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Knowledge to Money: Assessing the Business Performance Effects of Publicly Funded R&D Grants[1]

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INTRODUCTION

Through its publicly funded Research Councils (UKRCs), the UK invests around GBP 3 billion per year in supporting R&D and innovation. This investment is set to increase sharply in future years as the Industrial Strategy Challenge Fund – announced in the government's 2016 Autumn Statement – is steadily expanded to an additional GBP 2 billion per year by 2020. Of particular importance in terms of business engagement in the UK Research Councils are Innovate UK, which provides grants to firms and other organizations to support innovation, and the Engineering and Physical Science Research Council (EPSRC), which funds university research, often in collaboration with industry.

To date, assessments of the impact of UK Research Council grants have been largely partial and case based. Where quantitative assessments of impact have been attempted, they have often relied on the limited information available in innovation surveys or focused on specific elements of the public science system. However, several previous reviews provide evidence from a range of countries on the positive role of research grants, subsidies, and tax credits in helping firms to innovate successfully (Zuniga-Vicente et al. 2014; Becker 2015; Dimos and Pugh 2016). A more limited strand of the literature looks at the impact of R&D subsidies and programs on the overall performance of firms, taking into consideration turnover or productivity growth (Belderbos et al. 2004; Cin et al. 2017). Although somewhat mixed, this literature has generally supported the existence of a positive relationship between public R&D support, innovation, and firms' growth (Aguiar and Gagnepain 2017).

Here, for the first time we link data on all UK Research Council grants with longitudinal data on the performance of all UK firms to assess the impacts on business growth of participating in UK Research Council funded projects but also to explore how growth impacts vary depending on firm characteristics, project participants, and the particular Research Council providing finance. Our results show that participating in Research Council projects had a positive impact on firms' growth although, as expected, this effect varies depending on the nature of the participating firm, the characteristics of project participants, and the funder.

PUBLIC FUNDING FOR R&D AND INNOVATION IN THE UK – THE UK RESEARCH COUNCILS

Our analysis covers the years 2006 to 2016, a period during which there were significant changes in the UK innovation and industrial policy landscape (Hildreth and Bailey 2013). In England, Regional Development Agencies (RDAs) originally established by the Labour government (1998–2002) were abolished in 2010–12, leading to a centralization of innovation policy in what is now Innovate UK. Innovate UK projects aim to support innovation in firms; competitive grant funding is provided directly to private companies often for collaborative projects.

Changes in innovation support policy in the UK have been accompanied by relative stability in the provision of public funding for university R&D and collaborative basic research. The UK's seven Research Councils[2] vary in size, with the most significant in terms of business engagement being the Engineering and Physical Sciences Research Council (EPSRC). Originally established in 1994, by the end of our study period EPSRC had an annual budget of around GBP 900 million, which is used to fund research (c. GBP 700 million) and training and fellowship grants (c. GBP 200 million) (EPSRC 2015). Individual EPSRC research projects are university-led, often involving business collaborators, and are selected for funding on a competitive basis. EPSRC funding is provided only to university partners, with business partners either making financial or in-kind contributions (e.g., equipment use or staff time) to a project. Evidence of the impact of EPSRC support on participating firms is relatively limited, although Scandura (2016) provides evidence of input additionality in terms of both R&D expenditure and employment two years after the end of EPSRC projects.

A breakdown of the total number and value of projects supported by the UK Research Councils over the period 2004–2016 by funding source is provided in Figure 1. Over 13 years, the UK Research Councils funded more than 70,000 research projects, allocating almost GBP 32 billion. The largest funders were the Engineering and Physical Sciences Research Council (EPSRC), supporting 22 percent of total projects and allocating almost 30 percent of the overall funds available, followed by the Medical Research Council – funding only

