Cut to the chase

productivity hub

R&D expenditure and innovation by Kiwi firms

Productivity Commission Working Paper 2015/2 and Motu Working Paper 15-08, June 2015

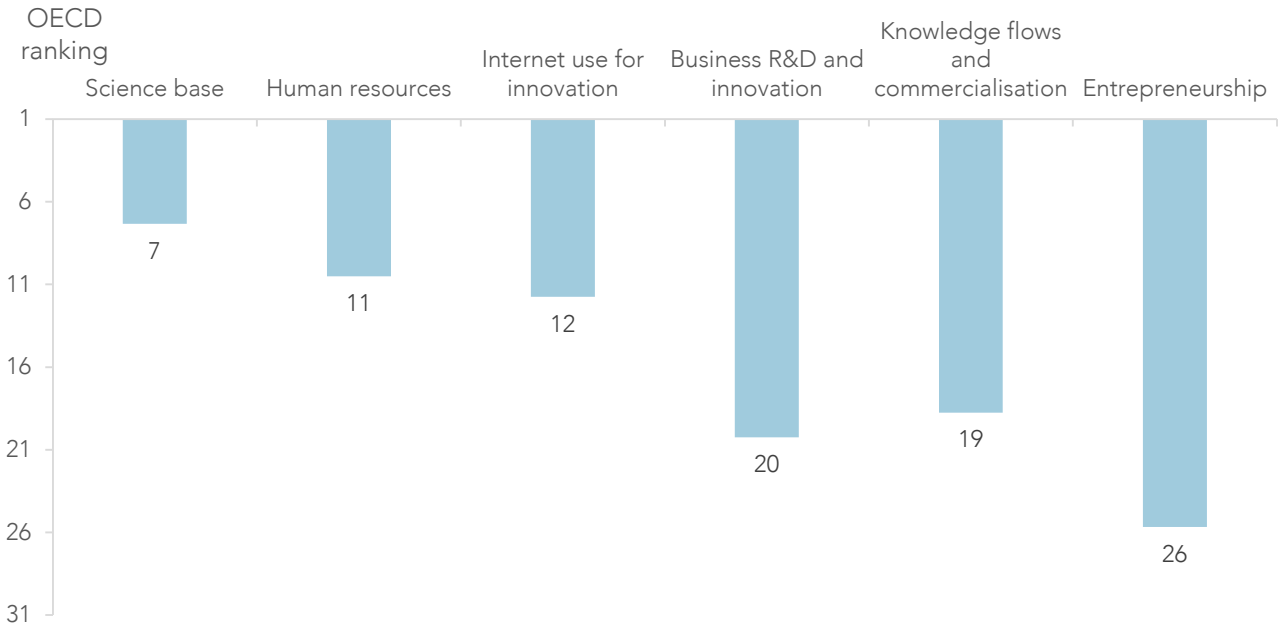
This Cut to the Chase discusses two working papers on innovation produced under the Longitudinal Business Database Partnership: "Measuring the innovative activity of New Zealand firms", by Simon Wakeman (NZPC) and Trinh Le (Motu), and "The impact of R&D subsidy on innovation: A study of New Zealand Firms" by Motu researchers Adam Jaffe and Trinh Le. The Longitudinal Business Database Partnership is a collaboration between Productivity Hub agencies – the Productivity Commission, the Ministry of Business, Innovation and Employment, Statistics New Zealand and the Treasury – and Motu Economic and Public Policy Research.

The importance of innovation

Innovation is a key driver of productivity growth. Innovation allows firms to generate more with less – increasing economic wealth while consuming fewer resources. Despite a supposed "number 8 fencing wire" attitude, New Zealand does not perform particularly well at innovation. An OECD paper published by the Productivity Commission estimates that as much as 40% of New Zealand's productivity gap compared to the OECD average is arguably the result of low investment in knowledge-based capital, including innovation.

This is backed up by international comparisons that show New Zealand ranks highly in generating ideas but New Zealand firms invest relatively little and perform poorly in commercialisation. Figure 1 shows New Zealand's average ranking in the top-level categories of OECD innovation indices, ordered by where they sit on the spectrum from idea generation to commercialisation. It shows New Zealand slipping down the OECD rankings on indices further down the commercialisation chain.

Figure 1: New Zealand's average ranking in top-level categories of OECD innovation indices



Source: OECD (2012). Comparative performance of national science and innovation systems.

