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R&D and innovation pathways to business productivity and growth: What does the evidence suggest?

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R&D and innovation pathways to business productivity and growth: What does the evidence suggest?

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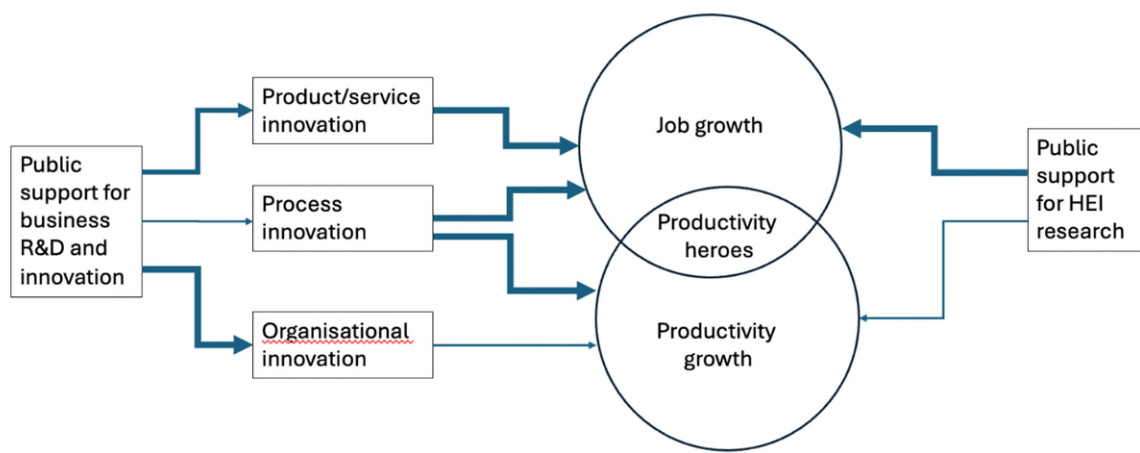
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OVERVIEW

Recent studies provide some strong evidence on the pathways through which public R&D support - for both business and university R&D - support innovation, productivity and growth. These pathways are complex. Recent work by the ERC on 'productivity heroes' emphasises the rarity of combining job and productivity growth in firms, while different types of innovation impact aspects of business performance differently. The figure below summarises the key direct linkages, although spillovers may also be important (these are discussed separately below). In the figure, bolder linkages are those which the evidence suggests are strongest.

Linking R&D, innovation and business performance



1. INTRODUCTION

In this note we consider the pathways through which investment in R&D, and the innovation it induces, can contribute to productivity and growth. The focus is on the differential impacts of privately and publicly funded R&D, the pathways from R&D to different types of innovation (e.g., product/service, process, organisational change) and how this can influence productivity and job growth.

We develop the argument following a 'value chain' approach which links R&D spending to innovation, and so to business growth and productivity:

- Section 2 lays the foundations, briefly exploring the diversity of innovation itself and the different (and weakly correlated) aspects of business performance;
- Section 3 briefly compares R&D support in the UK to that in a group of benchmark countries.
- Section 4 considers the mechanisms through which R&D (and particularly publicly supported R&D) can influence innovation, both directly and through spillovers to the wider economy.
- Section 5 considers the links between innovation and different dimensions of business performance.
- Section 6 summarises the evidence and the rather complex links between R&D, productivity and growth.

2. STARTING POINTS – DIVERSITY IN INNOVATION AND FIRM PERFORMANCE

2.1 Diversity in innovation

Innovation – which provides the primary link between R&D investments and business performance - can take a number of forms relating to firms' products or services, business processes, operating routines and organisational structures. Each might be expected to have differential impacts on the different dimensions of firm performance (Turner and Roper, 2020):

- Product or service innovation may allow firms to achieve a position of market leadership, become dominant in their product class or market, and gain first-mover advantage;
- Process innovation may enable firms to optimise elements of their operations. New processes may also allow firms to adopt more flexible production systems which may also allow firms to adopt more complex innovation strategies with potentially higher returns (Hewitt-Dundas 2004).
- Organisational innovations – changes in managerial or marketing systems or work organisation – are also likely to be linked to performance outcomes, particularly when combined with product/service or process innovations.

