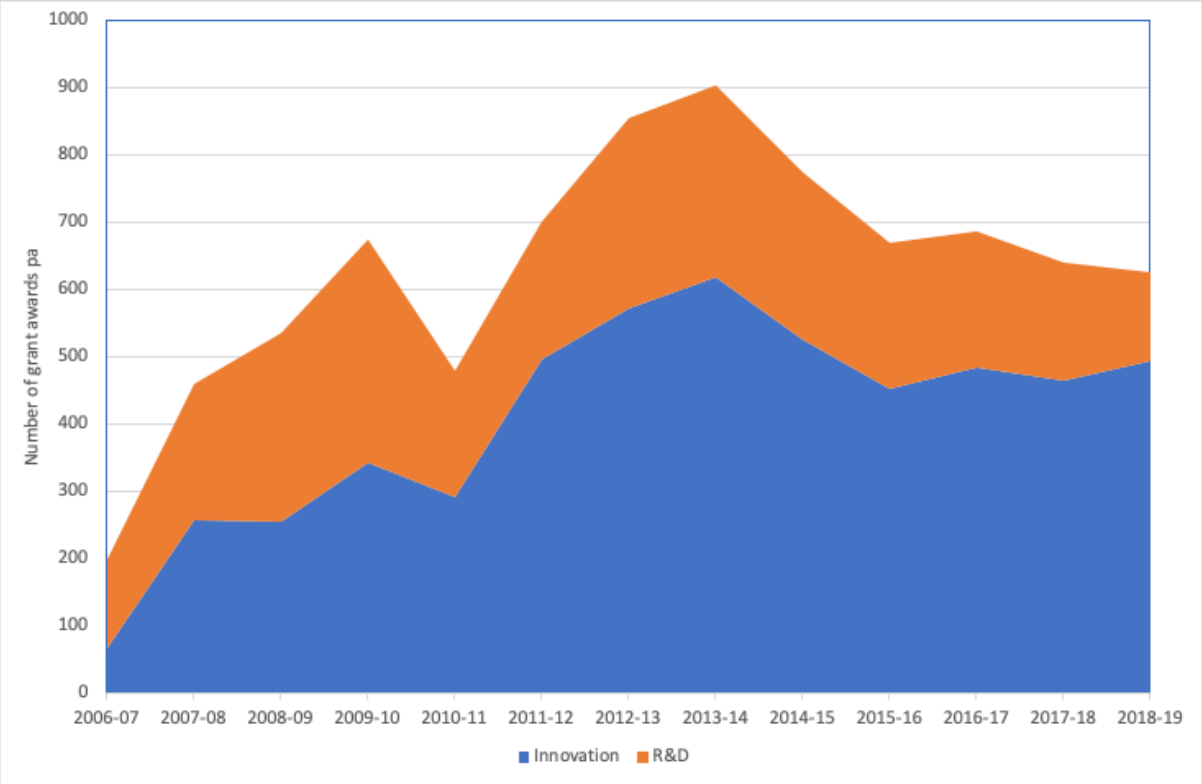
Data on individual grant awards for R&D and innovation was made available by Invest NI covering the period 2006-19. During this period 8,202 awards were made, 5,315 for innovation and 2,887 for R&D (Table 1 and Figure 5). Innovation grants tended to be smaller in value reflecting the inclusion of Innovation Vouchers. For the majority of grant recipients identified in the database, Company Reference Numbers (CRNs) were available. Where these were not included these were added drawing on data from Companies House and the FAME database.

Table 1: Profile of Invest NI grants for innovation and R&D by year of award

	Number of grants			Value of grants £m			Value of projects £m		
	Innovation	**R&D**	**Total**	**Innovation**	**R&D**	**Total**	**Innovation**	**R&D**	**Total**
2006-07	66	132	198	1.0	18.0	19.1	2.6	49.6	52.2
2007-08	258	201	459	2.5	19.3	21.9	9.0	47.9	57.0
2008-09	255	280	535	2.5	27.3	29.7	7.7	68.0	75.6
2009-10	342	333	675	2.7	49.0	51.7	7.8	149.0	156.8
2010-11	290	188	478	1.8	28.8	30.6	5.7	116.8	122.6
2011-12	497	204	701	2.5	19.9	22.4	7.3	61.3	68.6
2012-13	572	283	855	4.5	34.0	38.5	11.4	104.4	115.8
2013-14	617	287	904	3.6	65.2	68.9	9.7	228.7	238.4
2014-15	526	248	774	2.8	39.5	42.3	7.6	123.4	131.0
2015-16	451	219	670	3.0	22.9	25.9	8.6	66.2	74.7
2016-17	483	204	687	3.4	57.9	61.3	9.7	186.7	196.4
2017-18	464	177	641	4.0	39.2	43.2	11.7	132.2	144.0
2018-19	494	131	625	4.3	48.5	52.7	12.1	255.6	267.8
Total	**5,315**	**2,887**	**8,202**	**38.6**	**469.5**	**508.1**	**111.0**	**1589.9**	**1700.9**

Source: Invest NI

Figure 5: Number of Invest NI grants pa: Innovation and R&D



Source: Invest NI

The majority of Invest NI grant awards were either to companies registered in Northern Ireland (65.8 per cent) or GB companies with a Northern Ireland operation or office (15.8 per cent) (Table 2). Of the remainder, 69 awards were made to Irish registered companies (0.8 per cent) or to non-UK firms, subsidiaries of other businesses or other public sector, third sector or educational organisations. This group for which no Company Reference Numbers are available accounted for around 17.5 per cent of all grant payments. On average grant payments to GB registered companies and those in the group with no CRNs were larger than those to NI firms. This may reflect the smaller size of many NI based businesses.