Motu

NEW ZEALAND PRODUCTIVITY COMMISSION
Te Kōmihana Whai Hua o Aotearoa

Understanding innovation at the firm level

Although the aggregate data suggests that investment in innovation by New Zealand firms is relatively low, there is limited recent evidence on innovative activity and performance at the firm level. Using data from Statistics New Zealand's Longitudinal Business Database (LBD), it is possible to develop an understanding of innovation at the firm level. This database links information from tax records, trade data, a variety of surveys, patenting and trademark activity, and government programmes over a number of years to create a comprehensive picture of the activity and performance of New Zealand firms. The rich information in the LBD not only provides a range of alternative innovation measures, but also makes it possible to construct a detailed picture of each firm and examine how innovative activity varies across a range of firm characteristics.

Firm-level innovation begins with the firm generating innovative ideas in a number of ways, including spending money on research & development (R&D) and capturing insights from front-line employees and customers. To generate commercial value from these ideas, the firm needs to turn them into new goods and services, operational processes, marketing methods, etc.

Ultimately, firms realise a return to innovation from increased revenue or lower costs, contributing to profit growth. The economy and society more generally benefit not only from the better products generated from innovation, but also the knowledge that spills over from R&D investment and innovation to other firms and individuals. These innovation spillovers are the reason governments intervene to encourage innovation by firms.

Innovation is not a mechanical process of simply turning inputs into output. Instead it involves a complex interaction of elements from within and outside the firm. To be successful, innovating firms need not only to be able to generate ideas and turn them into products via internal R&D, but also to absorb ideas and knowledge from their environment (universities, customers, suppliers, and even competitors) and to connect the products they generate with the needs of others. This requires not just research and product development capability, but also the expertise within management to orientate the organisation towards absorbing new ideas and tailoring them to the market. Moreover, an innovating firm often depends on being surrounded by others at the top of their game and feeding off the spillovers those others generate. Successful firms are typically part of a whole ecosystem of organisations oriented towards innovation.

Indeed, as Wakeman and Le show, the share of New Zealand firms engaged in innovation can range from 0.2% to 40%, depending on which aspect of innovation is being measured. Most noticeably, a much higher proportion of firms report generating innovation outputs, such as new goods and services and new operational processes, than investing in the inputs to innovation, such as engaging in R&D activity or registering a trademark.

Nevertheless, it is typically much easier to measure innovation inputs (R&D expenditure) than innovation outputs (new goods and services, operational processes, etc.). Less tangible aspects such as management capability and the strength of the innovation ecosystem are even more difficult to measure. This presents a challenge both for research and for policy. For example, data availability (specifically on R&D) means that there is considerable international evidence on the impact of R&D subsidies on firms' innovation input (e.g., on investment in R&D, tangible assets or employment). However, much less is known about the impact of R&D subsidies on firms' innovation output.

Similarly, because R&D expenditure is the easiest quantity to measure, and appears most frequently in international comparisons, innovation policy often pays a lot of attention to raising (business) R&D expenditure. Although there is clearly a link between R&D expenditure and innovation output, the correlation is not perfect and there are a number of other factors that need to come together for a firm to successfully innovate.

The innovative activity of New Zealand firms

Wakeman and Le found that innovation rates varied across time and by firm characteristics, but across the various measures the patterns differed. These patterns, summarised in Table 1, reveal some noteworthy facts.

Table 1: Patterns of innovation across time and by firm characteristics

	Innovation inputs		Innovation outputs		
	R&D intensity (R&D expenditure as % total expenditure)	R&D activity (% of firms engaged in R&D)	Sales from new goods & services (% all sales)	Introduced new goods & services (% of firms)	Introduced new organisational processes (% of firms)
Average rate	0.1	7.8	2.7	19.3	22.5
Time trend	Increasing (until 2011)	Increasing to 2011, then decreasing	Decreasing over time	Decreasing over time	Decreasing over time
Size	Highest among SMEs	Increasing with size	Decreasing with size	Increasing with size	Increasing with size
Age	Decreasing with age	Invariant with age	Decreasing with age	Decreasing with age	Decreasing with age
Foreign owned	Higher for foreign owned	Higher for foreign owned	Higher for foreign owned	Higher for foreign owned	Higher for foreign owned
Exporting status	Higher for exporters	Higher for exporters	Higher for exporters	Higher for exporters	Higher for exporters
Industry	Highest in *Machinery & Equipment Manufacturing* and *Property & Business Services*	Highest in *Petroleum, Coal, Chemical & Associated Manufacturing* and *Machinery & Equipment Manufacturing*	Highest in *Machinery & Equipment Manufacturing*	Highest in *Food, Beverage & Tobacco Manufacturing* and *Machinery & Equipment Manufacturing*	Highest in *Other Services*

Source: Wakeman & Le (2015) "Measuring the innovative activity of New Zealand firms".

R&D expenditure and activity is increasing while innovation output is decreasing

The proportion of firms engaged in R&D activity and R&D intensity increased over time (at least until 2011), but both the proportion of firms generating innovation outputs and the percentage of sales from new goods and services declined. Although this analysis does not provide conclusive evidence, this suggests that the productivity of the innovation process at the firm level may have declined.