Exposito and Sanchis-Llopis (2018) report evidence of the impact of product/service, process and organisational innovation on the financial and operational performance of Spanish manufacturing SMEs. Based on cross-sectional survey data for 1424 SMEs they find:

- A positive correlation between product innovation, sales growth and costs;
- Few significant process effects on sales growth or costs; and,
- A negative association between organisational innovation and costs.

They conclude:

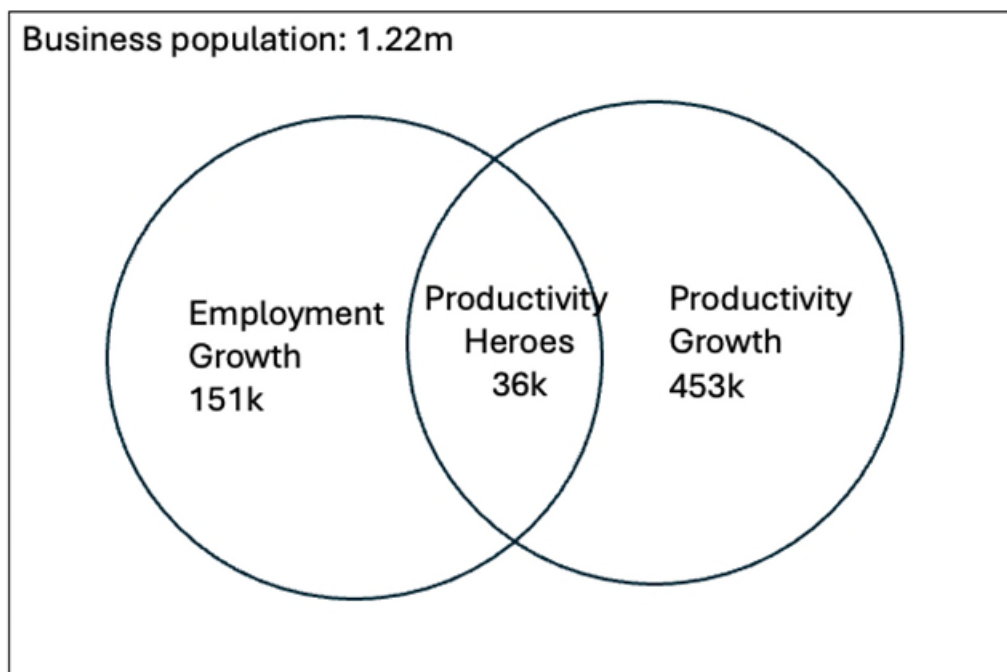
'the strength of the innovation–performance relationship depends on the type of innovation and on the performance, dimension considered ... our findings confirm that the impact of innovation initiatives on business performance should be analysed from a multi-dimensional approach' (Exposito and Sanchis-Llopis 2018, p. 925).

2.2 Dimensions of business performance

These differential impacts of R&D and innovation support on growth and efficiency are perhaps unsurprising. Previous studies have suggested the weak correlations between different performance metrics such as sales and employment growth (Chandler et al. 2009; Baum, Locke et al. 2001; Delmar et al. 2003), and growth in sales per employee. Moreover, it is clear from analyses of high-growth firms and population cohorts that high growth – on whatever metric – is rarely sustained and is therefore inherently unpredictable – the 'picking winners' problem (Coad et al. 2013; Anyadike-Danes and Hart 2018).

Recent UK analysis of ‘productivity hero’ firms also emphasises the relatively low correlation between productivity and jobs growth, and hence the potential conflict between alternative policy targets. ‘Productivity Heroes’ are defined as firms growing both their revenues and headcount but their revenues at a faster rate – hence also increasing their productivity (turnover per employee) (Hart and Bonner 2024). In 2021-22 of 1.22m businesses with employees in the UK, 453k achieved increasing productivity, 151k increased their job count, but only 36k increased both jobs and productivity (Figure 1).