Table 2: Average grant and total investment by category

			Grant	Total investment
	Awards	%	Mean (£)	Mean (£)
No CRN	1,438	17.5	81,981	406,288
NI company	5,395	65.8	42,159	127,241
GB company	1,300	15.8	123,887	326,841
Irish comp.	69	0.8	24,597	77,163
Total	8,202	100.0	61,946	207,379

Source: Invest NI

3.2 UK grants and business performance data

In addition to the Northern Ireland grant data provided by Invest NI, our analysis draws on information on UKRI funded R&D collaborative projects, and firm-level data from the ONS. Data on UKRI funded projects is taken from the Gateway to Research (GtR) website[10] developed by UKRI. GtR provides information on all publicly funded research projects over the 2004 to 2016 period, including data from Innovate UK, the seven Research Councils and the National Centre for the Replacement, Refinement and Reduction of Animals in Research (NC3Rs). GtR also provides information about approximately 34,000 organizations that participated in publicly-funded innovation and R&D projects, including details on the number and value of funded projects, the number and characteristics of partners, the topics and outcomes of the research projects, the value of grants awarded per year, the Research Council providing the funding, and information about each projects' leaders. The GtR data relates solely to the public funding contribution to each project and does not provide any indication of other financial contributions by firms or other organizations.

UK Research Councils provide research funding through a wide range of schemes. The main interventions are grants, university-industry (U-I) collaborations, followed by training grants, fellowships, innovation vouchers and collaborative R&D projects. In most Research Council funded projects, higher education institutions take the role of project coordinators, while collaborators from national and international industry and other organisations participate as non-funded partners. Innovate UK projects aimed at the commercialisation of innovation operate differently, with much of the funding going to private companies inside and outside of the UK.[11] The focus of awards may also be very different across Research Councils, from purely responsive mode where research councils have an open call for high quality research ideas, to more strategic investments which seek projects around a particular theme. Unfortunately, the database reports only the projects successfully funded by Research Councils, not allowing us to control for the selection and rationing process.

Finally, we matched both the Invest NI and the GtR data with firm-level data from the ONS Business Structure Database (BSD), accessed through the UK Data Service and covering the whole population of businesses in the UK between 1997 and 2020 (ONS 2021). The BSD provides information on firms' age, ownership, turnover, employment, industrial classification at the SIC 4-digit level and postcode. We have matched this database with the Invest NI and the GtR data using the Company Reference Numbers (CRNs) provided, gathering firm-level information about almost all the Northern Ireland firms who have participated in Invest NI or UKRI publicly funded research projects, combining in this way information on project participation with firm-level characteristics. After the matching is performed, our final sample represents 66% of the total number of R&D and innovation Invest NI grant beneficiaries, about 61% of the overall amount of grants funded. The final sample excludes those organisations with no CRNs (unmatched or unnamed firms, non-for-profit organizations, etc.), other UK firms not located in Northern Ireland, and other foreign companies.

We first analyse the temporal evolution of Invest NI R&D and Innovation grants for private firms in Figure 6. The number and value of R&D grants increased rapidly from 2006-2009 before stabilising although the number of new R&D awards declined somewhat after 2015.

[10] We abstracted the data for this study between the 2nd and the 5th of January 2017 from the Gateway to Research website available at the following link: https://gtr.ukri.org/

[11] See Vanino et al. (2019) for a more exhaustive analysis of the UKRI grants and their impact on business performance.

The time profile of innovation grants suggests a rather different pattern, peaking around 2014 in terms of the number of awards but increasing steadily in terms of value.

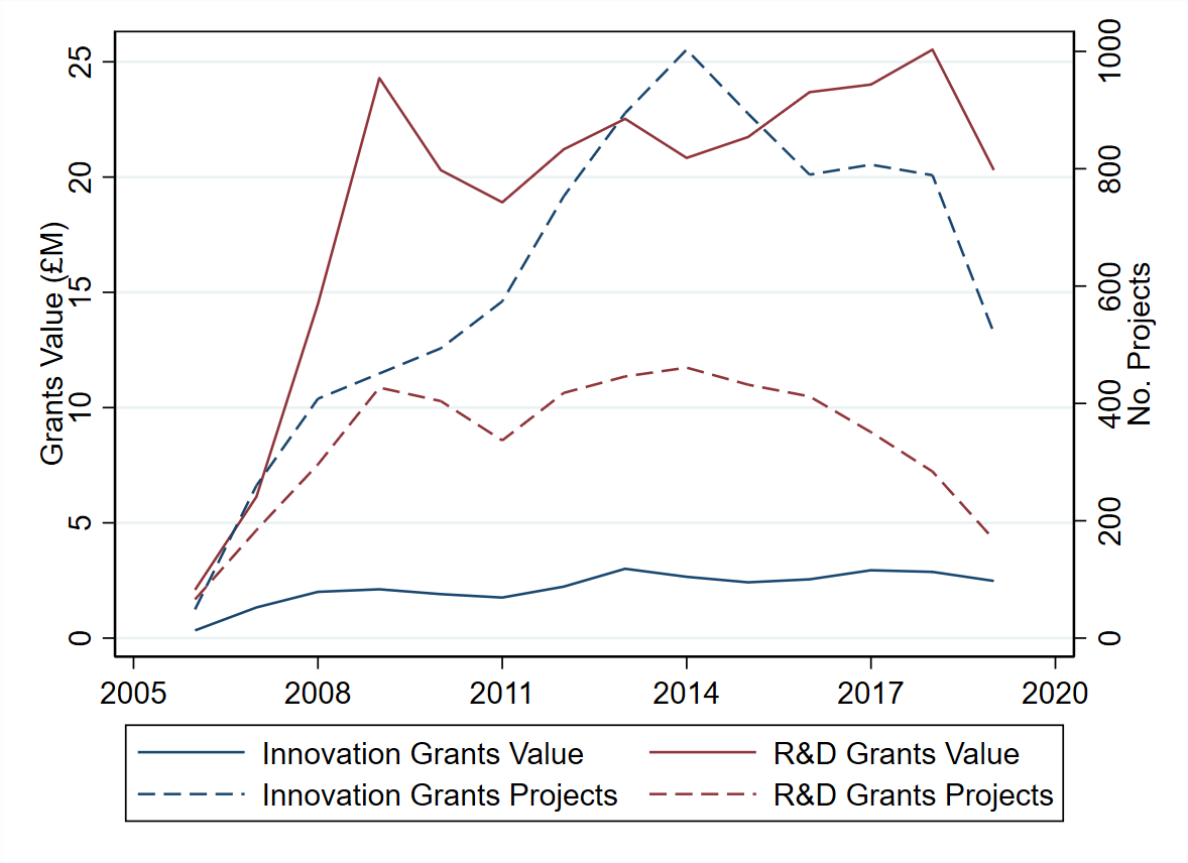


Figure 6: Evolution of Invest NI R&D and Innovation grants for private firms

Notes: Statistics based on administrative data from Invest NI and the ONS Business Structure Database. These statistics are based on the sample of Invest NI supported firms matched with the BSD.