Smaller, younger firms are more innovative

Although a higher proportion of larger firms are both introducing new innovations and investing in innovation inputs, on the measures adjusted for firm size – the percentage of sales from new goods and services and R&D intensity – smaller firms had higher rates of innovation. In general, younger firms were more likely to innovate than older firms. This is consistent with international evidence showing that innovations are often brought to market by new firms.

The extent and type of innovative activity varies by industry

R&D activity and patenting activity was highest in the manufacturing industries, and firms in those industries were also more likely to introduce new goods and services and operational processes. By comparison, firms

in the services sector were just as or more likely to introduce new organisational processes and marketing methods.

There is more to innovation than R&D

The correlations between the different measures showed only a loose connection between the percentage of expenditure that goes on R&D (i.e., R&D intensity) and either whether a firm generates new innovation or the percentage of sales that come from goods and services new to the firm. Even in those industries in which we would expect R&D to matter the most, R&D intensity did not appear to be closely related to the rate of innovation output. Moreover, R&D intensity followed different patterns across time, and with respect to age, region and industry than output measures. This indicates that R&D intensity does not provide a good overall proxy for the innovation rate of New Zealand firms.

There was a fairly high overlap between the set of firms engaged in R&D activity and those generating the various types of innovation output. This suggests that whether a firm is engaged in R&D – or, at an aggregate level, the proportion of firms engaged in R&D – may tell us more about the level of innovation in the economy than R&D intensity. Nevertheless, the R&D indicator did not follow the same patterns across firm characteristics as the innovation output measures, suggesting that it is not a sufficient proxy for innovation either. To properly capture innovation we need to look at multiple measures, including those that reflect the less technological forms of innovation such as organisational processes and marketing methods.

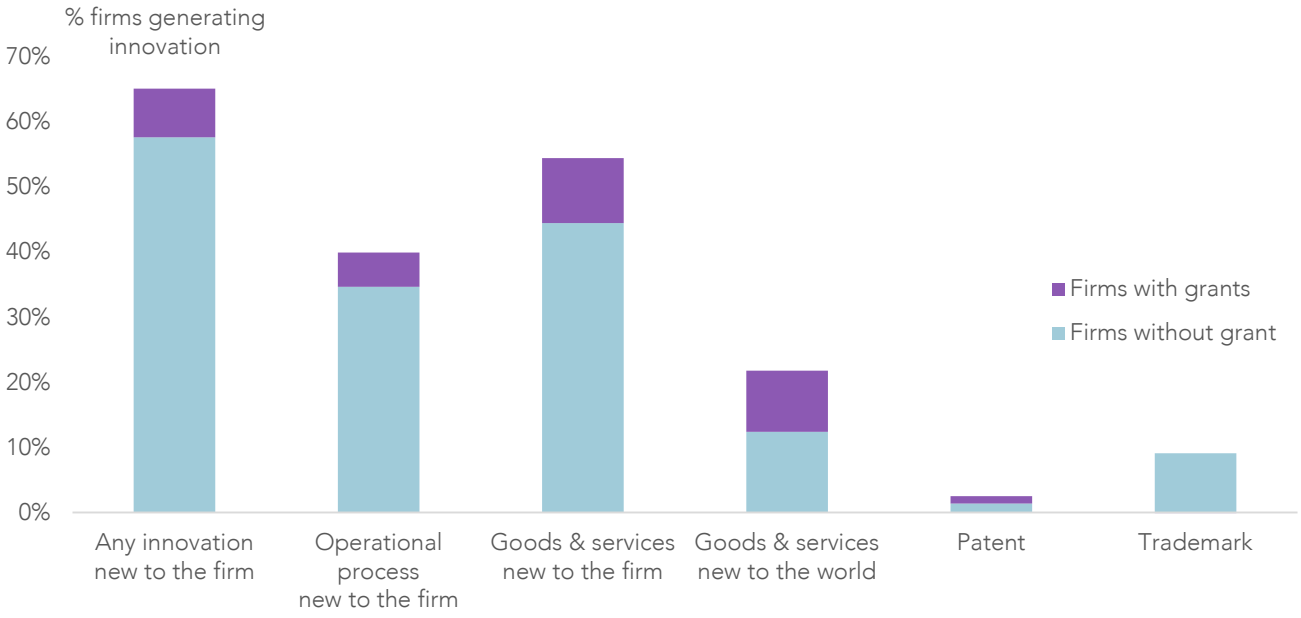
The impact of R&D grants on innovation

Jaffe and Le examined the impact of R&D grants on innovation output for firms in New Zealand, and made the following key findings.