Figure 1: Job growth, productivity growth and productivity heroes (2021-22)



Source: Hart and Bonner, 2024

3. R&D AND R&D SUPPORT¹

Trends in UK business R&D spend are well known and not discussed here. It is interesting, however, to briefly compare public support profiles in the UK to that in some other reference countries. Figure 2 illustrates that the UK provides a higher level of support for R&D than a group of our international competitors, increasingly through tax incentives. Figures 3 and 4 provide an indication of how relative levels of R&D support have changed over the last decade. Relative to GDP, and relative to the group of benchmark countries considered here, levels of public support for business R&D in the UK have increased sharply over recent years.

¹ This section is based on data analysis by Dr Kevin Mulligan, Queen’s University Belfast.

Figure 2: Government support for firm-level R&D (2020)

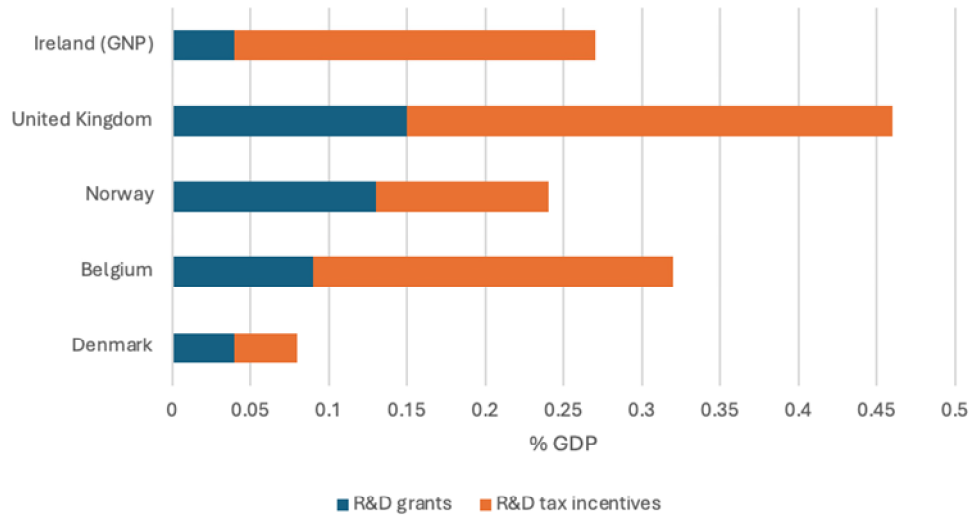
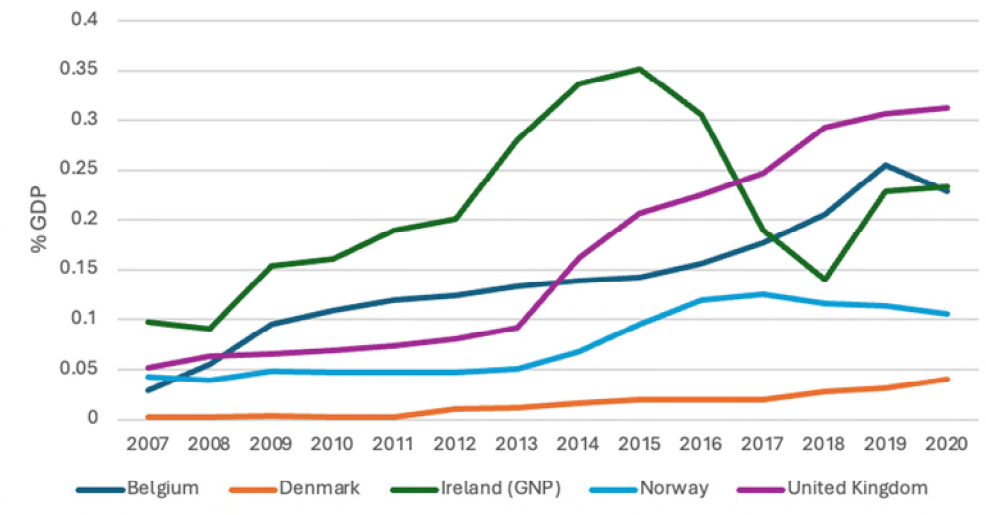
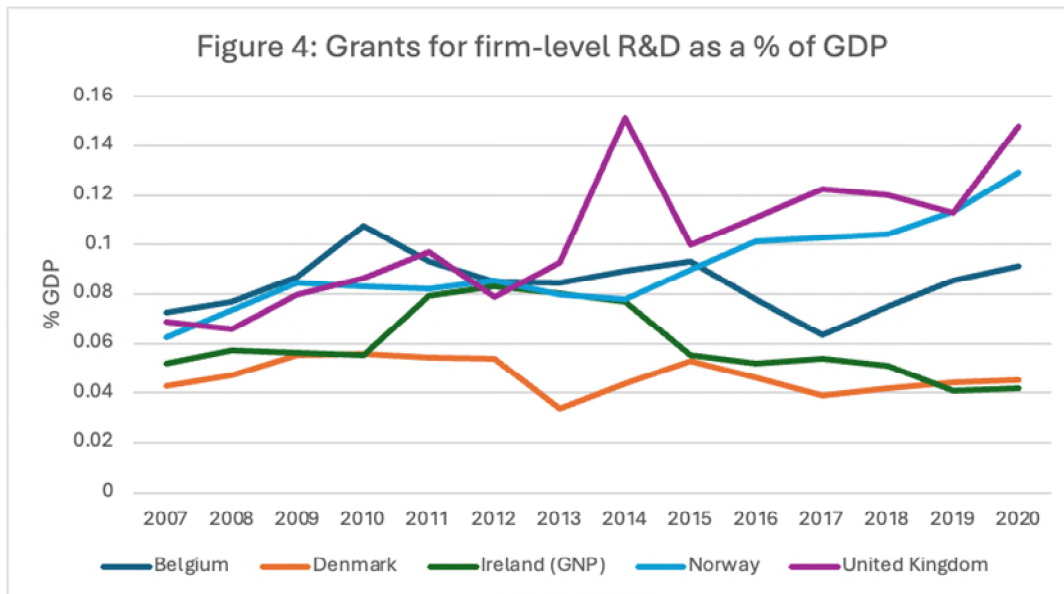