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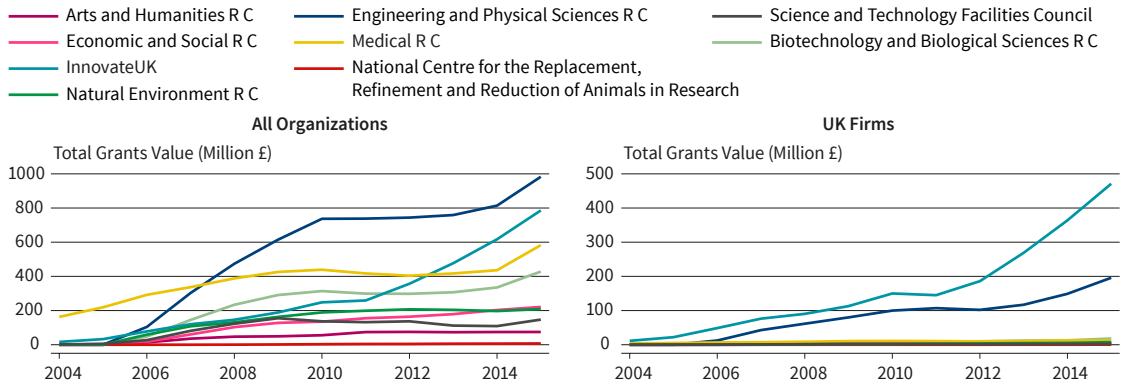
[2] That is the Arts and Humanities Research Council (AHRC), the Biotechnology and Biological Sciences Research Council (BBSRC), the Economic and Social Research Council (ESRC), the Engineering and Physical Sciences Research Council (EPSRC), the Medical Research Council (MRC), the Natural Environment Research Council (NERC).

Figure 1

Total Grants Value per Research Council (RC)



Note: Statistics based on Gateway to research (GtR) data for the period 2004-2016.
Source: GtR Data (2004–2015).

10 percent of the total number of projects but accounting for more than 22 percent of the total value – and Innovate UK, responsible for the support of almost 20 percent of all projects and allocating more than 15 percent of all resources.

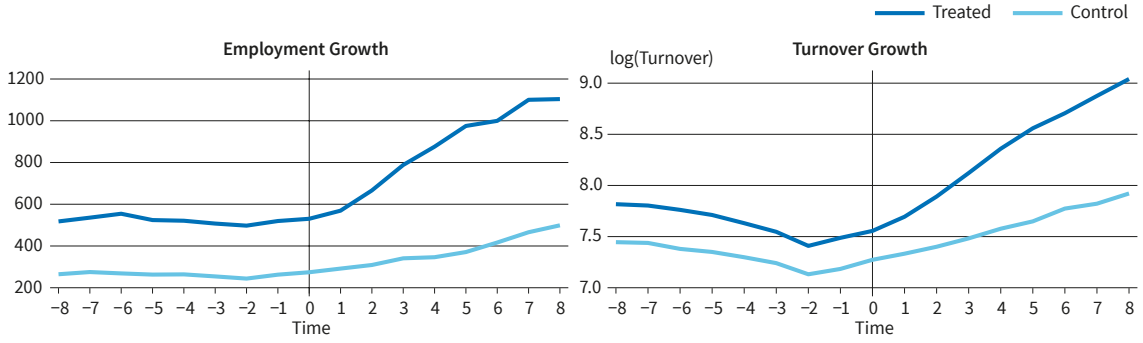
IDENTIFYING THE BUSINESS PERFORMANCE EFFECTS OF THE RESEARCH COUNCILS

A significant hurdle in the identification of the causal relationship between R&D grants are non-random allocation decisions and the self-selection of firms into this kind of program. To overcome these issues, we apply a propensity score matching (PSM) technique at the firm level to create a suitable control group of non-treated firms that is as similar as possible to the group of treated firms based on the likelihood of receiving the treatment (Caliendo and Kopeinig 2008). We estimate the probability that any firm participates in a publicly funded research project, the so-called propensity score, based on a large set of relevant observable characteristics, which have been found to influence the likelihood of participation in the previous literature. These include firm-level variables such as employment, employment squared, turnover, firm age, employment, and productivity growth in the 2-year period before the projects have been awarded, firms' market share, group membership, foreign ownership, and single-plant firm dummies to control for firms' characteristics, and the total number of patents to control for firms' previous innovation activities. In addition, we include a number of variables to reflect the characteristics of the local business ecosystem.