We can then start exploiting the level of detail of these datasets to analyse the characteristics of firms receiving R&D and innovation support from Invest NI. For instance, in Table 3 we see that Invest NI is mainly supporting micro (less than 10 employees) and small enterprises (less than 50 employees), representing more than 85% of all firms supported. This evidence is indicative of the type of activities supported by Invest NI, mainly helping smaller firms to get involved with R&D activities, and with the adoption of new innovation and technologies. If we consider instead the value of grants awarded by firm size distribution, we observe that despite micro firms receiving the largest amount of funding overall, the average grant per company is much smaller than for other supported firms, around £33,000 (Table 3). This is similar in size to small firms, while the average grant per firm is more than double for medium firms (between 50 and 250 employees), while the very few large firms (more than 250 employees) supported usually receive around £450,000 from Invest NI to support their R&D and innovation activities. This is in line with the more general size distribution of firms involved in UKRI funded R&D projects analysed in previous studies (Scandura, 2016, Vanino et al., 2019), where on average, larger firms usually attract a greater value of grant funding.

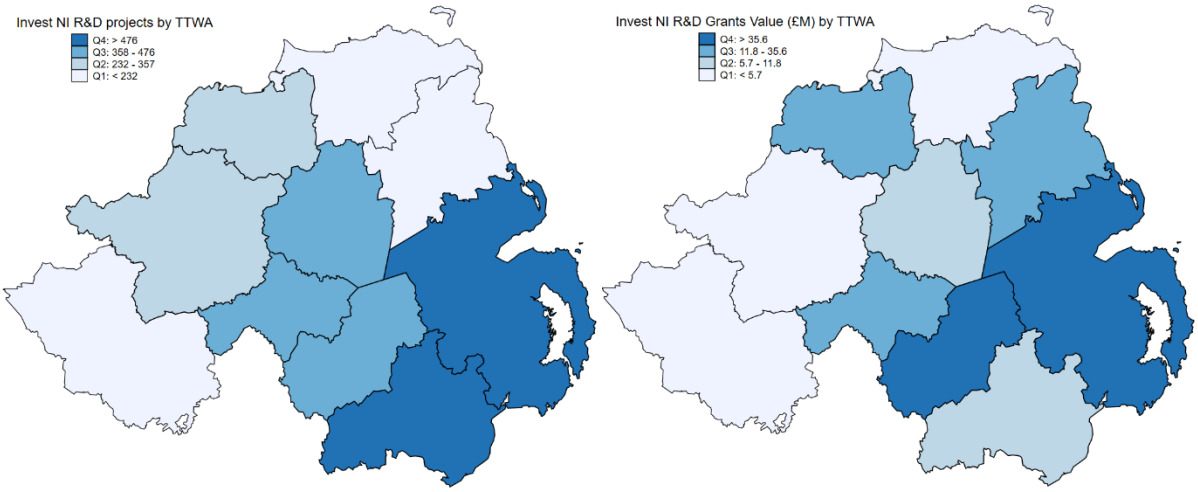
Table 3: Distribution of Invest NI grant funding by firm size

Size	No. Firms	Grants Value (£)	Per-Business Value (£)
Micro	3,228	108,941,848.5	33,750
Small	1,535	67,534,276.8	43,996
Medium	557	40,946,411.6	73,512
Large	137	61,825,157.5	451,278

Notes: Statistics based on administrative data from Invest NI and the ONS Business Structure Database. We define micro enterprises firms with less than 10 employees, small firms with 10-49 employees, medium are firms with 50-250 employees, while large are firms with more than 250 employees.

In Figure 7 we analyse the regional distribution of firms receiving R&D and innovation grants from Invest NI. We can observe that most of the supported projects are located in the areas of Belfast and Newry and Banbridge, while only a limited number of projects are supported in the regions of Ballymena, Coleraine and Enniskillen. However, other than Belfast, it is the region of Craigavon that attracts the largest amount of funding, followed by Dungannon, Ballymena and Derry. This is also evidence of the type of projects and firms supported across regions, where Invest NI seems to support the R&D and innovation activities of mostly micro and small businesses in Newry and Banbridge, while larger companies are mostly supported in Craigavon and Ballymena, based on the average grant value per project in each TTWA.

Figure 7: Regional distribution of Invest NI R&D and Innovation supported projects and grants value.



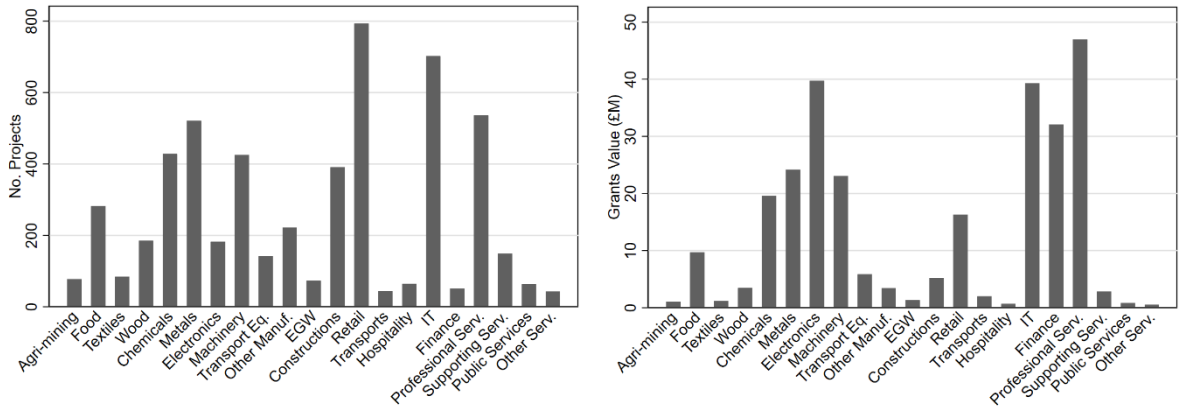
Notes: Statistics based on administrative data from Invest NI and the ONS Business Structure Database mapped across Travel To Work Areas (TTWA)[12].