Figure 3: Tax incentives for firm-level R&D as a % of GDP





Source: OECD Tax incentives for R&D and innovation database, see: <https://www.oecd.org/innovation/tax-incentives-RD-innovation/>

4. R&D, PUBLICLY SUPPORTED R&D AND INNOVATION

There are four direct mechanisms which may link public R&D support for firms to increased innovation activity and economic performance (Vanino et al. 2019):

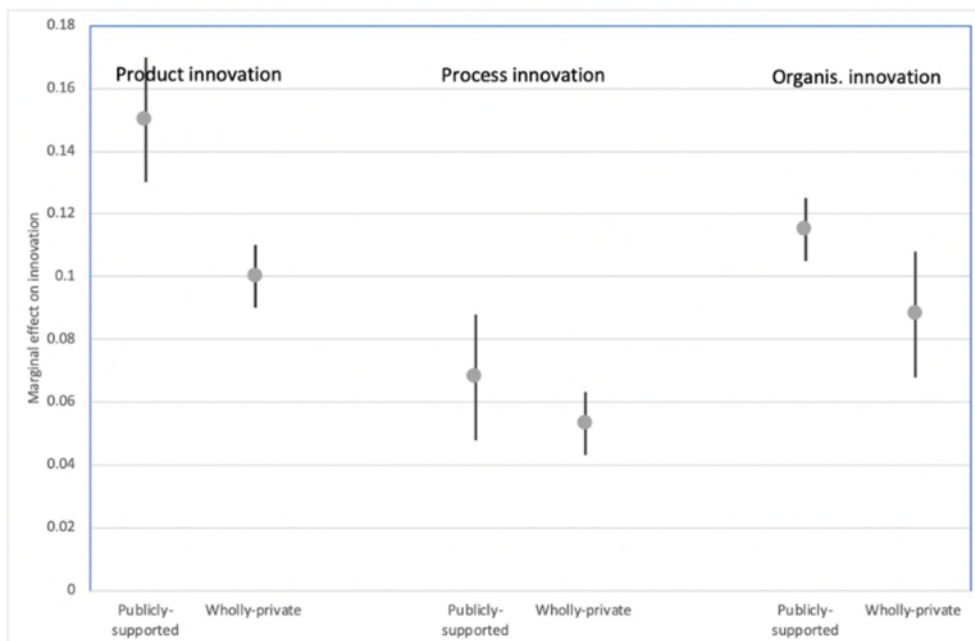
- First, public R&D support will increase liquidity and financial slack in recipient companies which may help to overcome innovation risk and increase the likelihood that a firm will undertake risky projects such as innovations (Zona 2012). Over-subsidising R&D and innovation, however, can risk grant dependency (Kilponen and Santavirta 2007).
- Second, through cost-sharing, public support for private R&D and innovation reduces the required investment and de-risks private investment. Public support may encourage firms to undertake projects with a higher risk-reward ratio, with the potential for a greater impact where rates of subsidy are higher. At the same time, there is a risk of negative selection bias if subsidy rates are high and this encourages firms to seek public support for their riskier projects.
- Third, where there are market failures, public support for innovation may have market-making objectives to address particular social or economic challenges (Mazzucato 2016). For example, there may be a particular role for public sector market-making where technologies are emergent and markets uncertain (Van Alphen et al. 2009), or where there are wider social benefits (e.g. to disadvantaged groups) from an innovation (Zehavi and Breznitz 2017).
- Fourth, public R&D and innovation support can play an enabling or bridging role, helping firms to access otherwise unavailable new or pre-existing knowledge. Innovation vouchers, for example, incentivise firms to approach knowledge providers,