We then compare the performance of participating firms before and after their participation in publicly funded projects compared to the difference in performance of a control group of similar but non-participating firms over the same period. This approach is known as difference-in-difference. Note that firms in our sample may have received Research Council grants in any year between 2006 and 2016, and although they may have participated in more than one project, we focus on the impact of the first project in order to better identify the causal effect of receiving public support while

Figure 2

Employment and Turnover Trends for Treated and Untreated Firms Before and After the Beginning of the UK Research Council Funded Projects (t=0)



Note: Statistics based on Gateway to Research (GtR) and the Business Structure Database (BSD) for the period 2004-2016. Average value of employment and turnover for treated observations reported up to 8 years before and after the treatment year t=0.
Source: GtR Data (2004–2015).

getting rid of other externalities and learning processes occurring during the implementation of a project (Scandura, 2016).

After estimating the propensity score, our final sample contains almost 6,000 UK firms participating in their first R&D project funded by UKRCs and an equal number of similar untreated firms included in the control group. Figure 2 plots the time trends for the two main outcome variables for the pre-project and treatment periods for all firms in our dataset. In the pre-project period, i.e., before the beginning of the UK Research Council funded projects at time *t=0*, the outcome variables employment and turnover exhibit very similar trends to the group of untreated firms.

Table 1

Impact of Participation in Publicly Funded Research on UK firms' Performance – Average Treatment Effects (ATTs) Using Two Alternative Estimation Approaches

	General		General - Kernel	
	Short-term	Medium-term	Short-term	Medium-term
Employment	0.0483***	0.207***	0.0642***	0.171***
	(0.0101)	(0.0196)	(0.0071)	(0.0121)
Turnover	0.0763***	0.231***	0.0892***	0.252***
	(0.0182)	(0.0371)	(0.0173)	(0.0299)
No. Treated	5662	3668	5662	3668

Notes: Estimation based on Gateway to Research (GtR) and the Business Structure Database (BSD) for the period 2004-2016. ATT effect estimated using a propensity score nearest-neighbour matching procedure. Abadie and Imbens (2011) standard errors (s.e.) reported in parentheses for the Nearest-Neighbour matching, while bootstrapped standard errors for the Kernel matching. *** p<0.001, ** p<0.01, * p<0.05. The number of firms included in the treated group is reported. Short-term (ST) refers to growth between t-1 and t+2, medium-term (MT) between t-1 and t+5. Source: Authors' calculations (2019).

EMPIRICAL RESULTS

Columns 1 and 2 in Table 1 show that participating in projects funded by Research Councils has a positive impact on firms' employment and turnover growth in our general sample, both in the short and medium term. Employment grows on average 4.8 percent faster in treated firms in the 3 years following the award, and almost 21 percent in the medium term. Turnover growth is also positively affected by participation, increasing in the short term by almost 7.6 percent and 23 percent in the medium term. These findings are in line with the previous literature, explaining the larger effect in the medium term due to the time needed to develop new R&D activities after the start of a research project and to commercially exploit the results of new innovations (Barajas et al. 2012; NESTA 2012; Dimos and Pugh 2016).

Overall, we also find that participation in RC-funded projects has a similar effect on the employment growth of firms in both manufacturing and services industries, increasing it by around 24 percent after 6 years. However, the impact on turnover growth is greater for manufacturing companies, increasing by almost 31 percent in the medium term, compared to only 19.5 percent in service firms. Differentiating between high-tech/low-tech manufacturing firms and between Knowledge Intensive Services (KIS) and non-KIS companies, we find that the effects on employment are relatively similar for high-tech compared with low-tech manufacturing firms, while the substantial effects on medium-term turnover growth, almost 30 percent, are experienced only by high-tech firms. This latter result is similar to what might be anticipated on the basis of the previous literature (Love et al. 2011; Bellucci et al. 2016). Participating firms in KIS sectors benefit substantially more in terms of both short-term and medium-term employment compared with those in non-KIS sectors, 25 percent versus 11 percent in the medium term, for example, while here turnover growth effects are more balanced between the two groups of firms. Overall, these results suggest that participation in publicly funded research projects has a positive effect even on the performance of firms in sectors with low average R&D intensity, however only in the medium term.