In Figure 8 we consider the industrial distribution of supported firms and note a strong clustering in relatively few sectors. Here, firms are classified by their primary SIC codes and this may only represent one aspect of a diverse portfolio of activities. For example, firms whose primary SIC codes are in the retail, wholesale and logistics sector ("retail") account for the

[12] Travel to Work Areas (TTWAs) are zones defined where the bulk of their resident population work within the same area. The fundamental criterion used in their creation is that, of the resident economically active population, at least 75 per cent actually work in the area, and also, that of everyone working in the area, at least 75 per cent actually live in the area.

largest number of funded projects. Looking in more detail at the specific companies included here suggests, however, that all of these firms also have manufacturing activities in Northern Ireland, and it is this aspect of their business that would be supported by Invest NI. Other concentrations of support are in IT, professional services and construction in the services industry. In manufacturing industries, the metals, machinery, chemical and food sectors are those attracting the largest number of projects. However, in terms of grants value, the retail, wholesale and logistics sector ("retail") sector attracts only a limited amount of funding, thus receiving small R&D and innovation support from Invest NI but for a large number of smaller grants. On the contrary, most of the funding is attracted by firms in the professional services, the manufacturing of electronics, IT and financial services. This trend is particularly driven by firms in the financial services and manufacturing of electronics sectors, where a very limited number of firms secured few but very large R&D and innovation grants from Invest NI.

Figure 8: Industrial distribution of Invest NI R&D and Innovation supported projects and grants value.



Notes: Statistics based on administrative data from Invest NI and the ONS Business Structure Database. Sectors definition based on the SIC 2007 2-digit industrial classification.

Overall, the differences highlighted above in terms of the distribution of firms supported by Invest NI R&D and innovation grants are quite stark, in particular, in terms of firm size and grants value. This body of evidence calls for a more accurate analysis of these differences, and of their effects on the businesses performance of firms supported by Invest NI, to better understand the role of their R&D and innovation grants in supporting business growth.

3.3 Econometric Methodology

We develop an econometric analysis to evaluate the effect of Invest NI R&D and innovation support on the performance of participating firms, focusing on employment and turnover growth. Receiving an Invest NI R&D and innovation grant cannot be considered an exogenous shock but is very likely to be affected by endogenous factors influencing the self-selection of firms into this kind of activity. To overcome this issue we apply a propensity score matching (PSM) technique at the firm-level, as developed in previous studies facing similar empirical challenges (Scandura 2016; Vanino et al., 2019), creating a suitable control group of non-treated firms which is as similar as possible to the group of treated firms based on the likelihood of being supported by Invest NI. By using a PSM technique we aim to control for selection bias based on observable covariates by comparing treated with comparable untreated firms, while taking into account unobserved heterogeneity by comparing their differences in performance growth before and after the treatment.

Our identification strategy relies on comparing the performance of affected firms before and after receiving the support from Invest NI, compared to the performance of a control group of similar but unsupported Northern Ireland firms. Through the construction of a valid control group based on the observable differences between treated and untreated, our matching approach should control for endogeneity bias. The final step is to assess the average treatment effect on the treated firms, the ATT effect, to estimate the difference in the outcome variables between firms supported by Invest NI and firms which did not, using a linear regression model as developed by Leuven and Sianesi (2017).

Our baseline analysis considers the impact of receiving a R&D and innovation grant from Invest NI in respect to unsupported firms. We focus on the impact of the first grant awarded, in order to better identify this causal effect (Scandura, 2016). We then measure the average growth rate of the outcome variables y^1_{t+n}, employment and turnover[13], as the difference between the pre-treatment log level at time *t-1* and the levels in the short-term 3 years after the treatment, and in the medium-term (MT) 6 years after the treatment.[14] Since we are interested in identifying the differences in firms' performance after the first grant, we can express the average treatment effect (τ_{ATT}) in terms of performance growth after the beginning of the R&D and innovation project at time *t+n* as $E(y^1_{t+n}|\, S_t = 1)$, and the counterfactual performance growth for the same group of firms had they not participated as $E(y^0_{t+n}|\, S_t = 1)$:

$$\tau_{ATT} = E(y^1_{t+n} - y^0_{t+n}|\, S_t = 1) = E(y^1_{t+n}|\, S_t = 1) - E(y^0_{t+n}|\, S_t = 1)$$

where *S* denotes the two groups of firms, *S=1* is the treated group receiving the grant from Invest NI and *S=0* is the untreated group. The fundamental problem is that only one of the two possible cases is observed for each firm, i.e. whether the firm has received the grant $E(y^1_{t+n}|\, S_t = 1)$ or not $E(y^0_{t+n}|\, S_t = 0)$. Hence, we need to build a suitable control group by considering instead the effect of no treatment on the performance growth of similar firms which did not receive the grant.

To build the control group we use a propensity score matching technique to select suitable controls from the very large group of untreated firms, matching observed characteristics as closely as possible to those of treated firms before the beginning of the R&D and innovation project (Vanino et al., 2019). We estimate the probability of receiving the grant, the so-called propensity score, based on a set of relevant observable characteristics which have been found to influence the likelihood of participation in the previous literature. We use a probit model with industry, region and year fixed-effects to estimate the propensity score for all observations, using several covariates which may explain the probability of participation. We include a set of firm-level variables such as employment, turnover, firm age, employment and productivity growth in the 2-years period before the treatment, firms market share, group membership, foreign ownership and single-plant firm dummies to control for firms' characteristics, and the total number of patents owned to control for firms' previous innovation activities.[15] In addition, we take into account other control variables at the industry-region level to control for location and sector specific factors, such as the agglomeration index, the amount of Invest NI grants awarded, employment and turnover per employee.

[13] Due to the limited number of variables included in the BSD database, it is not possible to estimate the impact of Catapults engagement on measures of firms' productivity such as total factor productivity or gross value added.
[14] Superscript 1 in y^1_{t+n} indicates the engagement with Catapults; *n* denotes the number of years after the first engagement.
[15] Data on firms' patents was provided by the UK Intellectual Property Office.