something they may not have done without the voucher. At the same time vouchers incentivise knowledge providers to work with new partners who they might not have worked with otherwise (OECD 2010).

4.1 Public funding for business R&D and innovation

There is consistent evidence of the relationship between R&D, publicly funded business R&D and innovation. Turner and Roper (2020) compare the innovation effects of publicly funded business R&D in the UK based on the UK innovation survey. They find that where a firm's R&D is publicly supported spending is greater and the impacts on product/service, process and organisational innovation are stronger. Figure 5 below profiles these effects providing point estimates and confidence intervals. Notably the effects of publicly supported R&D on product/service innovation are notably stronger than those on process change.

Figure 5: Firm R&D and different types of innovation



Source: Turner and Roper (2020), Figure 1.

4.2 Public funding for HEI R&D and business performance

Support for R&D in HEIs in the UK is provided primarily through UKRI. Models of support differ, widely however, which may influence channels through which firms benefit from R&D support:

- Where support is provided as innovation grants or loans through Innovate UK firms benefit from both financial and knowledge advantages;
- Where support is provided through other Research Councils firms do not benefit directly from financial advantages but do derive benefits from participating in collaborative projects.

Table 1 summarises evidence on the impact of this support on business growth in jobs and sales. Both are significant whether support is provided directly to firms or through collaborative projects. Evidence on productivity effects is limited but the similarity between the employment growth and turnover growth effects suggests that any productivity (turnover per employee) effects are likely to be weaker than those on growth. This result is reflected in European evidence from Italy and Finland is more equivocal, identifying positive growth effects (in employment and assets) from public R&D support but providing little evidence of positive efficiency effects (Bayona-Saez et al. 2010; Karhunen and Huovari 2015).

Table 1: Impact of participation in publicly funded R&D and innovation projects by different Research Councils

	EPSRC		Innovate UK		MRC		Other RCs	
	ST	MT	ST	MT	ST	MT	ST	MT
Employment	0.0618** (0.0239)	0.242*** (0.0428)	0.0437*** (0.0102)	0.165*** (0.0204)	0.0556 (0.0472)	0.317*** (0.0748)	0.0198 (0.0302)	0.232*** (0.0568)
Turnover	0.163*** (0.0441)	0.266*** (0.0741)	0.0353* (0.0198)	0.175*** (0.0388)	0.156 (0.117)	0.230 (0.170)	0.00653 (0.0592)	0.179 (0.110)
No. Treated	931	723	4160	2471	199	172	426	291