We also considered the effect of different project characteristics on the performance of participating firms. In particular, we consider the number of projects in which firms participated, the number and characteristics of participants, and the value of project grants.

- We find a stronger positive impact for participants in multiple projects (rather than one project), increasing their size by almost 30 percent and their turnover by 36 percent six years after the beginning of their first Research Council-funded project.
- The number of partners in Research Council-funded projects has little effect on subsequent employment growth. Larger projects with more partners do have some beneficial influence only on turnover growth.
- About 25 percent of the treated firms in our sample participated in Research Council-funded projects that involved one or more foreign partners. With regard to turnover growth over a medium-term horizon, external knowledge introduced by foreign partners and leaders seems to be conducive to better performance for participating domestic firms.

RESEARCH COUNCILS COMPARED

Our data also allows us to analyze the effectiveness of research projects funded by different UK Research Councils in accelerating the growth of participating firms. We focus our attention mainly on the grants awarded by the two main bodies responsible for the

Table 2

Impact of Participation in Publicly Funded Research on UK Firms' Performance – Average Treatment Effects (ATTs) for EPSRC and Innovate UK

	EPSRC		Innovate UK	
	Short-term	Medium-term	Short-term	Medium-term
Employment	0.0618**	0.242***	0.0437***	0.165***
	(0.0239)	(0.0428)	(0.0102)	(0.0204)
Turnover	0.163***	0.266***	0.0353*	0.175***
	(0.0441)	(0.0741)	(0.0198)	(0.0388)
No. Treated	931	723	4160	2471

Notes: Estimation based on Gateway to Research (GtR) and the Business Structure Database (BSD) for the period 2004-2016. ATT effect estimated using a propensity score nearest-neighbour matching procedure. Abadie and Imbens (2011) standard errors (s.e.) reported in parentheses for the Nearest-Neighbour matching, while bootstrapped standard errors for the Kernel matching. *** p<0.001, ** p<0.01, * p<0.05. The number of firms included in the treated group is reported. Short-term (ST) refers to growth between t-1 and t+2, medium-term (MT) between t-1 and t+5. Source: Authors' calculations (2019).

largest part of grants involving private firms: Innovate UK and the Engineering and Physical Science Research Council (EPSRC). The performance impact on firms participating in R&D projects supported by these two bodies could differ systematically from each other given the different focus and target of their policy intervention. Innovate UK provides support to private firms with a focus on reducing R&D risks, enabling and supporting business innovation and the commercialization of R&D outputs. By contrast, the EPSRC focuses mainly on the support of universities' basic and applied research, i.e., well before the commercialization phase of innovation, and extends only to private firms that collaborate with funded universities in University-Industry partnerships.

Firms involved in projects funded by EPSRC seem to benefit strongly in terms of both employment and turnover growth, increasing their scale by 24 percent in respect to comparable non-treated firms six years after the start of the project, while experiencing turnover growth by 26 percent after six years. Firms supported by Innovate UK experience smaller short-term and medium-term performance gains, both in terms of employment and turnover.

We further explored the heterogeneity of the EPSRC and Innovate UK by comparing projects involving and not involving a university partner. Contrary to expectations, we find larger impacts on both employment and turnover growth in the short and medium term for firms participating in Innovate UK projects that do not involve a university partner. One possibility is that these non-university Innovate UK projects are closer to market than those involving universities, and that this leads to stronger commercial impacts on participating firms in the short and medium term. It is difficult from our data, however, to identify the precise nature of the R&D being conducted as part of any specific project, so this interpretation remains somewhat speculative.