We estimate a separate propensity score for each treatment and sub-sample of interest (see below), in order to take into account the heterogeneous likelihood of being treated, for firms with different characteristics. For the baseline analysis we draw a sample of control untreated firms from the general population of firms operating within the same industry. We then compare the difference in business growth between firms supported by R&D grants or by innovation vouchers, thus considering only companies funded by Invest NI. We then want to compare the effect of being supported by Invest NI or by UKRI. Thus, we first look at the different effect between UKRI supported companies and a sample of NI firms not engaging with UKRI or with Invest NI. Secondly, we compare directly the business growth effect of being supported by Invest NI or by UKRI for R&D and innovation activities. Finally, to study potential crowding-out effects, we estimate the probability of receiving UKRI support for a group of Invest NI funded firms vis-à-vis a control group of firms not funded by Invest NI that have never been supported by UKRI neither. Table 4 reports the results of the propensity score estimation for the baseline analysis of being funded by Invest NI, which are consistent with previous studies. In particular, large and more productive firms seem to be more likely to be funded by Invest NI, in particular younger and domestic-owned companies if located in regions and industry which have already received a large amount of R&D and innovation Invest NI support.

Table 4: Propensity score estimation and balancing test for matched observations in the analysis of receiving support from Invest NI

Variable	Coeff.	S.E.	Treated	Control	Mean Bias	Bias Reduction	T-value	P-value	V(T)/V(C)
Employment	0.4002***	(0.0166)	2.851	2.929	-7.2	91.2	-1.16	0.248	0.67
Productivity	0.1222***	(0.0194)	4.486	4.485	0.1	99.9	0.02	0.985	0.72
Age	-0.243***	(0.0264)	2.768	2.761	0.7	98.4	0.23	0.822	1.03
Employment Growth	0.0270	(0.0318)	0.144	0.187	-9.5	73.8	-1.65	0.100	0.63
Productivity Growth	0.0181	(0.0209)	0.128	0.095	4.0	67.5	0.91	0.362	0.84
Group	-0.044	(0.0454)	0.235	0.250	-4.8	86.3	-0.72	0.474	.
Foreign	-0.229***	(0.0727)	0.077	0.094	-10.9	48.6	-1.35	0.178	.
Agglomeration	0.0004	(0.0027)	2.554	2.717	-3.2	88.3	-0.52	0.602	0.47
Entry Rate	-0.241	(0.7281)	0.008	0.008	-0.4	98.0	-0.11	0.913	1.71
Reg-Ind. Productivity	-0.024	(0.0288)	4.555	4.547	1.2	96.8	0.26	0.794	0.86
Reg-Ind. Employm.	-0.056***	(0.0117)	5.350	5.467	-6.7	85.7	-1.49	0.136	0.81
Market Share	-0.113	(0.0820)	0.159	0.164	-2.3	95.8	-0.34	0.735	0.96
Reg-Ind. NI Grants	0.0274***	(0.0032)	4.226	4.012	2.5	95.4	0.52	0.600	0.54
Single Plant	-0.445***	(0.0787)	0.021	0.029	-1.9	97.5	-1.06	0.291	.
Patents	-0.125	(0.1130)	0.009	0.011	-1.9	75.3	-0.21	0.833	0.53
	No. Obs.	R-sq	Ps R-sq	LR Chi-sq	p-value	Mean Bias	Median Bias	B	R
	288,250	0.2857	0.004	9.26	0.864	3.8	2.5	14.3	0.69

Notes: Propensity score estimation and matching balancing test reported in this table refers to the results shown in Table 3. Estimations and tests for the other analysis are similar and consistent, and available upon request. The second and third columns report the results of the propensity score estimation using a probit model. Robust standard errors (s.e.) reported in parentheses. *** p<0.001, ** p<0.01, * p<0.05. Columns 4 and 5 present the mean value of each control variable for firms in the treated and control groups after the implementation of the matching technique. In column 6 we display the median standard bias across all the covariates included in the logit estimation after the matching procedure. Columns 7 and 8 report the t-tests for the equality of the mean values between treated and untreated firms in the matched sample. Column 9 shows the ratio of variance of residuals orthogonal to linear index of the propensity score in treated group. The bottom row presents a summary of statistics regarding the whole sample: the pseudo R2 from the probit estimation and the corresponding χ^2 statistic and p-value of likelihood-ratio test of joint significance of covariates; the mean and median bias as summary indicators of the distribution of bias across the samples; the Rubin's B shows the absolute standardized difference of means of linear index of propensity score in treated and matched non-treated groups, while the Rubin's R is the ratio of treated to matched non-treated variances of the propensity score index. Finally, the total number of treated and control observations in the support sample is included.

After estimating the propensity scores, we proceed by matching the untreated and treated observations based on this. First, we impose a common support condition, dropping the treated and untreated observations whose propensity scores are larger or smaller than the maximum or minimum of the other category. Secondly, we apply a Nearest-Neighbour matching technique with a strict Caliper bandwidth, matching each treated observation only with the closest untreated observation within a 0.05 range in the propensity score. We restrict the matching to firms located in the same region at the Travel To Work Area (TTWA) level and operating within the same sector at the SIC 2-digit level.[16] Finally, we have clustered the standard errors following the Abadie and Imbens (2011) methodology for the Nearest-Neighbour matching procedure to take into account the additional source of variability introduced by the estimation of the propensity score. Table 2 also reports the results of the balancing tests verifying the consistency of the construction of the control group and the overall quality of the matching procedure. To check the propensity score balancing we report mean differences across the treated and control group for the set of variables used to estimate the propensity score after matching. Where differences between treated and untreated firms were observed before matching, these are significantly reduced after matching. The bias after matching for all covariates is reduced below the 25% critical threshold, and the t-values for differences in the means are not significant, suggesting a consistent and balanced matching, and that there are no systematic differences in the observable characteristics of treated and untreated firms before receiving support from Invest NI. Overall, the matching procedure satisfies the balancing property, suggesting that the conditional independence assumption is not violated, since y^1_{t+n} and y^0_{t+n}, respectively are statistically independent for firms with the same set of exogenous characteristics.

Finally, we are able to estimate a linear regression model following the Leuven and Sianesi (2017) methodology on a pooled cross-sectional dataset where for any given firm we observe the treatment dummy, the propensity score, the different control variables and the dependent variables of employment and turnover growth between period *t-1* and the short-term (*t+2*) and the medium term (*t+5*) periods. We start by estimating the overall effect, before exploring the heterogeneity of this effect by differentiating between firms operating in manufacturing and services sectors, high-tech and low-tech companies,[17] and between micro-small and medium-large enterprises.