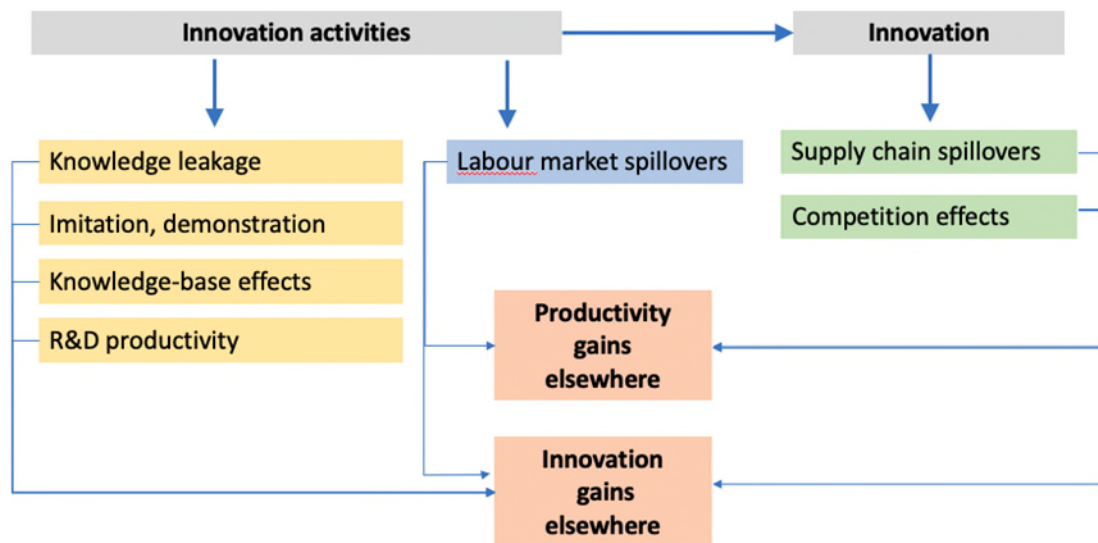
Source: Vanino et al. (2019), Table 13.

4.3 Spillovers

Beyond the immediate recipients of public support for R&D, the empirical literature provides consistent evidence of the positive benefits of spillovers both to innovation (in other firms) and productivity (See Ozusaglam et al. 2023 for a recent review). Knowledge spillovers which may influence innovation (I2I) or productivity (I2P) in other organisations beyond the innovator occur through three main mechanisms (Figure 5):

- From firms' innovation activities ('process spillovers') which lead to the introduction of that innovation – effects which will be largely I2I spillovers. This may be knowledge leakages, imitation or demonstration effects, knowledge-base effects or work through increased R&D productivity.
- From the innovation itself ('innovation spillovers') – effects which may influence both innovation (I2I) and productivity (I2P) in other firms and occur either through supply chain linkages or – potentially negative - competition effects.
- Spillovers ('labour market spillovers') may also occur through the labour market as knowledge moves between enterprises as a result of job changes. Again, labour market spillovers may be either I2I or I2P.

Figure 5: Spillover mechanisms



This supports the general case for public intervention to support private sector R&D and innovation due to resulting spillovers. Studies also suggest a range of factors which may either intensify or reduce the effect of innovation and productivity spillovers in any particular context. Evidence suggests that strong connectivity and co-location between assisted and other firms supports stronger spillovers. Technological proximity is likely to have a similar effect. Another key metric is the level of absorptive capacity of recipient firms. This latter point may be particularly significant in the UK, potentially limiting the spillover benefits from public investments in R&D and innovation. This is suggested by evidence from the Global Innovation Index 2022 which suggests that while the UK ranks 4th overall in terms of the strength of its innovation activities, the absorptive capacity of UK firms ranks only 30th globally². This disparity in ranking is partly attributable to relatively low levels of ICT services imports, net inflows of FDI and a relatively low level of research talent in UK firms.

