Cut to the chase

productivity hub

Understanding the productivity of New Zealand firms

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This *Cut to the Chase* highlights three recent papers that use firm-level data to understand better the productivity of New Zealand firms: "Firm productivity growth and skills" by David Maré, Dean Hyslop and Richard Fabling; "Production function estimation using New Zealand's Longitudinal Business Database" by Richard Fabling and David Maré; and "Addressing the absence of hours information in linked employer-employee data" by Richard Fabling and David Maré. These papers are a product of the Productivity Hub's Longitudinal Business Data Research Partnership with Motu Economic and Public Policy Research.

Building an evidence base for lifting productivity

New Zealand has a poor productivity track record and lifting productivity is a key economic challenge. Since forming in 2012, the Productivity Hub has implemented an ambitious research programme aimed at understanding better the reasons for New Zealand's generally poor productivity performance. This has included research across several areas relevant to understanding the productivity of New Zealand firms, including: the innovation ecosystem; skills, migration and demographic change; natural and intangible assets; and the efficiency with which resources are allocated across firms.[1]

The Productivity Commission is also drawing on this research to write a "productivity narrative" that outlines the big-picture causes of New Zealand's generally low productivity and the broad policy considerations needed to turn this around.

Good research requires good data

Insightful economic research is built on good data. There are two complementary sources of data used in productivity analysis. First, official productivity statistics that use internationally-agreed techniques provide consistent and reliable productivity measures for whole industries and the total economy. Second, increasingly available microdata and improvements in computer processing power make it possible to estimate the productivity of individual firms in the economy.

Statistics New Zealand's Longitudinal Business Database (LBD) is a world-leading, integrated microdata set covering most New Zealand firms. Having access to firm-level data provides researchers with a degree of resolution that isn't possible with aggregate data. This greatly enhances the range of questions that can be investigated and opens up a wealth of policy-relevant research into the economic forces influencing firm productivity. The LBD's extensive administrative and survey data – including the *Business Operations Survey* – provides rich information on firm characteristics.

Firm-level data make it possible to investigate the impact of many firm and industry features on productivity. Across firms, this could include whether a firm is foreign owned or exports, its management capability, its investment in R&D, and its use of technology and innovation. At the industry level, the data can be used to assess the impact of competition or regulatory conditions on the productivity of firms in a particular industry.

The LBD also contains data on firm location, making it possible to investigate productivity differences across firms in different parts of the country. Anonymised data also exist on various characteristics of the people that work for each firm. This makes it possible to investigate a range of issues, including the impact of worker

[1] For a full description of the Hub's research agenda, see Nolan (2014) "Lifting New Zealand's productivity: a research agenda", Policy Quarterly, Vol. 10, Issue 2.

skills and experience (discussed below) and how productivity can "spill over" as individual workers move from one firm to another.

Reliable measures of firm productivity are a key requirement across much of the Productivity Hub's research agenda. The three papers covered in this *Cut to the Chase* make vital contributions to meeting this requirement. They describe the data and methods used to calculate firm productivity in the LBD. One of the papers has an application: using the data to understand better the link between employee skills and firm productivity.

Measuring the productivity of firms

Productivity measures how well firms convert inputs into outputs. The simplicity of productivity as a concept belies the practical difficulties of defining and measuring the productivity of firms in the LBD.

In the case of a single productive input, the idea of productivity translates quite naturally into measures such as a firm's labour productivity – the value add per employee created by the firm. It is relatively easy to calculate labour productivity and evaluate whether it is high or low for individual firms.

More sophisticated productivity measures – collectively called multi-factor productivity (*mfp*) – assess value added relative to a broader range of inputs, such as the productive capital of the firm. A simple ratio of outputs to inputs could still be used to compare productivity across firms that use identical input mixes. However, in the more realistic case of firms that use different input mixes, measuring the productivity of different input-output combinations requires an understanding of the production processes that firms use to transform inputs into outputs.

Economists model production processes (or technologies as they are sometimes called) by means of production functions. These are then used, in conjunction with data on inputs and outputs, to estimate the multi-factor productivity of firms. Because technologies differ across firms, production functions are usually estimated across groups of firms that are likely to use similar technology, which is usually taken to be firms in the same industry. The *mfp* of a particular firm is measured relative to an industry benchmark. A firm with high *mfp* is one that produces more output than other firms in its industry, allowing for the quantity of inputs used and given benchmark industry technology.