By matching based on the propensity score and controlling for year, region and industry fixed-effect, along with other control variables, we get a reliable estimate of the impact of receiving R&D and innovation support from Invest NI. However, it is important to bear in mind the

[16] To test the sensitivity of the matching method, as a robustness check we apply a Kernel matching technique with a strict bandwidth of 0.05, using a kernel-weighted distribution which down-weights the contribution to the outcome of non-treated firms which are further from the propensity score of treated observations within a certain range.

[17] Following the ONS-Eurostat classification, we consider as high-tech firms in the following SIC 2007 industries: (20) chemicals; (21) pharmaceuticals; (26) computer, electronic and optical products; (27) electrical equipment; (28) machinery; (29) motor vehicles; (30) transport equipment; (50) water transports; (51) air transports; (58) publishing activities; (59) motion picture, video and television programme production, sound recording and music publish activities; (60) programming and broadcasting activities; (61) telecommunications; (62) computer programming, consultancy and related activities; (63) information service activities; (64) financial intermediation; (65) insurance; (66) auxiliary activities to financial intermediation; (69) legal and accounting activities; (70) activities of head offices, management consultancy activities; (71) architectural and engineering activities, technical testing and analysis; (72) scientific research and development; (73) advertising and market research; (74) other professional, scientific and technical activities; (75) veterinary activities; (78) employment activities; (80) security and investigation activities; (85) education; (86) human health and social work activities; (90) arts, entertainment and recreation.

limitations of this methodology. First, despite being widely adopted in innovation policy research because of its ability to deal with potential common support problems, propensity score matching does not fully reduce the concerns of unobservable factors explaining grant allocation and post-grant performances. Second, this methodology cannot establish the impact of the treatment beyond the eligible groups of treated and control observations included in the analysis, potentially biasing the estimation of the overall economic effect if these groups are not representative of the entire population.

4. Estimation results

4.1 Do Invest NI R&D and innovation grants support faster growth?

We start in Table 5 with our baseline analysis looking at the short (3 years) and medium term (6 years) effect on employment and turnover growth for firms receiving R&D and Innovation funding from Invest NI. Here, the control group includes comparable non-funded Northern Ireland firms within the same region and industry that have never engaged with the public R&D funding system. The average treatment on the treated (ATT) effects reported in the table suggest the direct impacts of grant support[18]. For example, for the general group of all firms, employment growth over 3 years after the grant award the ATT=0.143, i.e., grant-aided firms grew their employment 14.3% faster than non-grant aided firms. The '***' attached to this ATT estimate in the table suggests this impact is highly statistically significant providing an indication of the robustness of our estimates.

Invest NI R&D and innovation grants have strong and statistically significant impacts on both turnover and employment growth. Grant-aided companies grow employment 14.3% faster after 3 years and 27.2% faster over 6 years than comparable firms and grow turnover faster by 28.2% and 49.3% respectively. These effects are consistent across both manufacturing and services firms and for those both with and without UKRI support. Growth effects are larger for micro and smaller firms, high-tech firms and those in receipt of multiple grants.

Growth impacts are stronger in terms of turnover, growing almost 50% faster in 6 years for all firms. This is particularly relevant for services and high-tech companies, which also experienced employment growth in the medium term (over 6 years) which was 30% faster than non-engaged firms. We note that this effect is particularly strong for micro and small enterprises, while the estimated magnitude is smaller and statistically weaker for medium and large firms. In addition, most of this effect is driven by multi-grant holders, while the effect is much smaller for single-grant holders.

Finally, we show that this effect is robust and similar in magnitude when we exclude firms which have previously also received UKRI R&D supports. This provides strong evidence of the importance of Invest NI R&D and Innovation grants to support local enterprises in their innovative activities, in particular smaller firms, on top of the already available national public R&D funding.

[18] In the baseline analysis we consider the effect of the receipt of a grant as a binary variable. In Table 6 we examine separately the impact of Invest NI Innovation and R&D grants. This provides some insight into the scale of impact of different grant values as R&D grants are significantly larger than Innovation grants.

Table 5: Short (3 year) and medium-term (6 year) employment and turnover growth effect for firms funded by Invest NI R&D and Innovation grants

	ST D.Empl.	*MT D.Empl.*	*ST D.Turn.*	*MT D.Turn.*
		General (N=896)		
ATT	0.1432***	0.2726***	0.2821***	0.4932***
b.s.e.	(0.0201)	(0.0271)	(0.0332)	(0.0448)
		Manufacturing (N=391)		
ATT	0.0970***	0.1892***	0.2326***	0.3350***
b.s.e.	(0.0299)	(0.0400)	(0.0485)	(0.0655)
		Services (N=490)		
ATT	0.1782***	0.3292***	0.3264***	0.4682***
b.s.e.	(0.0275)	(0.0369)	(0.0435)	(0.0612)
		High-Tech (N=261)		
ATT	0.1911***	0.3351***	0.3409***	0.5123***
b.s.e.	(0.0377)	(0.0517)	(0.0683)	(0.0855)
		Low-Tech (N=634)		
ATT	0.1300***	0.2240***	0.2315***	0.3417***
b.s.e.	(0.0227)	(0.0308)	(0.0348)	(0.0468)
		Micro-Small (N=730)		
ATT	0.1728***	0.3194***	0.2670***	0.4563***
b.s.e.	(0.0221)	(0.0303)	(0.0376)	(0.0515)
		Medium-Large (N=161)		
ATT	0.1302**	0.2602***	0.0688	0.2550**
b.s.e.	(0.0559)	(0.0741)	(0.0886)	(0.1142)
		Single-Grant (N=278)		
ATT	0.0471	0.0849*	0.2095***	0.2211***
b.s.e.	(0.0331)	(0.0470)	(0.0616)	(0.0784)
		Multi-Grant (N=618)		
ATT	0.1677***	0.2948***	0.2763***	0.4751***
b.s.e.	(0.0238)	(0.0318)	(0.0387)	(0.0525)
		No UKRI (N=862)		
ATT	0.1676***	0.2731***	0.2918***	0.4315***
b.s.e.	(0.0198)	(0.0271)	(0.0315)	(0.0437)

Notes: Estimation based on administrative Invest NI data, Gateway to Research (GtR) and the Business Structure Database (BSD). ATT effect estimated using a propensity score nearest-neighbour matching procedure. Bootstrapped Abadie and Imbens (2011) standard errors (b,s.e.) reported in parentheses. *** p<0.001, ** p<0.01, * p<0.05. Short-term refers to growth between t-1 and t+2, medium-term between t-1 and t+5. Number of treated observations reported in title parentheses. The number of control observations included in each subgroup is equal to the number of treated.