5. FROM INNOVATION TO BUSINESS PERFORMANCE

Innovation itself is, however, of little interest until it either generates value added for firms or consumers, and/or benefits for the environment or individuals' quality of life. However, as suggested earlier 'innovation' is itself very varied with potentially different impacts on performance. Table 2 reflects the impacts of different types of innovation on growth and productivity (efficiency), as well as the timing of these effects, based on an analysis of the UK Innovation Survey (Turner and Roper, 2020):

- Product or service innovation has a positive relationship to employment growth but a negative effect on sales growth and efficiency growth after two years. These effects are short-term becoming weakly positive four years beyond the date at which innovation is measured.

² See <https://www.wipo.int/edocs/pubdocs/en/wipo-pub-2000-2023-en-main-report-global-innovation-index-2023-16th-edition.pdf>.

- Process innovation has a positive effect on both efficiency growth and turnover growth in the short term. Employment growth effects are insignificant initially but positive and significant four years after innovation is measured.
- Organisational innovation has a positive sales-growth effect, a negative employment-growth effect and a net-positive efficiency effect. These effects persist for efficiency growth and employment growth but are far weaker four years after innovation is measured.

Table 2: Innovation effects on efficiency growth, turnover growth and employment growth

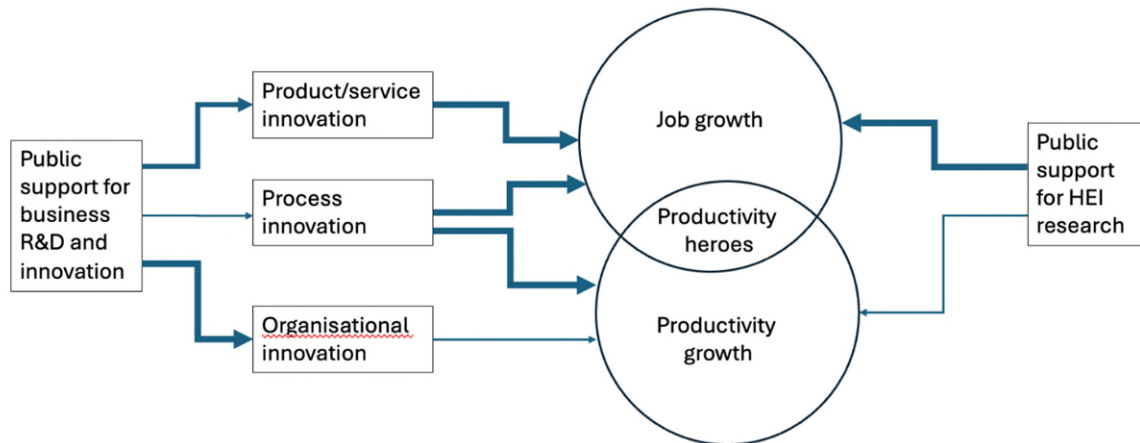
	Innovation type	Efficiency growth	Turnover growth	Employment growth
One wave lag				
	Product	- ***	- ***	+ **
	Process	+ ***	+ ***	+
	Organisational	+ ***	+ **	- ***
Two wave lag				
	Product	+	+	+ *
	Process	-	+	+ ***
	Organisational	+	-	- ***

Notes: * denotes significance at the 10 per cent level, ** denotes significance at the 5 per cent level and *** denotes significance at the 1 per cent level. Source: Turner and Roper (2020), Table 6.

6. FROM R&D TO PRODUCTIVITY HERO

Previous sections have summarised the evidence on R&D, innovation and business performance. Figure 6 provides a stylised summary of the existing evidence with stronger links represented by bolder arrows. This figure draws in particular on evidence from Turner and Roper (2020), Vanino et al. (2019) and Hart and Bonner (2024). It represents the direct effects from public support for R&D and innovation which will also generate positive spillovers (see Figure 5).

Figure 6: Linking R&D, innovation and business performance



Public support for business R&D and innovation in the UK has weaker effects on process than on product/service innovation. This may reflect the emphasis in Innovate UK support towards leading edge innovation. In some other countries targeted process and/or organisational innovation programmes have been introduced (e.g. the INNOVIRIS scheme in Belgium). Links from product/service innovation seem stronger on growth than on productivity. Process innovation, and to some extent organisational innovation, seem more likely to support Productivity Heroes and productivity growth. Public support HEI research also has strong growth effects but there is less evidence of any strong effect on productivity.

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