Production functions can be set up in a number of different ways and tailored to answer specific questions about technology or features of market structure (such as imperfect competition). Another consideration in estimating firm productivity is the number of productive inputs to take into account. In general, the more inputs included, the more inter-firm differences are captured in the industry benchmark and the less will be attributed to firm *mfp*. In this sense, *mfp* is a residual measure of firm output that that cannot be attributed to firm characteristics and the inputs it uses.

The data on productive inputs

Measuring the inputs and outputs of firms presents another formidable practical challenge. In practise, the range of outputs produced by a firm are summarised into a single index. Similarly, the diverse inputs used to produce output are generally classified into a few generic input types – typically under the headings of capital, labour and intermediate inputs.

Productivity is about the relationship between the *physical* quantities of inputs and outputs used by firms. However, with the exception of labour input – for which data on the number of employees at each firm is available – the data in the LBD are derived from anonymised accounting information on each firm's revenue from selling outputs and expenditure on buying inputs. Because firm-level price data do not exist, price indices at the industry level are used to convert these accounting measures into quantity indexes.

There are two main sources of accounting data for firms in the LBD. The *Annual Enterprise Survey* (AES) is the benchmark data source used to estimate firm productivity. However, AES is based on a declining sample of New Zealand firms. To plug the gaps, account summaries that firms provide to the Inland Revenue Department on their IR10 forms are used.

Some modelling, imputation and other adjustments are used to improve data consistency across these two primary sources. Firm-level modelling is also used to estimate capital within firms.

Inevitably, despite all care being taken, some anomalies will remain in the data. To further improve signal and reduce noise, pragmatic rules are used to identify and remove data of questionable quality. This leads to a loss of about 4% of annual observations, leaving an average of around 190,000 firms per year over the period 2000-2013.

Using the productivity data

The above methods generate a consistent productivity dataset across a large number of New Zealand firms. The dataset includes firms of all sizes, including sole-proprietor firms that do not have any employees. The industry coverage of firms in the dataset is also extremely broad, covering the primary, manufacturing and services sectors. This contrasts to firm-level datasets in other countries that often cover only large firms in the manufacturing sector.

Robustness and sensitivity

As discussed above, estimating *mfp* involves important choices about the production function and data. They include decisions on the number of inputs that are controlled for and the way in which the benchmark technology is captured in the production function.

Given the importance of these choices, firm-level *mfp* estimates need to be interpreted in the context of the assumptions made in their construction. Accordingly, it may be wise for researchers to check the sensitivity of their empirical results to different data sources and the form of the production function. This is not so much a question of which approach is right or wrong, but about understanding the consequences of the choices being made.

As it happens, productivity estimates across firms that are calculated using different production functions and estimation techniques turn out to be highly correlated. When aggregated, estimates of productivity growth at the firm level are also broadly consistent with official aggregate productivity growth estimates. While this gives some confidence in the robustness of firm-level productivity estimates based on the LBD, it does not obviate the need for care and sensitivity analysis.

Worker skills and firm productivity

Productivity estimates are typically based on the *quantity* of labour used by firms to produce output. However, the characteristics of a firm's workers also have an important influence on productivity, with different types of labour impacting differently on the technologies that firms adopt and their performance more generally. Because data on individual workers are linked to the data on firms in the LBD, it is possible to construct a measure of the *quality* of a firm's labour force and measure the impact of this on productivity.

The measure of worker quality – which is derived from earnings data – reflects the bundle of skills, qualifications and experience of individual workers. As such, it picks up a broader range of worker attributes beyond qualifications.