4.2 Does the growth effect of INI R&D and innovation grants differ?

We further distinguish in Table 6 between different types of support provided by Invest NI, looking at the estimated difference in short and medium term employment and turnover growth between firms supported by Invest NI in terms of R&D grants or innovation grants. These two types of grants in fact are focusing on different types of R&D activities, the former focusing

more on abstract research, while the latter more on applied and commercial research. In this case, we take into account only companies funded by Invest NI, considering as "treated" firms supported by R&D grants, while including in as "untreated" the larger group of comparable firms that have received only innovation vouchers.

We observe no significant difference between the impact of R&D and innovation grants on turnover growth (Table 6). We can observe that the only statistically significant difference in the effects on supported businesses between these two types of funding is on medium-term employment growth. In fact, larger and longer-term R&D grants seem to trigger a more sustained employment growth in the medium-term by almost 14% in respect to innovation grants, but only for medium-large companies in high-tech sectors, the main beneficiaries of this type of support.

Table 6: Difference in short and medium term employment and turnover growth effect for firms receiving R&D grants or innovation grants from Invest NI

	ST D.Empl.	*MT D.Empl.*	*ST D.Turn.*	*MT D.Turn.*
		General (N=339)		
ATT	0.0398	0.1453*	-0.015	0.0888
b.s.e.	(0.0454)	(0.0817)	(0.1039)	(0.1351)
		Manufacturing (N=183)		
ATT	-0.039	0.0156	-0.101	0.0123
b.s.e.	(0.0648)	(0.0794)	(0.0980)	(0.1059)
		Services (N=149)		
ATT	-0.025	-0.004	-0.108	-0.049
b.s.e.	(0.0719)	(0.1197)	(0.1277)	(0.1931)
		High-Tech (N=146)		
ATT	0.0136	0.1272**	0.1933	0.3319
b.s.e.	(0.1191)	(0.0734)	(0.2989)	(0.4292)
		Low-Tech (N=191)		
ATT	0.0619	0.0965	0.0641	0.1196
b.s.e.	(0.0535)	(0.0824)	(0.0897)	(0.1015)
		Micro-Small (N=253)		
ATT	-0.002	0.0235	-0.084	0.0155
b.s.e.	(0.0492)	(0.0727)	(0.0975)	(0.1251)
		Medium-Large (N=66)		
ATT	-0.004	0.1797*	0.0417	0.1787
b.s.e.	(0.1007)	(0.1057)	(0.1181)	(0.1461)

Notes: Estimation based on administrative Invest NI data, Gateway to Research (GtR) and the Business Structure Database (BSD). ATT effect estimated using a propensity score nearest-neighbour matching procedure. Bootstrapped Abadie and Imbens (2011) standard errors (b,s.e.) reported in parentheses. *** p<0.001, ** p<0.01, * p<0.05. Short-term refers to growth between t-1 and t+2, medium-term between t-1 and t+5. Number of treated observations reported in title parentheses. The number of control observations included in each subgroup is equal to the number of treated.

4.3 Do UKRI grants support faster growth in NI firms?

The following step is to compare the effectiveness in supporting business growth between national R&D support provided by UKRI and regional R&D funding schemes operated by

Invest NI. To do this, we first check in Table 7 the difference in business performance between companies in Northern Ireland funded by UKRI and a control group of comparable NI firms within the same region and industry that have never been supported neither by UKRI nor by Invest NI.

Despite identifying only a limited number of UKRI supported firms in Northern Ireland, we can see that national UKRI R&D funding plays an important role in fostering employment and turnover growth in this region, in particular for firms operating in high-tech services. The estimated magnitude of this effect is significantly larger than for the rest of the UK, as shown previously by Vanino et al. (2019), suggesting how the support of national public R&D funding could be particularly beneficial to foster business growth in peripheral regions of the country, like Northern Ireland. Results here need to be regarded as somewhat tentative due to the small number of companies involved.

Table 7: Short and medium term employment and turnover growth effect for firms funded by UKRI grants in Northern Ireland

	ST D.Empl.	*MT D.Empl.*	*ST D.Turn.*	*MT D.Turn.*
		General (N=49)		
ATT	0.1714	0.4588***	0.4533***	0.6949***
b.s.e.	(0.1171)	(0.1565)	(0.1526)	(0.1850)
		Manufacturing (N=25)		
ATT	0.3236**	0.6387***	0.3666***	0.5755***
b.s.e.	(0.1381)	(0.1475)	(0.1429)	(0.1649)
		Services (N=21)		
ATT	0.1650	0.5647**	0.7548***	1.2470***
b.s.e.	(0.1865)	(0.2627)	(0.2809)	(0.4284)
		High-Tech (N=18)		
ATT	0.4291**	0.8723***	0.8884***	1.3205***
b.s.e.	(0.2119)	(0.2602)	(0.3103)	(0.3877)
		Low-Tech (N=28)		
ATT	0.4220***	0.7188***	0.3743*	0.7149***
b.s.e.	(0.1642)	(0.2557)	(0.1917)	(0.2569)
		Micro-Small (N=22)		
ATT	0.2784**	0.5976***	1.0888**	0.7991**
b.s.e.	(0.1418)	(0.2197)	(0.5054)	(0.3117)
		Medium-Large (N=25)		
ATT	0.4520**	0.6592***	0.6165***	0.7765***
b.s.e.	(0.2044)	(0.2082)	(0.2205)	(0.2341)

Notes: Estimation based on administrative Invest NI data, Gateway to Research (GtR) and the Business Structure Database (BSD). ATT effect estimated using a propensity score nearest-neighbour matching procedure. Bootstrapped Abadie and Imbens (2011) standard errors (b,s.e.) reported in parentheses. *** p<0.001, ** p<0.01, * p<0.05. Short-term refers to growth between t-1 and t+2, medium-term between t-1 and t+5. Number of treated observations reported in title parentheses. The number of control observations included in each subgroup is equal to the number of treated.