R&D grants increase the likelihood of filing patents and introducing new goods and services

Although a portion of the superior innovation performance by grant-receiving firms observed reflects selection – that is, more innovative firms were more likely to get grants – there appeared to be a causal effect of receiving a grant on innovative performance. More specifically, they found that receiving a R&D grant almost doubled the probability that a firm introduces goods and services new to the world, but had a much weaker effect on introducing goods and services new to the firm or new operational processes (Figure 2). Moreover, the receipt of a R&D grant significantly increased the probability that a firm applies for a patent, but there was no impact on the probability of applying for a trademark. R&D project grants had much larger effects than R&D capability-building grants, but there is no evidence that receiving a R&D grant has any different effect on small-to-medium vs. larger firms.

Figure 2: The impact of R&D grants on innovation outputs



Source: Jaffe & Le (2015). The impact of R&D subsidy on innovation: A study of New Zealand firms.

R&D grants may divert resources from organisational and marketing innovation towards product innovation

An interesting, secondary finding of the analysis was that while R&D grants had a positive and significant effect on introducing product innovation, they had no effect on organisational or marketing innovation. By contrast, receiving a NZTE Enterprise Training Programme (ETP) grant, which is aimed at upskilling the owners and operators of small-to-medium enterprises to help them develop and grow their businesses, showed significant effects on organisational and marketing innovation among the same set of firms (albeit with a smaller effect on product innovation). There was not enough evidence to conclude that firms receiving R&D grants were less likely to engage in organisational or marketing innovation, relative to firms that did not receive a grant. Nevertheless, the choice to spend resources on R&D grants instead of the ETP (or another commercially focused grants) may be directing firms toward product innovation instead of organisational or marketing innovation.

Even if R&D grants increase innovation, they may not raise firm economic performance

A previous study by the Ministry of Economic Development (MED) in 2011 examined whether the R&D grant programme increased the recipient firm's sales, employment and productivity. That study found some evidence that R&D capability-building grants had an impact on performance, but no evidence that R&D project grants had an impact. Moreover, the positive impact was limited to small firms, with no evidence that grants had an impact for larger firms. While Jaffe & Le find evidence that R&D grants increase innovation, they do not necessarily contradict the finding from the earlier MED study that they do not improve overall firm performance.

How could R&D grants increase firm innovation but not improve overall firm economic performance? One explanation is that the link between innovation and firm economic performance is so highly variable, the lag is so long, or the innovation measures are such poor proxies that the effect cannot be detected. However, an alternative is that innovation is not a sufficiently important determinant of firm economic performance to have an effect – or perhaps there is not even a relationship between R&D grants and "true" innovation (and hence no effect on economic performance), and employees of grant-receiving firms are simply rationalising having received a grant by saying that they are innovating even if they are not. These alternative explanations obviously have different implications for the policy effectiveness; the former suggests R&D grants may be an effective tool for improving economic performance, while the latter implies they are not.[1]

What next?

Ultimately, we wish to understand what drives firm productivity and/or performance. Wakeman & Le described the different measures of innovation, and pointed to a divergence in the patterns that appear with the input-based measures of innovation (particularly R&D intensity) and the output-based measures, but provided no evidence about the relationship between the different measures of innovation and firm performance. Similarly, Jaffe & Le provided evidence that R&D project grants are a valuable policy tool for increasing innovation output, but did not examine the effect on firm economic performance. However, as they note, innovation is only an intermediate outcome and the ultimate policy goal must be increased productivity and sales of improved products.

Work is now underway to examine the relationship between R&D grants and a set of firm-level performance measures. This will give us better evidence on whether – and where – R&D grants have an effect on firm economic performance. This work will also examine the relationship between innovation and firm performance – in particular, whether there is a causal link between innovation (as measured) and performance variables such as revenue growth, profitability, and labour and multi-factor productivity. This research aims to provide valuable guidance as Callaghan Innovation ramps up its R&D support programmes, and the Government refines its innovation policy to help drive the economic performance of New Zealand firms.

Full paper and related research available from www.productivity.govt.nz/research or www.motu.org.nz

[1] It is important to note that these studies only reviewed the effects of discretionary grants from 1995-2013, and did not consider the effects of non-discretionary grants in place since 2013.

About the Productivity Commission

The Commission – an independent Crown Entity – completes in-depth inquiry reports on topics selected by the Government, carries out productivity-related research, and promotes understanding of productivity issues.

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About the Productivity Hub

The Productivity Hub is a partnership of agencies which aims to improve how policy can contribute to the productivity performance of the New Zealand economy and the wellbeing of New Zealanders. The Hub will achieve this by connecting people, shaping research agendas and sharing research.

The Hub Board is made up of representatives from the Productivity Commission, the Ministry of Business, Innovation and Employment, Statistics New Zealand and the Treasury. Several other agencies and non-government groups are active in the partnership.