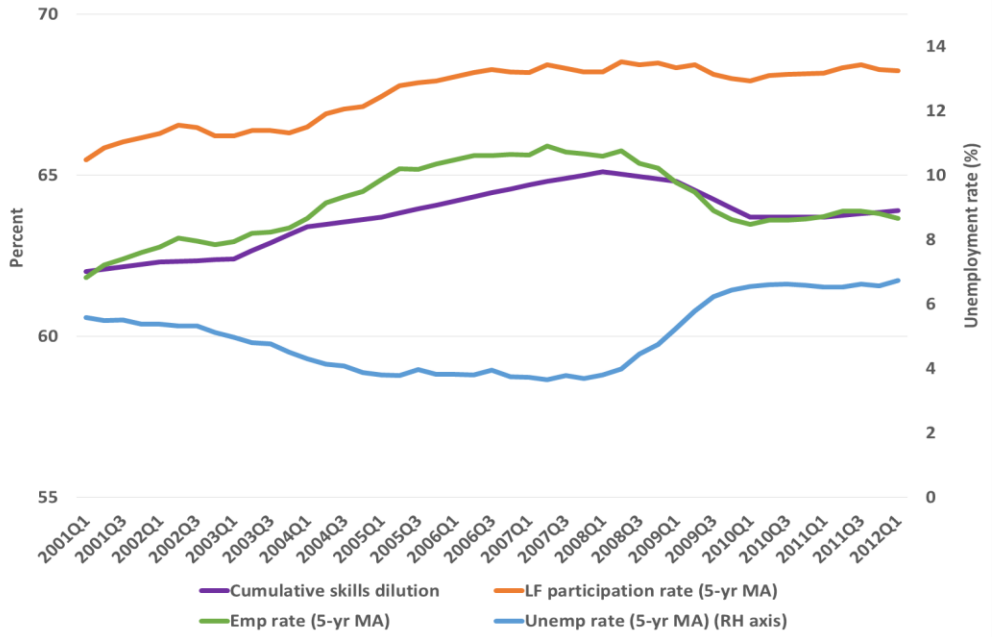
Based on this measure, the average quality of the New Zealand work force declined slightly by 1.8% from 2001-2012. The fall was particularly pronounced in the business cycle upswing that preceded the Global Financial Crisis that began in 2008.

This somewhat surprising decline in the average quality of New Zealand workers reflects the net result of two opposing forces. First, average skills increased due to ageing (ie, greater experience) and rising qualifications. For example, the share of tertiary qualified workers grew from 15% to 25% while the share of workers with no qualifications fell from 19% to 14% between 2001 and 2013. At the same time, full-time equivalent employment increased strongly by around 15% (Figure 1). The large number of new workers who came into the labour market had, on average, lower skills than existing workers. This lead to a dilution in worker quality that more than offset the improvement in qualifications and experience.

Of course, getting low-skilled workers into jobs is important to improving wellbeing and testament to the benefits of New Zealand's relatively flexible labour market. It also provides part of the explanation for New Zealand's generally low productivity growth. Adjusted for quality, labour input in New Zealand grew by 13.3% from 2001 to 2012, as opposed to 15% in unadjusted terms. Slower growth in quality-adjusted labour

input translates into faster growth in *mfp*. Specifically, *mfp* growth adjusted for changes in worker quality increased by an average of 0.24% per year compared to 0.14% per year for the unadjusted measure.

Figure 1: Skill dilution and the employment rate



Data access

The measures of firm productivity derived from the LBD provide an important foundation for a broad range of policy-relevant research being conducted by the Productivity Hub and others. The dataset of firm-level productivity produced through this work is available for use within Statistics New Zealand's secure microdata environment by researchers working for selected government agencies. Access for research purposes is permitted under strict provisions that maintain the confidentiality of firms and workers.

The three papers covered in this CTTC are available at www.motu.org.nz.

About the Productivity Commission

The New Zealand Productivity Commission – an independent Crown entity – conducts in-depth inquiries on topics selected by the Government, carries out productivity-related research, and promotes understanding of productivity issues.

Email us: info@productivity.govt.nz Follow us on Twitter: @nzprocom

About Motu Economic and Public Policy Research

Motu Economic and Public Policy Research Trust is an independent economic research institute which never advocates an expressed ideology or political position. A charitable trust, Motu is founded on the belief that sound public policy depends on sound research accompanied by reasoned discussion.

Email us: info@motu.org.nz Follow us on Twitter: @moturesearch

About the Productivity Hub

The Productivity Hub is a partnership of agencies which aims to improve the contribution of policy 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.