4.4 Does UKRI or INI support have the strongest effect on growth?

In Table 8 we formally estimate whether there are significant differences in the performance of businesses supported by regional Invest NI schemes or by the national UKRI funding. In this case, we consider as "treated" firms that have been supported by Invest NI grants, and we compare them with a control group of similar firms which have been awarded a UKRI funded R&D grant.

Overall, we see few consistent differences in the impact of regional and national R&D and innovation support measures. However, each type of support proves important for different groups of firms. We can see that businesses supported by regional Invest NI grants perform better than UKRI supported businesses only in low-tech sectors. In particular, regional R&D grants are much more effective than national UKRI funding in supporting micro and small firms. On the contrary, national UKRI support is more beneficial overall in terms of turnover growth in the medium term. This is particularly true for high-tech and medium-large companies, even if companies received only one R&D grant from UKRI.

Despite being based on a limited number of observations, this evidence could corroborate the complementarity between regional and national R&D support schemes. In fact, a potential interpretation of these results is that regional supporting schemes could mainly benefit smaller firms in low-tech industries through smaller scale innovation grants, by helping them to adopt new technologies and commercialise new innovations. On the other contrary, national R&D funding could be more appropriate to support medium-large firms in high-tech sectors, supporting larger scale collaborations with universities and other private partners for the development of more advanced and risky research projects.

Table 8: Difference in short and medium term employment and turnover growth between firms funded by Invest NI or by UKRI.

	ST D.Empl.	*MT D.Empl.*	*ST D.Turn.*	*MT D.Turn.*
		General (N=158)		
ATT	0.0761	0.0299	-0.120	-0.339*
b.s.e.	(0.0916)	(0.1441)	(0.1630)	(0.2045)
		Services (N=117)		
ATT	0.1549*	0.0906	-0.079	-0.229
b.s.e.	(0.0824)	(0.1400)	(0.1962)	(0.2395)
		High-Tech (N=28)		
ATT	-0.126	-0.497**	-0.384	-0.636
b.s.e.	(0.1517)	(0.2264)	(0.3490)	(0.6742)
		Low-Tech (N=81)		
ATT	0.3928***	0.4731**	0.4304***	0.5183**
b.s.e.	(0.1024)	(0.1994)	(0.1297)	(0.2386)
		Micro-Small (N=132)		
ATT	0.1228*	0.2147**	0.0673	0.2413
b.s.e.	(0.0784)	(0.1069)	(0.1368)	(0.4158)
		Single-Grant (N=76)		
ATT	-0.005	-0.499**	-0.764**	-1.201***
b.s.e.	(0.2383)	(0.2191)	(0.3039)	(0.3804)
		Multi-Grant (N=90)		
ATT	0.1483*	0.0696	-0.203	-0.028
b.s.e.	(0.0900)	(0.1424)	(0.3448)	(0.3665)

Notes: Estimation based on administrative Invest NI data, Gateway to Research (GtR) and the Business Structure Database (BSD). ATT effect estimated using a propensity score nearest-neighbour matching procedure. Bootstrapped Abadie and Imbens (2011) standard errors (b,s.e.) reported in parentheses. *** p<0.001, ** p<0.01, * p<0.05. Short-term refers to growth between t-1 and t+2, medium-term between t-1 and t+5. Number of treated observations reported in title parentheses. The number of control observations included in each subgroup is equal to the number of treated.

4.5 Does receiving INI support increase the probability of receiving UKRI support?

Finally, we further explore the potential complementarity between regional and national R&D public support schemes by analysing in Table 9 whether the support of Invest NI R&D and innovation funding could help Northern Ireland companies to apply and successfully secure R&D grants from UKRI. To estimate this, we consider as treated firms that have received an Invest NI R&D and innovation grant, while the control group consists of firms that have never been funded by Invest NI and have not previously received R&D support by UKRI.

Our findings corroborate this hypothesis, identifying particularly higher probabilities of securing national UKRI funding for firms previously supported by regional Invest NI schemes operating in high-tech sectors (+3.3%), especially for medium-large companies (+6.6%), and those which managed to secure multiple R&D grants from Invest NI (+2.6%). This is additional evidence in favour of the complementarity hypothesis, showing how regional R&D support schemes could be used to better prepare future applications, and leverage additional funding from national UKRI R&D public support.

Table 9: Effect of regional Invest NI R&D and innovation support on the short and medium term probability of securing national UKRI R&D funding.

	ST P(UKRI)	*MT P(UKRI)*	*ST P(UKRI)*	*MT P(UKRI)*
	General (N=1332)		Micro-Small (N=1119)	
ATT	0.0142***	0.0187***	0.0116***	0.0142***
b.s.e.	(0.0043)	(0.0047)	(0.0036)	(0.0039)
	Manufacturing (N=540)		Medium-Large (N=210)	
ATT	0.0203***	0.0240***	0.0476***	0.0666***
b.s.e.	(0.0074)	(0.0081)	(0.0161)	(0.0184)
	Services (N=773)		Single-Grant (N=539)	
ATT	0.0103**	0.0155***	0.0018	0.0001
b.s.e.	(0.0044)	(0.0051)	(0.0039)	(0.0043)
	High-Tech (N=385)		Multi-Grant (N=793)	
ATT	0.0233**	0.0337***	0.0189***	0.0264***
b.s.e.	(0.0105)	(0.0115)	(0.0069)	(0.0078)
	Low-Tech (N=945)			
ATT	0.0126***	0.0148***		
b.s.e.	(0.0039)	(0.0044)		

Notes: Estimation based on administrative Invest NI data, Gateway to Research (GtR) and the Business Structure Database (BSD). ATT effect estimated using a propensity score nearest-neighbour matching procedure. Bootstrapped Abadie and Imbens (2011) standard errors (b,s.e.) reported in parentheses. *** p<0.001, ** p<0.01, * p<0.05. Short-term refers to the t-1 and t+2 period, while medium-term between t-1 and t+5. Number of treated observations reported in title parentheses. The number of control observations included in each subgroup is equal to the number of treated.

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