CONCLUSIONS

Over the past decade, UK Research Councils have invested more than GBP 3 billion per year in supporting R&D and innovation projects. In this study for the first time, we provide a comprehensive assessment of UK public support for R&D and innovation, assessing the impact of participation in publicly funded research grants on the performance of UK firms. Our analysis suggests four main conclusions, which prove robust across a range of different estimation methods and techniques. First, firms involved in UKRC-funded projects grew around 6 percent faster in the short term and 22 percent in the medium term than similar firms that did not participate in UK Research Council projects. Second, this effect is stronger in the most R&D intense regions and industries, in particular for smaller and less productive firms. Third, benefits from publicly funded R&D projects are significant in particular when collaborating with domestic and industrially related partners, regardless of the number or size of projects. Fourth, business growth is mainly driven by EPSRC and Innovate UK support, with a particularly relevant role played by Innovate UK in fostering SMEs' growth after the closure of the Regional Development Agencies in 2012.

Overall, our analysis shows that public support by Research Councils has a strong positive impact on participating firms' growth in the short and medium term. Our results reinforce those of other studies which have suggested – albeit on the basis of a more partial and largely case-based assessment – the benefits of public support for private R&D and innovation. Our analysis also suggests new insights related to how the characteristics of grant recipients, and the nature of research collaboration, affect the impact of public support. For the UK, where recent policy announcements point to significant increases in public support for private R&D and innovation in future years, our central results are reassuring: increasing levels of public support for R&D and innovation will have significant effects on future growth.

Our sub-sample results, however, raise some questions about whether the current focus of R&D and innovation policy in the UK is consistent with maximizing additionality. Policy in the UK currently focuses on supporting excellence in R&D and innovation, with resources allocated primarily through thematic competitions for funding. This results in a concentration of support in high-productivity businesses. Indeed, during our study period, 65 percent of public support for

business R&D and innovation in the UK was allocated to firms in the top quartile of the productivity distribution. Our results suggest that support provided to these already highly productive firms has limited additionality and growth effects. Additionality would be greater where support can be allocated to smaller firms with lower pre-award productivity. The size of grants – relative to the size of the firm – also seems important in shaping additionality and could be used along with prior productivity to guide the allocation of support. Over recent years, UK innovation policy has also adopted a strong sectoral focus. Our results provide support for this focused approach, suggesting that additionality is greatest in more R&D intensive industries.

Our study is subject to a number of limitations. First, at this point we consider only the direct impacts of public grant support for R&D and innovation on firms. Spillovers or multiplier effects may significantly enlarge these effects, while displacement or competition effects may reduce them (Roper et al. 2017). Both should be considered in future studies. Second, propensity score matching does not fully eliminate concerns that unobservable factors may explain grant allocation and post-grant performances. For instance, many of the firms participating in UK Research Council-funded projects (although not all small firms) will also be receiving R&D tax credits. As no data is available on which firms receive R&D tax credits, we are unable to explicitly condition our matching on whether or not a firm receives an R&D tax credit, or on the value of any tax relief. As any additional R&D investment carried out by a firm as a result of participating in a UKRC-funded project may increase the R&D tax relief received, it is conceivable that our results may also capture the effect of this second public innovation support instrument. Third, data linking and the timing of some grant awards in recent years mean that we are able to consider growth effects for only around two-thirds of firms that participated in publicly funded science and innovation projects. Fourth, despite all the robustness tests provided to assess the overall quality of our methodological approach, our identification strategy could still be affected by unobservable endogeneity bias. Further research is needed to investigate new approaches to improve the identification strategy; in this regard information on all grants applications, including the unsuccessful ones, would greatly improve the robustness of the policy evaluation. Finally, our study focuses only on UK public support for R&D and innovation. International evidence from similar ongoing studies may provide alternative perspectives reflecting different grant allocation mechanisms and selection priorities.

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